Description of Courses

CBE571 Energy Engineering

To study on the general energy engineering principles, the current status of alternative energy development and the overall coal energy utilization (pyrolysis, combustion, gasification, liquefaction) processes in this course.

CBE591 Special Lectures in Chemical and Biomolecular Engineering

This course aims to deliver special and important topics in the field of Chemical and Biomolecular Engineering for both undergraduate and graduate-level students. The course is not only for graduate school students, but also for undergraduates to deepen their knowledge as the course covers advanced contents of undergraduate courses.

CBE771 Advanced Electrochemical Engineering

Basic principles of electrochemistry including thermodynamic, electrochemical reaction, charge transport, and mass transport are to be explained. Based on understanding of these electrochemical principles, the design and analysis technologies for various electrochemical systems including sensors, fuel cells, secondary batteries, and capacitors are to be studied. (Prerequisite course : CBE371)

MS617 Solid-State Electrochemistry

Electrochemical means of converting and storing energy have great promise as alternative energy options for transportation and stationary applications due to their superior efficiencies. In this class, students will learn fundamental concepts of solid-state chemistry, defect chemisttry and electrochemistry based on materials science and further focus on the understanding of the operation mechanism and the material requirements of various solid-state electrochemical devices, including fuel cells and batteries.

MS626 Physical Properties of Energy Materials

This course deals with key physical phenomena and properties in elementary materials applied in energy storage and conversion devices. In-depth correlation between materials and devices for higher storage capacities and conversion efficiencies is also provided.

MS658 Materials science aspects of rechargeable batteries

This course deals with electrochemistry based on materials science and further expands to the understanding of the operation mechanism of advanced batteries. While conventional electrochemistry focuses on the surface reactions, more

discussions are placed on the reaction inside the material and the relation with material thermodynamics.

EE591 Introduction to Electric Vehicles

This course introduces electric vehicles consisting of two major subtopics: general knowledge of vehicles (chassises, drivetrains, electronics control units, and etc.) and electric vehicle E/E (electrical and electronics) architectures (electric motors, drivers, batteries, BMS, etc.).

EE594 Power Electronics Systems

3:0:3

본 과목에서는 Harmonic Analysis를 시작으로 하여, 각종 Converter(Buck, Boost, Buck-Boost)의 동작과 Inverter의 Commutation(Voltage Source, Current Source) 및 Chopper의 동작원리와 운영에 관해서 취급한다. (선수과목 : EE391)

EE772 Electronic Circuits for Green Energy

This course will teach students fundamental concepts and technologies for energy harvesting systems and their related circuits, as well as power management IC technologies that can minimize the power usage.

EE791 Power Conversion Circuits and Systems

This course covers the practical design and analysis of various DC / DC converters in the power conversion system. High frequency transformer, inductor, Magnetic Amplifier, Snubber, and Feedback Stabilization is studied to give students deep insight of power conversion system. Also the power factor correction circuit is introduced as AC / DC converter. Every student carry out the term project about design and modeling of a DC / DC converter. On completion of this course, students will have confidence on their ability of design and analysis of power conversion system.
(Prerequisites: EE391, EE594)

EE897 Special Topics in Power Electronics

This course covers topics of interest in power electronics for students at the graduate level. Course content is specifically designed by the instructor

ME411 Energy System Design and Optimization

3:0:3(3)

The primary objective of this course is to provide an integrated presentation of Thermodynamics, Fluid Mechanics, and Heat & Mass Transfer. The unifying theme is the application of these principles to real-life design processes of energy systems that involve the storage, transfer, and conversion of energy. Components as well as system modeling will be conducted using Python programing with an open-source

package, CoolProp (for thermodynamic properties of fluids). In addition, global optimization toolbox in MATLAB will be used for system optimization processes. The computation skills developed for the design of components in energy systems will be applied in the semester-long term project to the detailed design of a complete energy system.

ME430 Introduction to Reliability in Mechanical Engineering Design
3:0:3(6)

We will discuss Fundamentals of Reliability Engineering in Mechanical Design including failure distribution and basic statistics for reliability, reliability model, reliability testing, Normal and Weibull distribution, reliability estimation and application. The purpose of this lecture is to equip students to save human life by assuring reliability in design, maintenance, and operation of mechanical systems and preventing their failures throughout their engineering career.

ME432 Deformation, Fracture and Strength of Materials
3:0:3(6)

The objective of this course is to help the students understand macroscopic behaviors and microscopic characteristics of common engineering materials (metals, ceramics, plastics, and composites). Among many aspects (mechanical, thermal, electrical, optical, and chemical), mechanical properties of materials are specially emphasized in this course. Topics covered include (1) survey of various engineering materials and related engineering properties; (2) structure and deformation of crystalline solids; (3) fracture and strength of materials; (4) fatigue of materials under repeated loading conditions; (5) time-dep

ME440 Engineering Design via FEM
3:1:3(6)

This course introduces the fundamentals of finite element method and how to use commercial finite element analysis software. In particular, the basic principles of the finite element method are explained through easy-to-understand examples, and the fundamental mechanical/mathematical theories are taught. This course presents how to construct the stiffness matrix of a structure composed of simple structural elements such as springs and bars. The governing equations are derived for solid and structural problems, and the finite element formulation is obtained using the principle of virtual work. It also extends to finite element analysis utilizing two-dimensional continuum elements. The properties of finite element solutions are taught. Finite element models are obtained and various solid and structural problems are analyzed using commercial finite element analysis software.

ME800 Special topics in Mechanical Engineering
3:0:3(6)

This lecture is designed to deal with the selected theory and application in mechanical engineering part. The specific topics will be announced before the semester begins.

CH464 Electroanalytical Chemistry 3:0:3(3)

This course introduces fundamental electroanalytical concepts, electrochemical thermodynamics and kinetics, and is purposed to understand various electroanalytical experimental designs and the recent research works.

CH471 Introduction to Polymer Chemistry 3:0:3(3)

This course is designed to provide introductory knowledge on polymer chemistry to undergraduate students in the department of chemistry. Structure and properties of polymers as high molar-mass macromolecules will be discussed along with the synthetic methodologies and thermodynamic behavior.

MO501 전기동력시스템 모델링 및 제어
3:3:4

본 과목에서는 전기동력시스템을 동역학 및 제어 이론에 기반하여 모델링, 제어 및 설계 방법에 대해 학습한다. 특히, 기계 구동 시스템은 물론 모터, 배터리 등 전기 동력시스템에 걸친 다학제적인 기본 개념과 동작원리를 이해하고 이를 바탕으로 최신 전기 동력 시스템의 공학적 문제 및 연구에 대해 학습한다.

MO506 자동차 전기시스템의 기초
3:0:3

본 과목에서는 자동차의 전기 시스템을 구성하는 기초 전자 회로 및 전자기장, 반도체 소자 등의 개념과 동작 원리를 알기 쉽게 설명하고, 이를 토대로 모터, 센서, 통신회로, 무선충전 등 다양한 자동차 응용 기술을 분석하여, 이를 통해서 교통 및 자동차 분야의 융합 설계의 역량 확보를 위한 교육을 수행한다.

MO531 배터리시스템 모델링 및 제어
3:0:3

본 교과목에서는 전기동력시스템의 핵심요소부품인 배터리를 모델링 및 제어 이론에 기반하여 배터리의 상태 모니터링, 예측 및 제어 방법에 대해 학습한다. 특히, 전기차 및 하이브리드 전기차 적용시 발생할 수 있는 공학적 문제들을 정의하고 이들을 해결하기 위한 방법론과 이론을 학습하고자 하며 이를 위해 전기, 화학, 기계

에 걸친 다학제적인 접근을 통해 배터리의 동작원리 및 예측 방법들을 학습한다.

MO833 전기 동력 시스템 특론 3:0:3

본 과목은 미래 교통 시스템의 핵심 요소 중 하나인 전기 동력 시스템의 이론과 응용을 다루는 고급 과목이다. 본 과목의 주요 주제는 무선전력전송 시스템, 배터리 시스템, 하이브리드 전기 자동차 등을 포함한다. 구체적인 강의내용은 개설 전에 공고한다.

AI501 Machine Learning for AI

In this course, we will learn about introductory materials for machine learning, which is the fundamental and core technology for current generation of artificial intelligence. We will cover the most fundamental ideas and theories of machine learning, and introduce some of the important topics that will be covered in more advanced courses. Specifically, we will cover mathematical backgrounds for machine learning, fundamental concept of machine learning, supervised learning methods (regression & classification), unsupervised learning methods (clustering & dimensionality reduction), ensemble models, Bayesian approaches and models, neural networks, and reinforcement learning.

AI502 Deep Learning

In this course, we will learn about introductory materials for deep learning, which is a machine learning methodology that learns multiple layers of non-linear representations for given prediction tasks, while reviewing some of its applications to computer vision and natural language processing. The course will be mostly focused on understanding deep learning methodology, rather than implementing and using existing deep learning frameworks. We will have three to four lab courses on Tensorflow basics.

AI503 Mathematics for AI

In this lecture, I plan to introduce elementary mathematical concepts frequently used for the area of artificial intelligence. In particular, I will explain some introductory parts of linear algebra, multi-variate calculus, probability(or statistics), algorithms, complexity theory and information theory which are useful to building machine/deep learning models with corresponding applications.

AI504 Programming for AI

Programming for AI aims to introduce several programming languages for deep neural networks and deep probabilistic models. Topic covered includes various deep learning models and probabilistic inference on the programming platform.

AI505 Optimization for AI

Machine learning algorithms in general train their parameters from training data by optimizing their objective functions. This course covers optimization methods with examples of machine learning algorithms.

AI506 Data Mining and Search

Huge amounts of data are being generated everyday, and data-driven decision-making becomes increasingly important. The course covers a variety of topics in data mining, search, exploration, and preprocessing, with a focus on efficient algorithms and tools.

AI603 Machine Learning Theory

This course covers both classical and recent machine learning theory. In this course we provide fundamental ideas and theoretical frameworks so that students can understand and analyze complexity of algorithms and performance bounds for machine learning algorithms.

AI608 AI-based Time Series Analysis

This course provides a survey of the theory and application of time series methods. Topics covered include stationary and non-stationary models, autoregressions, multivariate time series, deep neural models for time series, inference in persistent time series and structural break. Real-world data in finance, manufaturing and healthcare will be provided for practice.

AI616 Deep Learning Theory

This course discusses theoretical foundations and recent research results in deep learning theory. Three central questions in deep learning theory are covered. (1) Approximation: What functions can deep neural networks represent? (2) Optimization: Why can we train deep neural networks to global optimality? (3) Generalization: Why can deep neural networks avoid overfitting?

AI701 Bayesian Machine Learning

Bayesian Learning conducts model seserach and predictive inference based on Bayesian principles. Topics covered include variational Bayesian inference, Bayesian hierarhical models, Bayesian optimization and Bayesian deep learning.

CS500 Design and Analysis of Algorithm 3:0:3(6)

This course introduces basic techniques for the design and analysis of computer

algorithms, such as divide-and-conquer, the greedy method, and dynamic programming. Students learn to reason algorithmically about problems arising in computer applications, and experience the practical aspects of implementing an abstract algorithm.

CS504 Computational Geometry 3:0:3(8)

Computational geometry studies algorithms and data structures for processing and storing geometric objects. This courses discusses algorithm design techniques such as plane sweep and geometric divide & conquer; data structures such as point location structures, interval trees, segment trees, and BSP trees; and geometric structures such as arrangements, triangulations, Voronoi diagrams, and Delaunay triangulations.

CS510 Computer Architecture 3:0:3(6)

This goal of this course is to provide the student with an understanding of (*i*) the architectural aspect of the performance issues, and (*ii*) investigation of the full spectrum of design alternatives and their trade-offs.

CCS520 Theory of Programming Languages 3:0:3(6)

This course reviews design principles and implementation techniques of various programming languages. This course also introduces a wide spectrum of programming paradigms such as functional programming, logic programming, and object-oriented programming.

CS522 Theory of Formal Language and Automata 3:0:3(6)

This course is intended to understand the current theories of deterministic parsing of context-free grammars. Two basic parsing schemes, LR(k) and LL(k) parsing, are considered and the practical SLR(1) and LALR(1) techniques are discussed. The syntactic error recovery in LR-based parsing is also discussed.

CS524 Program Analysis 3:0:3

This course introduces a technique called program analysis that estimates the behavior of programs before running them. Instead of running programs with infinite inputs, program analysis statically estimates runtime behaviors of programs within a finite time. The course will cover fundamental theories, designs and implementations of program analysis including semantic formalism and the theory of abstract interpretation.

CS530 Operating System 3:0:3(6)

The main focus of this course is to understand the concurrency features of modern operating systems. Concurrent programming is dealt with in detail to simulate various parts of an OS. Other topics that are required to understand the process-oriented OS structure are also discussed.

CS543 Distributed Systems 3:0:3(3)

This course provides theoretical knowledge and hands-on experience with distributed systems' design and implementation. The course will focus on the principles

underlying modern distributed systems such as networking, naming, security, distributed sychronization, concurrency, fault tolerance, etc. along with case studies. Emphasis will be on evaluating and critiquing approaches and ideas. (*Prerequisite: CS510, CS530)*

CS546 Wireless Mobile Internet 3:0:3(5)

This course is intended for graduate students who want to understand Wireless Mobile Internet. It provides a comprehensive technical guide covering introductory concepts, fundamental techniques, recent advances and open issues in ad hoc networks and wireless mesh networks. The course consists of lectures, exams and term project.

CS550 Software Engineering 3:0:3(4)

This course covers fundamental concepts required in developing reliable softwares in a cost-effective manner.

CS552 Models of Software Systems 3:0:3(10)

For long time, computer scientists have investigated the problem of automating software development from a specification to its program. So far the efforts were not fully successful but much of the results can be fruitfully applied to development of small programs and critical small portions of large programs. In this course, we study the important results of such efforts and, for that, we learn how to model software systems with formal description techniques, how to model software systems such that the various properties expected of the software systems are verifiable and how to verify various properties of software systems though the models.

CS554 Designs for Software and Systems 2:3:3(4)

Development of software and systems requires to understand engineering design paradigms and methods for bridging the gap between a problem to be solved and a working system. This course teaches how to understand problems and to design, architect, and evaluate software solutions.

CS564 Data Science Methodology) 3:0:3(6)

The ability to handle big data and statistically analyse them is crucial for data scientists. This course covers social data basics and tools to handle, analyze, and visualize such data via utilizing key analysis packages in R.

CS570 Artificial Intelligence and Machine Learning 3:0:3(6)

Classical artificial intelligence algorithms and introduction to machine learning based on probability and statistics.

CS572 Intelligent Robotics 3:0:3(6)

The goal of this course is to provide students with state-of-the-art technologies in intelligent robotics. Major topics include sensing, path planning, and navigation, as well as artificial intelligence and neural networks for robotics.

CS574 Natural Language Processing I **3:0:3(6)**

As a typical application of symbolic AI machine translation (M.T) addresses the major issues involving computational linguistics, rules base, and more fundamentally knowledge representation and inference. In this regard, the goal of the course is to provide students with first-hand experience with a real AI problem. The topics include application of M.T., basic problems in M.T., and classical approaches to the problems.

CS579 Computational Linguistics **3:0:3(6)**

This course focuses on universal models for languages, especially English and Korean. For computational study, issues on knowledge representation, generalized explanation on linguistic phenomena are discussed. When these models are applied to natural language processing, properties needed for computational models and their implementation methodologies are studied.

CS591 Software Ecosystem **3:0:3(5)**

As the importance of software in the overall industrial economy grows, and as the software industry undergoes important transformations, this course reviews software technology and the issues that surround its dissemination and use from a number of relevant perspectives. This includes the perpectives from the user, the creator, manager, software supply industry, software creation industry, government.

CS592 Special Topics in Computing **3:0:3**

This free topic course for graduate students covers ever evolving computer science topics to expose the latest trends in computer science to students. In addition, the course provides a validating platform to find a new topic intended for future regular courses.

CS610 Parallel Processing **3:0:3(8)**

This course discusses both parallel software and parallel architectures. It starts with an overview of the basic foundations such as hardware technology, applications and, computational models. An overview of parallel software and their limitations is provided. Some existing parallel machines and proposed parallel architectures are also covered.

CS620 Advanced Compiler Construction **3:0:3(2)**

This course's goal is to expose students to some research issues in modern programming language implementation. Topics include conventional data-flow analysis techniques, semantics-based flow analysis, type inference, type-based program analysis, and garbage collection.

CS632 Embedded Operating Systems **3:0:3(6)**

The goal of this course is to provide in-depth design concepts and implementation skills required for designing and developing embedded operating systems. Topics covered include boot loader, process management, memory management, I/O device

management, and file systems in embedded operating systems.

CS634 Real-Time Systems **3:0:3**

This course aims to provide 1) broad understanding on real-time systems, 2) in-depth knowledge on real-time scheduling theories, and 3) hands-on experience on real-time operating systems. In particular, it will deal with real-time issues on smartphone operating systems.

CS650 Advanced Software Engineering **3:0:3(6)**

In this course, the fundamental concepts of object-orientation are covered from requirement analysis to implementation with various object-oriented methods including OMT, Booch method, and UML. In addition, several advanced topics in the field of object-orientation are also covered. These advanced topics include parallel and distributed object system, real-time issues, and so on.

CS652 Software & Systems Product Line Engineering **3:0:3(6)**

In contrast that traditional software engineering has been focussed on single systems, software & systems product line (SSPL) is applicable to family of software systems and embedded systems. Students will understand the SSPL paradigms and will learn how to realize & evaluate SSPL. The key knowledge areas in this course include reference model, scoping, commonality, variability, domain and application engineering.

CS654 Software Process **3:0:3(6)**

Software process is an important leverage point from which to address software quality and productivity issues. Students will learn theoretical foundations on software process, the methods of defining process, and how to apply the process concepts to improve software quality and productivity.

CS655 System Modeling and Analysis **3:0:3(6)**

Today's information systems are getting more complex, and need for automation systems is ever increasing. In this course we address basic modelling methods in system analysis and study static and dynamic analysis of systems using Petri Nets.

CS656 Software Engineering Economics **3:0:3**

The primary objectives of this course are to enable the students to understand the fundamental principles underlying software management and economics; to analyze management situations via case studies; to analyze software cost/schedule tradeoff issues via software cost estimation tools and microeconomic techniques; and to apply the principles and techniques to practical situations.

CS665 Advanced Data Mining **3:0:3**

Mining big data helps us find useful patterns and anomalies which lead to high impact applications including fraud detection, recommendation system, cyber security, etc. This course covers advanced algorithms for mining big data.

CS670 Fuzzy and Intelligent System **3:0:3(6)**

The aim of this course is to introduce basic concepts and knowledge of the fuzzy theory and its applications. This course also covers some important intelligent systems including the neural network model and genetic algorithm, and the fusion of the different techniques will be discussed.

CS671 Advanced Machine Learning **3:0:3(6)**

This course will cover advanced and state-of-the-art machine learning such as graphical models, Bayesian inference, and nonparametric models.

CS672 Reinforcement Learning **3:0:3(2)**

This course covers reinforcement learning, which is one of the core research areas in machine learning and artificial intelligence. Reinforcement learning has various applications, such as robot navigation/control, intelligent user interfaces, and network routing. Students will be able to understand the fundamental concepts, and capture the recent research trends.

CS710 Special Topics in Computational Architecture **3:0:3(6)**

This course covers recently developed, new computer architectures. Students study and analyze new computational models, high-level languages, computer architectures etc.

CS712 Topics in Parallel Processing **3:0:3(6)**

In this course, students study parallel processing architectures, algorithms, and languages, especially their use in 5th generation computers. The course is based on recent papers, and can be seen as a continuation of Parallel Processing (CS610).

CS720 Special Topics in Programming Languages **3:0:3(2)**

This course covers recent research topics related to programming languages, such as theory, new paradigms, programming language design & implementation etc.

CS730 Special Topics in Operating Systems **3:0:3(6)**

The goal of this course is to develop abilities related to role and performance of operating systems. Students study and debate topics such as designing and implementing a new operating systems for a new environment, utilizing an existing operating systems effectively, OS architecture, ways of evaluating OS performance, file systems, threads, parallel operating systems, etc.

CS744 Special Topics in System Architecture **3:0:3(9)**

In this course, students learn about the structure of computer systems through individual projects and experiments related to user interfaces and object-oriented architectures.

IE 523 Production System Design

This course is an introduction to the design, evaluation, and control of production systems using mathematical, computational, and other modern analytical techniques.

Areas investigated will include costs, theory of production systems, forecasting, mathematical models for production planning, inventory control, material requirements planning, in-plant material flow systems, and project scheduling techniques. .

IE 531 Linear Programming
This course will intensively cover the theoretical, computational and application-directed aspects of linear programming problems. Also covered will be the solution methods and applications of large scale linear programming problems. Major topics include: Simplex method, revised simplex method, dual simplex method, duality theory, sensitivity analysis, Danzig-Wolfe decomposition method, numerical implementation, introduction to computational complexity, and introduction to polyhedral theory.

IE 532 Simulation and System Modeling
An advanced course on complex system modeling and simulation. Major topics include: system modeling formalism, world views, network system modeling, next-event simulation methodology, random number generation, input modeling, output analysis and variance reduction techniques, etc. Application case studies will be conducted using commercial simulation languages.

IE 533 Systems Engineering
This class involves analytical work on optimal design and management in system integration activities. Major topics include feasibility study, system analysis, conceptual and preliminary system design, system optimization, system evaluation, system reliability, and system supportability.

IE 536 Scheduling Theory and Applications
Various prototypes of scheduling problems in production systems, project management, and computer systems are discussed in view of resources and tasks, problem structure, performance measures, and complexity. Complexity analysis, specialized solution algorithms for each prototype, and the use of general solution techniques like mixed integer programming, network and combinatorial optimization techniques, dynamic programming, branch and bound techniques, and other recent search techniques are explained. Also, queueing theory, stochastic analysis, and simulation techniques for dynamic or stochastic scheduling problems are also introduced.

IE 541 Advanced Engineering Statistics
This course covers the theoretical foundations for statistical machine learning. Topics include: probability and distribution, convergence, maximum likelihood, hypothesis testing, Bayesian inference, nonparametric statistics and bootstrap resampling.

IE 542 Regression Analysis: Theory and Practice
This course reviews general theories of linear regression models with applications to

industrial engineering problems. Topics include: Principles of least squares method; multivariate normal distribution and quadratic forms; estimation and hypothesis testing; residual analysis; polynomial regression and ridge regression; regression model building; response surface methodology, etc. Computational aspects of regression analysis are also emphasized.

IE 553 Product Lifecycle Management
The purpose of this course is to provide concepts, state-of-the-art, and research trend in Product Lifecycle Management (PLM). In the early half of the course, various aspects and techniques of product lifecycle management will be covered. In the latter half, selected research papers in PLM will be discussed and the practice of the commercial PLM system will be provided. Furthermore, the product knowledge management issues will be covered as a future technology.

IE 576 Risk Management
This course covers modeling and analytical tools for many risk factors that appear in finance, insurance, and other operations. By introducting concepts and quantitative methods, we aim to provide students with practical skills which are desirable in this field.

IE 577 Fundamentals of Systems Engineering
In this course, we discuss system design and engineering process for large, complex system design and development. Specifically, procedures and techniques from the "V" model in traditional system engineering will be presented to enhance the students' capability as a system designer&engineer. This course is offered in collaboration with Aerospace Engineering Department, and diverse cases from aerospace, manufacturing, logistics, defense systems will be discussed.

IE 631 Integer Programming
Formulation, Theory and Algorithmic aspects of Integer Programming are discussed. We study how to formulate the real problems as integer programming models and discuss computational complexity, the description of the convex hull of feasible solutions. For computational methods, we study branch-and-bound, Lagrangian relaxation, strong cutting-plane method, etc. (Prerequisite: IE531 Linear Programming or permission of the Instructor).

IE 636 Intelligent Systems & Soft Computing
The first objective is to learn what kind of role precision and imprecision have in engineering and engineering system design. The second objective is to understand the need to use soft-computing in designing intelligent systems. The third objective is to have a basic understanding of different kinds of soft-computing methodologies as well as hybrid methodologies. The fourth objective is to design and build a fully functional Fuzzy Logic Controller / fuzzy application in a real world project case.

IE 638 Wireless and Cellular Communication Systems
This course provides an overview of wireless communication with an emphasis on cellular communication. The goal is to cover the basics of radio, duplexing and multiple access, cellular, mobile systems, standards, and applications.

IE 645 Quality Engineering
This course deals with theories and applications of advanced statistical quality control techniques. Topics include design and analysis of control charts, process capability analysis, real-time process control, design of sampling inspection plans, multivariate and bulk sampling inspection plans, screening plans, and robust design methodology.

IE 646 Data Mining
Topics include basic concepts, models and algorithms, case studies and deployment strategies. Major techniques are data visualization, clustering, association rules, decision trees and artificial neural networks. Web mining and CRM applications are also covered.