Course Outlines
1st Semester
DEEP LEARNING FOR INDUSTRIAL IMAGING
About the course
This course teaches you how to build convolutional neural networks (CNN). You will learn how to design intelligent systems using deep learning for classification, annotation, and object recognition. It includes three modules:

Image processing: Introduction of industrial imaging through big data and fundamentals of image processing techniques
Deep learning with convolutional neural network: Overview of neural network as classifiers, introduction of convolutional neural network and Deep learning architecture.
Deep learning tools: Implementation of Deep learning for Image classification and object recognition, e.g. using Keras.
You will learn
Understand the fundamental theory of image processing.
Able to describe the fundamental needs, challenges and limitations of Big data with industrial imaging.
Able to describe and understand the basic principles of convolution neural network.
Demonstrate the ability to use tools for deep learning in industrial imaging.
Requirements
Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Occasions for this course
Objectives
The aim of this course is to provide students with the fundamentals of image processing and deep learning models. The student will learn to design intelligent systems using deep learning, e.g., convolutional neural network for classification, annotation, and object recognition.

Learning outcomes
After completed the course, the student will be able to
1. Demonstrate the fundamental theory of image processing.
2. Describe the fundamental needs, challenges and limitations of Big data with industrial imaging.
3. Describe and understand the basic principles of convolution neural network.
4. Demonstrate the ability to use tools for deep learning in industrial imaging

Course content
Image processing: Introduction of industrial imaging through big data and fundamentals of image processing techniques.

Deep learning with convolutional neural network: overview of neural networks as classifiers, introduction to convolutional neural networks and Deep learning architecture.

Deep learning tools: implementation of Deep learning for Image classification and object recognition, e.g. using Keras.

Specific requirements
90 credits of which at least 60 credits in Computer Science or equivalent, including at least 15 credits in programming. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

MACHINE LEARNING WITH BIG DATA

The rapid development of digital technologies and advances in communications have led to gigantic amounts of data with complex structures called ‘Big data’ being produced every day at exponential growth.

The aim of this course is to give the student insights in fundamental concepts of machine learning with big data as well as recent research trends in the domain. The student will learn about problems and industrial challenges through domain-based case studies. Furthermore, the student will learn to use tools to develop systems using machine-learning algorithms in big data.

About the course

The course includes four modules:

Introduction and background: Introduction is intended to review Machine learning (ML) and Big Data processing techniques and its related subtopics with the focus on the underlying themes.

Case studies: Presents case studies from different application domains and discuss key technical issues e.g., noise handling, feature extraction, selection, and learning algorithms in developing such systems.

Machine learning techniques in big data analytics: This module consists of basic understanding of learning theory, clustering analysis, deep learning and other classification techniques appropriate for development work and issues in construction of systems using Big data.

Data analytics with tools: Presents open source tools e.g., KNIME and Spark with examples that guide through the basic analysis of big data.

You will learn

The student should after course completion be able to:

describe the basic principles of machine learning and big data

demonstrate the ability to identify key challenges to use big data with machine learning

show the ability to select suitable machine Learning algorithms to solve a given problem for big data.

demonstrate the ability to use tools for big data analytics and present the analysis result

Related industrial challenges addressed in the course

Structure and evaluate the vast amount of data to make sure that it is feasible to solve the customer problem.

Acquire new, previously unknown, knowledge from routinely available huge amount of industrial data to support effective automation, decision-making etc. in industries.

Transform knowledge acquired from the data into machines. This knowledge can be used by automated systems in various fields and provide economic values.

Requirements

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Objectives
The rapid development of digital technologies and advances in communications have led to gigantic amounts of data with complex structures called 'Big data' being produced every day at exponential growth. The aim of this course is to give the student insights in fundamental concepts of machine learning with big data as well as recent research trends in the domain. The student will learn about problems and industrial challenges through domain-based case studies. Furthermore, the student will learn to use tools to develop systems using machine-learning algorithms in big data.

Learning outcomes
After completing the course, the student shall be able to:

1. describe the basic principles of machine learning and big data
2. demonstrate the ability to identify key challenges to use big data with machine learning
3. show the ability to select suitable Machine Learning algorithms to solve a given problem for big data
4. demonstrate the ability to use tools for big data analytics and present the analysis result

Course content
Module 1. Introduction and background: introduction is intended to review Machine Learning (ML) and Big Data processing techniques and related subtopics with focus on the underlying themes.
Module 2. Case studies: presents case studies from different application domains and discuss key technical issues e.g., noise handling, feature extraction, selection, and learning algorithms in developing such systems.
Module 3. Machine learning techniques in big data analytics: this module consists of basic understanding of learning theory, clustering analysis, deep learning and other classification techniques appropriate for development work and issues in construction of systems using Big Data.
Module 4. Data analytics with tools: presents open source tools e.g., KNIME and Spark with examples that guide through the basic analysis of Big Data.

Specific requirements
90 credits of which at least 60 credits in Computer Science or equivalent, including at least 15 credits in programming. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination

Written assignment (INL1), (Module 1), 1,0 credit, (examines the learning outcome 1), marks Fail (U) or Pass (G)
Written assignment (INL2), (Module 2), 1,5 credits, (examines the learning outcome 2), marks Fail (U) or Pass (G)
Written assignment (INL3), (Module 3), 2,0 credits, (examines the learning outcome 3), marks Fail (U) or Pass (G)
Project (PRO1), (Module 4), 3 credits, (examines the learning outcome 4), marks Fail (U) or Pass (G)

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PREDICTIVE DATA ANALYTICS

The course will give insights in fundamental concepts of machine learning and actionable forecasting using predictive analytics. It will cover the key concepts to extract useful information and knowledge from big data sets for analytical modeling

About the course

The course aims to give insights in fundamental concepts of machine learning for predictive analytics to provide actionable, i.e., better and more informed decisions in, forecasting. It covers the key concepts to extract useful information and knowledge from data sets to construct predictive modeling. The course includes three modules:

Introduction: overview of Predictive data analytics and Machine learning for predictive analytics.
Data exploration and visualization: presents case studies from industrial application domains and discusses key technical issues related to how we can gain insights enabling to see trends and patterns in industrial data.
Predictive modeling: consists of issues in construction of predictive modeling, i.e., model data and determine Machine learning algorithms for predicative analytics and techniques for model evaluation.

You will learn

Select suitable machine learning algorithms to solve a given problem for predictive data analytics.
Explore data and produce datasets suitable for analytical modeling.
Basics of machine learning for predictive analytics

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

he course aims to give insights in fundamental concepts of machine learning for predictive analytics to provide actionable, i.e., better and more informed decisions in, forecasting. It covers the key concepts to extract useful information and knowledge from data sets to construct predictive modeling.

Learning outcomes

After the course, the steudents shall be able to:
1. describe the basics of machine learning for predictive analytics
2. demonstrate the ability to explore data and produce datasets suitable for analytical modeling.
3. show the ability to select suitable machine learning algorithms to solve a given problem for predictive data analytics.

Course content

Introduction: an overview of Predictive data analytics and Machine learning for predictive analytics.

Data Exploration and Visualization: presents case studies from industrial application domains and discusses key technical issues related to how we can gain insights enabling to see trends and patterns in industrial data.

Predictive modeling: consists of issues in construction of predictive modeling, i.e., model data and determine Machine learning algorithms for predicative analytics and techniques for model evaluation.

Specific requirements
90 credits of which at least 60 credits in Computer Science or equivalent, including 15 credits in programming as well as 2,5 credits in basic probability theory and 2,5 credits in linear algebra, or equivalent. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Written assignment (INL1), 1,0 credit, (examines the learning objective 1 and 2), marks Fail (U) or Pass (G)
Project (PRO1), 1,5 credits, (examines learning agreement 3), marks Fail (U) or Pass (G)

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STATISTICAL ANALYSIS IN INDUSTRIAL SYSTEMS

In this course you will learn state-of-the-art statistical modelling for the purpose of analysing industrial data. The course also presents the basics of relational databases and data manipulation techniques needed to prepare the data for analysis.

About the course

Modern industrial plants and environments measure and store all relevant production variables. In addition to observation, the data can also be obtained by experimentation.

In this course you will learn state-of-the-art statistical modelling for the purpose of analysing industrial data. An overview of the most popular statistical tools will be given. We will focus on the most powerful tool for the statistical data analysis called R, where you will learn how to use regression and ANOVA models for industrial data. Elements of probability theory and mathematical statistics will be provided as needed.

The course provides fundamental elements of applied statistical analysis that can be used to analyse and model the data obtained from industrial plants, as well as elements of probability theory and mathematical statistics needed for a deeper understanding of methods and a reliable interpretation of the results of the analysis.

The course is a self-study course with no scheduled meetings. It is organised in 4 modules and one project.

Structure of the modules:

Recorded video lectures with presentations also available as pdfs.
Additional reading and exercise material.
Quizzes after each lecture count as HEM1 and HEM2. You need to collect enough points on one lecture's quizzes to be able to progress to the next module. Quizzes are also in Canvas.
You can pose questions, ask for help, feedback and suggestions, and initialize discussions in Canvas.
Project:

The project is ususally done individually, but forming groups for the project work is also allowed. There are instructions for the project as well as some suggested data sources that can be used. Project is examined based on a report in which you describe your statistical data analysis done in the project work.

You will learn

to understand the common organization of industrial information systems
to get an overview and understanding of relation database management systems and be able to do SQL queries to extract the data
to do relevant data manipulation and visualization for the purpose of explorative data analysis

mathematical understanding of the most fundamental concepts of statistics and probability theory.
analysis of variance (ANOVA), regression modeling, and applying statistical test to the data
how to correctly interpret the results of the statistical analysis.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

Modern industrial plants and environments measure and store all relevant production variables. In addition to observation, the data can be obtained also by experimentation. The course provides fundamental elements of applied statistical analysis that can be used to analyze and model the data obtained from industrial plants. The elements of probability theory that support statistical concepts are also introduced, as there is a need for a deeper mathematical understanding. An introduction to most useful data storage and manipulation techniques is also given.

Learning outcomes

After the course, the students are expected to:

1. Have an understanding of the common organization of industrial information systems
2. Have an overview and understanding of relation database management systems and be able to do SQL queries to extract the data
3. Have an overview of available statistical tools and be able to do relevant data manipulation and visualization for the purpose of explorative data analysis
4. Have a mathematical understanding of the most fundamental concepts of statistics and probability theory.
5. Have a working knowledge of analysis of variance (ANOVA), regression modeling, and applying statistical test to the data
6. Be able to correctly interpret the results of the statistical analysis

Course content

* Distributed control system and functional levels of industrial control systems
* Level 2 control system software architecture
* Data storage techniques and overview of relational databases
* SQL query language and data import to a statistical tool
* Overview of available statistical tools
* Introduction to R software environment, data preparation, and data visualization
* Elements of probability theory and mathematical statistics and their application on data from industrial plants
* Regression and analysis of variance (ANOVA) models for industrial data.
* Fitting regression models and applying statistical tests (students can analyze their own data, or take example data sets from the literature)

Specific requirements
90 credits of which at least 60 credits within natural science or engineering, including 7.5 credits in Single Variable Calculus. The mathematics shall include knowledge of elementary calculus: integrals, derivations, series, and sums. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Written examination at home (HEM1), 0.5 credits, examines the learning objectives 1-3, marks Fail (U), 3, 4 or 5.
Written examination at home (HEM2) 1 credit, examines the learning objectives 4 and 5, marks Fail (U), 3, 4 or 5.
Project (PRO1), 1 credit, an assignment that is presented with a report of the project, examines learning outcomes 2, 3, 5, and 6, marks Fail (U) or Pass (G).

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TRUSTWORTHY ARTIFICIAL INTELLIGENCE

This course provides you with the necessary knowledge to critically evaluate existing AI methods, techniques, and algorithms. We focus on reliability, explainability, transparency, fairness, and trust in AI systems.

About the course

AI systems are increasingly being integrated into various industrial processes, including manufacturing, logistics, and autonomous vehicles. Trustworthy AI ensures that these systems operate reliably, reducing the risk of accidents or costly errors.

Trustworthy AI helps companies comply with ethical standards and legal regulations. It ensures that AI systems do not discriminate against certain groups, violate privacy rights, or engage in other unethical behaviors.

You will learn

to describe and understand the fundamentals of trustworthy AI,
apply XAI methods and algorithms
understand the measures of fair ML

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in the section Application information below.

Literature lists

Course literature is preliminary up to 8 weeks before course start. Course literature can be valid over several semesters.

Objectives

This course introduces concepts and relevant problems where trustworthiness in developing AI systems is crucial. The purpose is to enable the students to critically evaluate existing AI methods, techniques and algorithms to increase explainability, transparency, fairness and trust in AI systems.

Learning outcomes

After completing the course, the student shall be able to:

1. describe and understand the fundamentals of trustworthy AI,
2. demonstrate the ability to apply XAI methods and algorithms and
3. describe and understand the challenges and measures of fair ML.

Course content

- Introduction to trustworthiness in AI: fundamental concept, requirements, challenges, and limitations.

- Explainable AI: definition, requirements and methods.

- Algorithmic Fairness: Data bias, Ethics, Fair ML.

Specific requirements
90 credits of which at least 60 credits in Computer Science or equivalent, including 15 credits in programming as well as 2,5 credits in basic probability theory and 2,5 credits in linear algebra, or equivalent. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Assignment (INL1) 0.5 credits, examines the learning outcome 1, marks Fail (U) or Pass (G).

Exercise (OVN1), 2.0 credits, examines the learning outcomes 2-3, marks Fail (U) or Pass (G).

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FUNDAMENTALS OF INDUSTRIAL CYBERSECURITY

This course will give you an introduction to the context of industrial cybersecurity, security risk assessment and mitigation strategies.

About the course

Cybersecurity vulnerabilities are a threat to progress in the business sector and society. This is an accelerating threat due to the current rapid digitalisation, which in manufacturing is termed Industry 4.0. Companies are aware of this threat and realise the need to invest in countermeasures, but development is hampered by lack of competence. In this course, you will be made aware of the state-of-the-art in cybersecurity research and state of practice in industry.

You will learn to

describe the landscape of industrial cybersecurity, including main risks and protections
understand the most relevant cybersecurity mechanisms
analyze the cybersecurity needs in specific industrial contexts and plan for most appropriate countermeasures.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

Cybersecurity vulnerabilities are a threat to progress in the business sector and society. This is an accelerating threat due to the current rapid digitalisation, which in manufacturing is termed Industry 4.0. Companies are aware of this threat and realise the need to invest in countermeasures, but development is hampered by lack of competence. In this course, students will be made aware of the state-of-the-art in cybersecurity research and state of practice in industry.

Learning outcomes

After completing the course, the student shall be able to:
1. Describe the landscape of industrial cybersecurity, including main risks and protections.
2. Show understanding of most relevant cybersecurity mechanisms.
3. Analyze the cybersecurity needs in specific industrial contexts and plan for most appropriate countermeasures.

Course content

* Introduction to the context of industrial cybersecurity, including motivation, relevance and reference taxonomy
* Cybersecurity risk assessment, including safety and security interplay
* Mitigation strategies, including fault-tolerance, business continuity and disaster recovery

Specific requirements

120 credits, of which 60 credits in computer science or related subjects. In addition, Swedish B / Swedish 3 and English A / English 6 are required. In cases where the course is given in English, exceptions are made from Swedish B / Swedish 3.

Examination
Assignment (INL1), 2,5 credits, marks Fail (U) or Pass (G)

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METHODS AND TOOLS FOR INDUSTRIAL CYBERSECURITY

In this course you will learn cybersecurity analysis and design in industrial settings, with a special focus on smart factories and Industry 4.0.

About the course

The aim of the course is to provide proficiency in cybersecurity analysis and design in industrial settings, with a special focus on smart factories and Industry 4.0. To achieve this, you will learn about advanced cybersecurity concepts, methodologies and tools. You will also be able to apply your knowledge to industrial case studies.

You will also be able to apply your knowledge to industrial case studies.

You will learn:
describe advanced techniques for industrial cybersecurity analysis and design
analyze cybersecurity risks and vulnerabilities in reference scenarios
perform penetration testing by using tools for vulnerability scanning and ethical hacking
verify and ensure compliance to reference cybersecurity standards and regulations such as ISO 27001.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

The course has the objective to provide proficiency in cybersecurity analysis and design in industrial settings, with a special focus on smart factories and Industry 4.0. To that aim, students will learn about advanced cybersecurity concepts, methodologies and tools. They will also be able to apply their knowledge to case-studies of industrial relevance.

Learning outcomes

After completing the course, the student shall be able to:
1. Describe advanced techniques for industrial cybersecurity analysis and design.
2. Analyze cybersecurity risks and vulnerabilities in reference scenarios.
3. Perform penetration testing by using tools for vulnerability scanning and ethical hacking.
4. Verify and ensure compliance to reference cybersecurity standards and regulations such as ISO 27001.

Course content

* Techniques for threat analysis, vulnerability assessment and penetration testing.
* Cybersecurity monitoring and incident response, including forensics.
* Cybersecurity certification standards.
* Laboratory exercises with selected cybersecurity tools.
* Applications to example scenarios and case-studies of industrial relevance.

Specific requirements
120 credits whereof 60 credits in computer science including 2.5 credits in cybersecurity,or related subjects. In addition, Swedish B/Swedish 3 and English A/English 6 are required. For courses given in entirely in English exemption is made from the requirement in Swedish B/Swedish 3.

Examination
Assignment (INL1), 2,5 credits, marks Fail (U) or Pass (G)

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INTRODUCTION TO IOT INFRASTRUCTURES

This course provides a fundamental knowledge of IoT, targeting physical devices, communication and computation infrastructure. The course gives theoretical knowledge as well as hands-on experiences to build an IoT application.

About the course

Internet of Things (IoT) refers to the concept of connecting physical devices all around the world. The “thing” can refer to any device in the range from a simple sensor to a more sophisticated device such as a smartphone. From the industrial perspective, experts believe that by 2020 more than half of the businesses will integrate IoT.

This course focuses on fundamental aspects of IoT infrastructures. The goal is to provide knowledge and skills needed to build Internet of Things systems, going beyond traditional Embedded Systems courses; introducing a conceptual framework that embraces automation, communication and new forms of computing like Cloud and Fog/Edge.

The IoT World Forum proposes a seven-layer reference model for IoT, from physical devices in the first layer up to business process layer on the top. This course focuses only on the first three layers, including physical devices and controllers; connectivity; and computing layers.

The course is fully online and there is no physical lecture, even for the examination
The course is flexible in a sense that you can read the course material within the course duration in your pace, although we have a recommendation as well
The assignments are available from the beginning for those who have some backgrounds in the topic, although the grades will come at the end of the course
The project work in this course has a flexibility to choose among topics with different platforms, e.g., you can choose to do on a real raspberry pi or on simulation
The course pace is 17 % (approximately 6-7 hr/week) which makes it easy for those who have less time to put on the course
You will learn to
describe the fundamental concepts of IoT infrastructure
evaluate which IoT devices and communication infrastructure are suitable for an IoT application
use IoT platforms to collect information from IoT devices and visualize them
develop a simple IoT application in a simulation tool and evaluate it.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

The purpose of this course is to provide an introduction to the Internet of Things (IoT) infrastructures. The course will focus on various layers of IoT infrastructures, including physical devices, communication infrastructures and computation platforms (cloud/fog/edge computing). Moreover, the course will highlight practical aspects of the IoT infrastructures.

Learning outcomes
After completing this course, the student shall be able to:
1. describe and argue about the fundamental concepts of IoT infrastructures.
2. describe and evaluate various components in IoT infrastructures, including physical devices, communication infrastructures and computation platforms (cloud/fog/edge computing).
3. develop an IoT application based on the first two objectives and conduct an experimental evaluation.

Course content
- Layers in IoT infrastructures
- Sensors and actuators
- Controllers in IoT
- Operating systems for IoT
- Network communication protocols for IoT
- Cloud computing basics
- Fog/edge computing basics
- Industrial IoT applications

Specific requirements
100 credits where 60 credits in computer science and/or electronics and 7.5 credits in programming. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Written assignment (INL1), 1.5 credits, a problem that is solved and reported (either in a group or individually), examines the learning outcomes 1 and 2, marks Fail (U), 3, 4 or 5.
Project (PRO1), 1.0 credits, an assignment that is presented with a report and a video demonstration of the project, examines the learning outcome 3, marks Fail (U) or Pass (G)

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INTRODUCTION TO INTERNET OF THINGS FOR MANUFACTURING INDUSTRY

Learn how to use the Internet of Things (IoT) to develop smart products and services.

About the course

The Internet of Things (IoT) is a collective term for the technologies that enable devices with embedded electronics and internet connectivity such as appliances, machines, and vehicles to be controlled or exchange data over a network. In this course, you will gain basic knowledge of the various components that make up Industrial Internet of Things (IIoT) systems, including sensor technologies, smart tags, data communication, and cyber security.

You will learn

what requirements are imposed on data communication
understand computer communication technologies and their possibilities, limitations and expected role in the development of IIoT
understand appropriate measures against common security issues

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

The purpose of this course is to provide the student with basic knowledge of the different components included in the Industrial Internet of Things (IIoT) system including sensor technologies, smart labels, data management, data communication and cyber-security.

Learning outcomes

After completion of the course the student should be able to:
1. Describe and understand IIoT systems and data transfer requirements
2. Describe and understand computer communication technologies and their possibilities, limitations and expected role in the development of IIoT
3. Understand how different sensor types can be used in the manufacturing industry and know the characteristics of each type
4. Understand appropriate measures against common security issues
5. Demonstrate the ability to practically and theoretically translate their knowledge within the IIoT to applications in production, logistics and product development

Course content

The course contains lectures, project work and laboratory exercises where the student gets knowledge of different applications of IIoT in the manufacturing industry. For example, Ethernet, WiFi, 5G and IP over wireless networks.

Specific requirements

60 credits in mechanical engineering, production engineering, product and process development or equivalent or 40 credits in engineering/technology and at least 2 years' experience in full-time employment in a relevant area within industry.

Examination
Project (PRO1), 1.5 credits, marks Fail (U), 3, 4 or 5 (examines learing outcomes 1-5)
Laboratory work (LAB1), Laboratory work with applications of IIoT, 0.5 credit, marks Fail or Pass (G) (examines learning outcomes 2-4)

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STATISTICAL ANALYSIS IN INDUSTRIAL SYSTEMS

In this course you will learn state-of-the-art statistical modelling for the purpose of analysing industrial data. The course also presents the basics of relational databases and data manipulation techniques needed to prepare the data for analysis.

About the course

Modern industrial plants and environments measure and store all relevant production variables. In addition to observation, the data can also be obtained by experimentation.

In this course you will learn state-of-the-art statistical modelling for the purpose of analysing industrial data. An overview of the most popular statistical tools will be given. We will focus on the most powerful tool for the statistical data analysis called R, where you will learn how to use regression and ANOVA models for industrial data. Elements of probability theory and mathematical statistics will be provided as needed.

The course provides fundamental elements of applied statistical analysis that can be used to analyse and model the data obtained from industrial plants, as well as elements of probability theory and mathematical statistics needed for a deeper understanding of methods and a reliable interpretation of the results of the analysis.

The course is a self-study course with no scheduled meetings. It is organised in 4 modules and one project.

Structure of the modules:

Recorded video lectures with presentations also available as pdfs.
Additional reading and exercise material.
Quizzes after each lecture count as HEM1 and HEM2. You need to collect enough points on one lecture's quizzes to be able to progress to the next module. Quizzes are also in Canvas.
You can pose questions, ask for help, feedback and suggestions, and initialize discussions in Canvas.
Project:

The project is ususally done individually, but forming groups for the project work is also allowed. There are instructions for the project as well as some suggested data sources that can be used. Project is examined based on a report in which you describe your statistical data analysis done in the project work.

You will learn

to understand the common organization of industrial information systems
to get an overview and understanding of relation database management systems and be able to do SQL queries to extract the data
to do relevant data manipulation and visualization for the purpose of explorative data analysis
mathematical understanding of the most fundamental concepts of statistics and probability theory.

analysis of variance (ANOVA), regression modeling, and applying statistical test to the data how to correctly interpret the results of the statistical analysis.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

Modern industrial plants and environments measure and store all relevant production variables. In addition to observation, the data can be obtained also by experimentation. The course provides fundamental elements of applied statistical analysis that can be used to analyze and model the data obtained from industrial plants. The elements of probability theory that support statistical concepts are also introduced, as there is a need for a deeper mathematical understanding. An introduction to most useful data storage and manipulation techniques is also given.

Learning outcomes

After the course, the students are expected to:

1. Have an understanding of the common organization of industrial information systems
2. Have an overview and understanding of relation database management systems and be able to do SQL queries to extract the data
3. Have an overview of available statistical tools and be able to do relevant data manipulation and visualization for the purpose of explorative data analysis
4. Have a mathematical understanding of the most fundamental concepts of statistics and probability theory.
5. Have a working knowledge of analysis of variance (ANOVA), regression modeling, and applying statistical test to the data
6. Be able to correctly interpret the results of the statistical analysis

Course content

* Distributed control system and functional levels of industrial control systems
* Level 2 control system software architecture
* Data storage techniques and overview of relational databases
* SQL query language and data import to a statistical tool
* Overview of available statistical tools
* Introduction to R software environment, data preparation, and data visualization
* Elements of probability theory and mathematical statistics and their application on data from industrial plants
* Regression and analysis of variance (ANOVA) models for industrial data.
* Fitting regression models and applying statistical tests (students can analyze their own data, or take example data sets from the literature)

Specific requirements

90 credits of which at least 60 credits within natural science or engineering, including 7.5 credits in Single Variable Calculus. The mathematics shall include knowledge of elementary calculus:

integrals, derivations, series, and sums. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Written examination at home (HEM1), 0.5 credits, examines the learning objectives 1-3, marks Fail (U), 3, 4 or 5.
Written examination at home (HEM2) 1 credit, examines the learning objectives 4 and 5, marks Fail (U), 3, 4 or 5.
Project (PRO1), 1 credit, an assignment that is presented with a report of the project, examines learning outcomes 2, 3, 5, and 6, marks Fail (U) or Pass (G).

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INTERNET OF THINGS PLATFORMS FOR MANUFACTURING INDUSTRY
Do you want to deepen your knowledge in Industrial Internet of Things?

About the course
In this course, you will gain a deeper knowledge and understanding of the Industrial Internet of Things (IIoT), platforms and cloud services used in manufacturing industries.

You will learn to understand the use of IoT platforms and how to design and implement simple systems and how to create value by using IoT solutions within industrial systems. The course will provide you with practical and theoretical knowledge in IIoT, platforms and cloud services as well as in-depth knowledge in production, logistics and product development.

You will learn
what the advantages and disadvantages of using cloud services are
to explain the main drivers and barriers for the use of cloud services within manufacturing industry
to design and implement simple IIoT systems
to describe the value creation of using IIoT solutions in industrial systems
Requirements
Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.
Literature lists
Course literature is preliminary up to 8 weeks before course start. Course literature can be valid over several semesters.

Objectives
The purpose of this course is to provide deeper knowledge of Industrial Internet of Things, platforms and could services that would be applied on manufacturing industry.

Learning outcomes
After completion of the course the student should be able to:
1. Describe and understand the use of the IIoT platforms in industrial application
2. Describe the advantages and disadvantages in using cloud computing and describe the most important driving forces and obstacles for using Cloud Computing in the Manufacturing industry
3. Design and implement simple IIoT systems
4. Explain the value creation of using IIoT solutions in industrial systems
5. Demonstrate the ability to practically and theoretically translate their knowledge within the IIoT platforms and cloud services to applications in production, logistics and product development

Course content
The course contains lectures, project work and assignments where the student gets knowledge of different applications of IIoT solutions in the manufacturing industry.

Specific requirements
75 credits in mechanical engineering, production engineering, product and process development, computer engineering and/or computer science or equivalent including basic knowledge in IoT systems or 40 credits in engineering/technology and at least 2 years' experience in full-time employment in a relevant area within industry. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Assignment (INL1), 1 credit, marks Fail (U) or Pass (G) (examines learning outcomes 1 and 2)
Project (PRO1), 2 credits, marks Fail (U), 3, 4 or 5 (examines learing outcomes 3-5)

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COMPUTER NETWORKS I

In the rapid development of both computers and networks, there is an increasing need for people with knowledge in these areas.

About the course

This course will provide a basic theoretical and practical knowledge in the art of configuring and securing computer networks and create simpler topologies. Together with Computer Networks II, distance course (Datakommunikation i nätverk II, distanskurs) you will be covering most, but not all, of the content that are part of a Cisco Certified Network Associate (CCNA) certificate. The certificate is not part of this course.

The course covers Networking Today, OSI TCP/IP, IPv4, IPv6, IP-net including IP subnets, Ethernet, LAN, router and switch-configuration, network security fundamentals, address resolution, static and dynamic routing, routing protocols, switching, VLAN, VTP, inter VLAN routing, NAT, network redundancy, network media, network components, network terminology and traffic filtering, WLAN, Network Troubleshooting.

The course is a self-study course with materials provided from the Cisco Netacad platform and a textbook.

You will learn

the fundamental Ethernet technologies
how TCP/IP and the OSI model is constructed
to configure a simple computer network from scratch according to the instructions stated in routing and switching the focus
the basics of IPv4 and IPv6, as well as be able to calculate and describe the use of IP networks, IP subnets and subnet mask
MAC address structure and significance
the basics of routing, switching and traffic filtering
building small network and troubleshooting.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

This course will provide a basic theoretical and practical knowledge in the art of configuring computer networks and create simpler topologies.

Learning outcomes
The student should after the course be able to:

- Describe the fundamental Ethernet technologies
- Describe how TCP/IP and the OSI model is constructed
- Configure a simple computer network from scratch according to the instructions stated in routing and switching the focus
- Describe the basics of IPv4 and IPv6, as well as be able to calculate and describe the use of IP networks, IP subnets and subnet mask
- Describe MAC adressers structure and significance
- Describe the basics of routing, switching and traffic filtering

Course content
OSI, TCP/IP, IPv4, IPv6, IP-net including IP subnets, Ethernet, LAN, router and switch-configuration, static and dynamic routing, routing protocols, switching, VLAN, VTP, inter VLAN routing, NAT, network media, network components, network terminology and traffic filtering.

Tuition
Mainly web-based material. Laboratory work and feedback from teachers.

Requirements
Basic eligibility and Mathematics 3b or 3c or Mathematics C

Examination
Laboratory work (LAB1), 4 credits, marks Fail (U) or Pass (G).
Examination at home (HEM1), 3.5 credits, marks U, 3, 4 or 5.

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AUTOMATED TEST GENERATION

About the course

The increasing competition pressure for rapid introduction of new or modified system versions is posing problems to properly testing software. These pressures have led many organizations to transitioning their development processes to agile development and continuous integration, greatly shortening the time available to conduct comprehensive testing.

This course provides an understanding of automated software testing using program analysis with the goal of intelligently and algorithmically creating tests. The course covers search-based test generation, combinatorial and random testing while highlighting the challenges associated with the use of automatic test generation.

The course is based on individual study, beginning with a single introductory roll-call session.

You will learn

Understand algorithmic test generation techniques and their use in developer testing and continuous integration.
Understand how to automatically generate test cases with assertions.
Have a working knowledge and experience in static and dynamic generation of tests.
Have an overview knowledge in search-based testing and the use of machine learning for test generation.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

Automated test generation has become a popular way of testing software systems. The purpose of this course is to provide knowledge about how to test software systems through automatic techniques. The course covers basic theories and practical use cases of automated testing.

Learning outcomes

After completing the course the student should be able to:
1. describe and explain what automated test generation is.
2. implement test generation for a programming language.
3. understand and apply coverage criteria in a test generation tool to develop test cases and use a test generation tool on a software system.

Course content

The course covers the following topics:
- Introduction to automated test generation
- Methods for test generation
- Basis for coverage criteria
- Basis for random test generation
- Coverage criteria for software

- Automated model-based test design

The course will be divided into three modules:
● Module 1: Fundamentals of Automated Test Generation
● Module 2: Using Test Design Techniques in Automated Test Generation
● Module 3: Using Evaluation Criteria in Automated Test Generation

Specific requirements
120 credits, of which 80 credits in Computer Science and/or Computer Engineering. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Assignment (INL1), 0.5 credit, marks Fail (U) or Pass (G) (examines learning outcome 1)
Assignment (INL2), 0.5 credit, marks Fail (U) or Pass (G) (examines learning outcome 2)
Assignment (INL3), 0.5 credit, marks Fail (U) or Pass (G) (examines learning outcome 2)
Assignment (INL4), 1 credit, marks Fail (U) or Pass (G) (examines learning outcome 3)

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MODEL-BASED DEVELOPMENT: THEORY AND PRACTICE (MBD-TP)
This course will provide you with the principles behind model-driven development of software systems and the application of such a methodology in practice. Modelling is an effective solution to reduce problem complexity and, as a consequence, to enhance time-to-market and properties of the final product.

About the course
The course includes three modules:

Basic concepts of modelling; what are models, metamodels, model transformations, modelling languages.
Model-Driven Engineering in practice; domain-specific languages, UML profiles, design, analysis, and implementation of software systems through model-driven techniques.
Practical problems in modelling usage; evolution management, tool chaining.
The course is a self-study with pre-recorded videos and articles. There are no scheduled meetings.

You will learn to
Understand the general principles underlying Model-Driven Engineering techniques
Analyse the contextual success factors and pitfalls for the adoption of Model-Driven software development in their own organisation
Analyse potential issues related to tool compatibility, needs for modelling language extensions/customisations, support for distributed development.
Related industrial challenges addressed in the course
Foresee potentials and pitfalls entailed by the adoption of Model-Driven Engineering techniques in the current organisation setting
Draw a sustainable plan for introduction of modelling techniques in the development process.
Recognise tool maintenance and vendor locking factors
Requirements
Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.
Objectives
Model-Driven Development is a technique aiming at reducing the complexity of development and management of modern software applications through the exploitation of models. Even it is a young methodology, it gained more and more interest in industry, which considers it as a possible solution to alleviate the ever growing pressures of maximizing quality factors, notably time-to-market, performances, and maintainability. The aim of the course is to give an in-depth knowledge on the fundamentals of software systems modeling, analysis, and the automated generation of the implementation. The student will be made aware of both the state of art in research and state of practice in industry, with a special focus on UML modelling techniques and the general problems of managing evolution.

Learning outcomes
After completing the course, the student shall be able to:

1. understand the possibilities and limitations of Model-Driven Development for the design, analysis, and automated generation of software applications
2. evaluate scenarios and apply appropriate software modeling techniques in development projects (both in theory and in practice)
3. analyze evolution pressures and foresee possible issues in the management of the application lifecycle

Course content
The focus of this course will be on Model-Driven Development. The basics on software modeling technologies will be provided together with the issues related to the automated derivations of corresponding artifacts (models, analysis formats, code, documentation) and evolution management. The theoretical concepts will be paired with corresponding practical implementations, in order to get hands on existing technologies.

The course includes:
- Introduction to Software Engineering and Modeling
- Model-Based Development, Model-Driven Engineering, Model-Driven Architecture
- Metamodeling, modeling languages, domain-specific languages
- UML, profiling, action languages
- Model transformations, classification and their usage
- Evolution management in Model-Driven Development

Tuition
(Virtual) theoretical and practical lectures, theoretical and practical assignments.

Specific requirements
120 credits of which at least 80 credits within technology or informatics, including at least 30 credits in programming or software development.
In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination

Written assignment (INL1, module 1, 0,5 credits, (examines the learning objectives 1-3), marks Fail (U), Pass (G), or Pass with distinction (VG)
Written assignment (INL2), module 2, 1 credit, (examines the learning objectives 2 och 3), marks Fail (U), Pass (G), or Pass with distinction (VG)
Laboratory work (LAB1), module 2, 2 credits, (examines the learning objectives 2 och 3), marks Fail (U), 3, 4, or 5
Written assignment (INL3), module 3, 1 credit, (examines the learning objectives 2 och 3), marks Fail (U), Pass (G), or Pass with distinction (VG)
Laboratory work (LAB2), module 3, 2 credits, (examines the learning objectives 2 och 3), marks Fail (U), 3, 4, or 5
Written assignment (INL4), module 4, 1 credit, (examines the learning objectives 1-3), marks Fail (U), Pass (G), or Pass with distinction (VG)

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QUALITY ASSURANCE - CATCHING BUGS BY FORMAL VERIFICATION
The aim of the course is to introduce you to methods and tools for verifying systems that need to react to external stimuli. The methods use system models with precise formal semantics and will span model-checking as well as deductive verification.

About the course
The objective of the course is to understand the underpinning theories of formal verification, and learn how to apply tool support in order to verify system models. The course consists of lectures and assignments that will teach you the basics of formal verification, differences between techniques, as well as their potential applicability to real-world systems. A set of simple examples as well as real-world applications will be used throughout the course to illustrate the methods and their tool support.

The course covers modeling and verification of both discrete and timed systems, as well as verification of program code. It includes four modules:

Module 1: Modeling and Verification of Untimed Systems

Module 2: Model checking Real-time Systems

Module 3: Logics and Deductive Verification of Systems

Module 4: Specification and Verification of Code

You will learn to
At the end of the course you should be able to:

understand the differences between algorithmic and deductive verification
formalize requirements in temporal logic or predicate logic
model functional and timing behavior of systems
apply verification tools (such as UPPAAL and Dafne) to check properties of models and code, respectively.
Related industrial challenges addressed in the course
Uncover at early design stages potential trouble-spots/errors in design
Provide design-space exploration automated support
Increase assurance of future implementations
Requirements
Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.
Objectives
Software verification focuses on detecting possible bugs in the software prior to its implementation, which is crucial to industry. The aim of the course is to introduce the students into methods and tools for verifying systems that need to react to external stimuli. The methods

use system models with precise formal semantics and will span contract-based verification, model-checking as well as deductive verification. Students will learn some of the theories of formal verification, and how to use tool support in order to verify system models as well as programs.

Learning outcomes
After completing the course, the student shall be able to:

1. describe how formal modelling languages can be applied to model systems
2. model discrete and real-time systems using finite state automata and timed automata
3. specify simple system requirements in temporal logics
4. describe the principles used to verify models in model-checking and deductive verification
5. describe the principles of contract-based verification of programs
6. apply tools to model and verify discrete systems and real-time systems
7. apply contract-based tools to verify software programs (e.g., in C)

Course content
The course will cover the following topics: transition systems, modal logics, modeling, verification by model-checking, deductive formal verification, and contract-based verification of programs. Examples of tools that will be used in the course are: UPPAAL, PVS, VCC, Dafny etc.

Tuition
Lectures (web-based).

Specific requirements
120 credits, of which 80 credits in engineering or informatics, including at least 30 credits in computer science or software development. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English, exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination

Written assignment (INL1), 2,5 credits, examines the learning objectives 1 and 2, marks Fail (U) or Pass(G)
Written assignment (INL2), 2,5 credits, examines the learning objectives 3, 4, and 6, marks Fail (U) or Pass(G)
Written assignment (INL3), 2,5 credits, examines the learning objectives 5 and 7, marks Fail (U) or Pass(G)

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QUALITY ASSURANCE - MODEL BASED TESTING IN PRACTICE

This course deals with model-based testing, a class of technologies shown to be effective and efficient in assessing the quality and correctness of large software systems.

Throughout the course you will learn how to design and use model-based testing tools, how to create realistic models and how to use these models to automate the testing process in your organisation.

About the course

The course includes three modules:

Fundamentals of Model-based Testing: basic model-based testing terminology, what model-based testing is, finite state machines, how to select your tests using models, making these tests executable, tools for model-based testing, test management, choosing the model-based criteria to use and deciding how much automation is needed, test maintenance using model-based testing, test documentation in model-based testing.
Using Requirement Models in Model-based Testing: creating models from industrial code, automating test design, model-checking and searching through large models to find suitable tests, test automation, executing model-based tests.
Using Coverage Criteria in Model-based Testing: practical ways to search the input space thoroughly, graph-based coverage criteria, logic-based coverage criteria, how to provide traceability from code to tests, make regression testing easier.
The course is based on individual study, beginning with a single introductory roll-call session.

You will learn

about models and understand model-based testing
practical skills and abilities on applying model-based testing in industrial practice
to test software using model-based testing in structured, organised ways.

Related industrial challenges addressed in the course

In industry, software testing is an essential and very consuming activity in the process of engineering software. Model-based testing is a technology that tackles challenges related to test design, test selection and test execution.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

Model-based testing has become a popular way of testing software systems. The purpose of this course is to provide knowledge about how to test software systems through models. The course covers basic theories and practical use cases of model-based testing.

Learning outcomes

After completing the course, the student shall be able to:

1. describe and explain what model-based testing is
2. implement models in a specification language
3. understand and apply model coverage criteria in a model-based testing tool
4. develop test cases and use a model-based testing tool on a software system.

Course content
The course covers the following topics:

1. Introduction to model-based testing
2. Techniques for model-based testing
3. Basis for modeling requirements
4. Basis for modeling software systems
5. Coverage criteria for models
6. Designing tests in model-based testing

The course will be divided into three modules:

Module 1: Fundamentals of Model-based Testing, (covering topics 1 and 2)
Module 2: Using Requirement Models in Model-based Testing, (covering topics 3 and 4)
Module 3: Using Evaluation Criteria in Model-based Testing, (covering topics 5 and 6)

Tuition
Video lectures and assignments.

Specific requirements
120 credits of which at least 80 credits in Computer Science and/or Computer engineering or equivalent. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Written assignment (INL1), 0,5 credits, (examines the learning objective 1), Marks Fail (U) or Pass (G)
Written assignment (INL2), 0,5 credits, (examines the learning objective 2), Marks Fail (U) or Pass (G)
Written assignment (INL3), 0,5 credits, (examines the learning objective 3), Marks Fail (U) or Pass (G)
Written assignment (INL4), 1 credit, (examines the learning objective 4, Marks Fail (U) or Pass (G)

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SAFETY CRITICAL SOFTWARE
The purpose is to give the students an overview of issues and methods for development and assurance of safety-critical software, including details of selected technologies, methods and tools.

About the course
The course includes four modules:

Introduction to functional safety; knowledge that give increased understanding of the relationship between Embedded systems / safety-critical system / accidents / complexity / development models (development lifecycle models) / certification / “the safety case”.
Analysis and modelling methods; review of analysis and modelling techniques for the development of safety-critical systems.
Verification and validation of safety critical software, methods and activities to perform verification and validation
Architectures for safety critical systems. Safety as a design constraint
You will learn
the the main key issues, tools and methods used for development of safety-critical software
to apply selected tools and methods for development and quality assurance of safety-critical software
to document the safety assurance work
to adopt scientific advances within the area
Related industrial challenges addressed in the course
How to increase the knowledge and general enhancement of safety cultures in development of safety critical systems
How to clarifying the structure and scope of assurance activites in development of safety critical systems
Requirements
Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.
Objectives
The purpose is to give the students an overview of issues and methods for development and quality assurance of safety-critical software, including details of selected technologies, methods and tools.

Learning outcomes
After completing the course, the student shall be able to:

1. be well aware of key issues, tools and methods used for development of safety-critical software

2. be able to apply selected tools and methods for development and quality assurance of safety-critical software
3. have demonstrated ability to document the safety assurance work
4. have acquired an ability to adopt scientific advances within the area

Course content
1. Introduction to functional safety; knowledge that give increased understanding of the relationship between Embedded systems / safety-critical system / accidents / complexity / development models (development lifecycle models) / certification / "the safety case".
2. Analysis and modelling methods; review of analysis and modelling techniques for the development of safety-critical systems.
3. Verification and validation of safety critical software, methods and activities to perform verification and validation
4. Architectures for safety critical systems. Safety as a design constraint

Tuition
Web-based pre-recorded lectures.

Specific requirements
120 credits of which at least 80 credits should be within Computer Science, Computer Engineering or equivalent, and at least 18 months of documented work experience in software development or software related areas. In addition Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Oral examination (MUN1), digital oral examination through Teams, Module 1: Functional safety management, an introduction to functional safety, 2 credits, examines the learning objectives 1, 3 and 4, marks Fail (U) or Pass (G).
Oral examination (MUN2), digital oral examination through Teams, Module 2: Safety analysis, 1,5 credits, examines the learning objectives 1 and 4, marks Fail (U) or Pass (G).
Oral examination (MUN3), digital oral examination through Teams, Module 3: Software verification and validation, 1,5 credits, examines the learning objectives 1-4, marks Fail (U) or Pass (G).
Oral examination (MUN4), digital oral examination through Teams, Module 4: Architectures, 1 credit, examines the learning objectives 1,2 and 4, marks Fail (U) or Pass (G).

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SYSTEMS-OF-SYSTEMS ENGINEERING

In contemporary society, almost everything is getting digital and connected. In the Systems-of-Systems Engineering course, you will learn the principles for how to make these digitalised systems collaborate effectively.

About the course

This course makes you acquainted with the concept of systems-of-systems (SoS), which means that independent systems are collaborating. It gives you an understanding why SoS is an important topic in the current digitalisation and provides a theoretical and practical foundation for understanding important characteristics of SoS. It also gives you a deeper knowledge in a number of key concerns that need to be considered when engineering SoS.

If you are admitted, you may join the course any time between the course start in September until the beginning of October. With the recommended study pace of 25%, the course will take approximately seven calendar weeks to complete. Higher or lower study pace is possible as long as the course is finished no later than the emd of the autumn semester.

The course is fully online and there are no scheduled meetings, all lectures are pre-recorded. Examination mainly consists of written assignments during the course.

You will learn

Characteristics of SoS and important sub-classes.
Underlying principles from systems theory and systems engineering.
Methods and tools for SoS engineering.
Architecture of an SoS and how it can be specified.
Interoperability between constituent systems, and underlying principles for information representation.
Business models and incentives for collaborations between systems.
Analysis of trustworthiness of SoS, including risks, safety, and security.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

The purpose of the course is to make the participants acquainted with the concept of systems-of-systems, which means that independent systems are collaborating. The course should provide an understanding why systems-of-systems is an important topic in the current digitalization and provide a theoretical and practical foundation for understanding important characteristics of systems-of-systems. Further, the course should give the participants a deeper knowledge in a number of key concerns that needs to be considered when engineering systems-of-systems.

Learning outcomes

After the completion of the course the student shall be able to:

1. Present key principles of systems theory and systems-of-systems.
2. Describe building blocks and tools used in systems-of-systems engineering.
3. Explain analysis methods for key characteristics of a system-of-systems.

Course content
The course contains the following main parts:
* Characteristics of systems-of-systems and important sub-classes.
* Underlying principles from systems theory and systems engineering.
* Methods and tools for engineering systems-of-systems.
* The architecture of a system-of-systems and how it can be described.
* Interoperability between constituent systems, and underlying principles for information representation.
* Business models and incentives for collaborations between systems.
* Analysis of trustworthiness of systems-of-systems, including risks, safety, and security.

Specific requirements
120 credits of which at least 80 credits in engineering. In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Written assignment (INL1), 0,5 credits, examines learning outcome 1 (key principles of systems theory and systems-of-systems), marks Fail (U) or Pass (G).
Written assignment (INL2), 1 credits, examines learning outcome 2 (building blocks and tools used in systems-of-systems engineering), marks Fail (U) or Pass (G).
Written assignment (INL3), 1 credits, examines learning outcome 3 (analysis methods for key characteristics of a system-of-systems), marks Fail (U) or Pass (G).

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FAIL-SAFE DESIGN CONCEPTS

Today, many industries face an increased demand for designing dependeble systems witch encounters various challenges, including more complex electronics and software-intensive systems. If you want to learn about fail-safe design and embedded systems, this course is for you!

About the course

In the course, we will discuss different types of faults and possible sources of faults (technology, human and environment). Different types of faults are handled with different fault tolerance mechanisms, which are discussed for systems, hardware and software components. The course provides a solid foundation for understanding how to design fail-safe systems. The goal is to provide you with a toolbox of concepts for fail-safe design for both hardware and software so you can understand the rationale for appropriate mitigation strategies. The course is suitable for both engineers and students.

You will learn how to

compare different fault tolerant concepts and their ability to mitigate failure effects,
implement existing methods for fail-safe designs and
argue for redundancy concepts in fault tolerant architectures

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

The purpose is to give engineers and students a toolbox of fail-safe design concepts for industrial and embedded systems.

Learning outcomes

After completing the course the student shall be able to:

1. compare different fault tolerant concepts and their ability to mitigate failure effects,
2. implement existing methods for fail-safe designs, and
3. argue for redundancy concepts in fault tolerant architectures.

Course content

The course covers different types of faults and possible error sources (technology, human and environment). Different types of faults are addressed with fault tolerance mechanisms for systems, hardware and software components. This gives a solid base for understanding the design of fail-safe systems.

Specific requirements

At least 160 credits of which at least 15 credits within Computer Science and 20 credits within Electronics. In addition, Swedish B/Swedish 3 and English A/English 6 are required. For

courses given in entirely in English exemption is made from the requirement in Swedish B/Swedish 3.

Examination
Exercise (OVN1), online exercise where methods for fault tolerant concepts are compared with respect to their ability to mitigate failure effects, 1.5 credits, examines the learning outcome 1, marks Fail (U) or Pass (G).
Assignment (INL1), home assignment where existing methods for fail-safe designs are realized, and redundancy concepts in fault tolerant architectures are argumented for, 1 credit, examines the learning outcomes 2-3, marks Fail (U) or Pass (G).

A student who has a certificate from MDU regarding a disability has the opportunity to submit a request for supportive measures during written examinations or other forms of examination, in accordance with the Rules and Regulations for Examinations at First-cycle and Second-cycle Level at Mälardalen University (2020/1655). It is the examiner who takes decisions on any supportive measures, based on what kind of certificate is issued, and in that case which measures are to be applied.

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2nd Semester
INTRODUCTION TO MACHINE LEARNING
In this course you learn the foundation of Machine Learing.

About the course
Today, the explosion of data has created new opportunities to apply machine learning (ML). Handling of the large amounts of data created by the very rapid digitization would not be possible without Machine Learning (ML).

The purpose of the course "Introduction to Machine Learning" is to give you the foundation for ML. You will get an introduction to the basic areas of ML: data, statistics and probability for ML.

You will learn to
describe fundamentals of machine learning
understand the basic of data manipulation and processing
perform basic mathematical and statistical operations for machine learning using Python.
Objectives
The aim of the course is to provide fundamentals of machine learning as well as introduce basic concepts of data manipulation and processing, mathematics, statistics and probability insofar they are related to machine learning.

Learning outcomes
After completing the course, the student shall be able to:

1. describe fundamentals of machine learning,
2. understand the basic of data manipulation and processing and also
3. perform basic mathematical and statistical operations for machine learning using Python.

Course content
The course content covers:

- Fundamentals of machine learning: Overview, AI components, branches, goals, types, algorithms, and applications. Basic mathematical background for machine learning using Python.

- Introduction to data: Data, data manipulation, processing and visualization. Basics of statistics and probability required to process data.

Requirements
Basic eligibility and Mathematics 3b or 3c or Mathematics C

Examination
Written assignment (INL1), 2 credits, examines the learning objectives 1-3, marks Fail (U), or Pass (G).

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INTRODUCTION TO APPLIED AI FOR MANUFACTURING INDUSTRY

Do you want to learn how to manage and process data to build AI applications for the manufacturing industry?

About the course

Applied AI refers to AI technology that is used for practical purposes, usually within an industry or organization. Applied AI can be used to help people make better decisions, work more efficiently, and to automate processes. This course will provide you with the knowledge to collect, manage, process and analyze data to build AI applications for the manufacturing industry. You will learn the latest tools and techniques to analyze large datasets, apply machine learning algorithms, and present your results.

You will learn

the basic concepts of machine learning and big data
the most important prerequisites and challenges in using big data and machine learning in the manufacturing industry
to understand and use suitable tools for analyzing large data sets and presenting the analysis results
At the end of the course, you will have knowledge and understanding of the principles of machine learning and big data, and the ability to apply these concepts to different problems in the manufacturing industry.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

The aim of this course is to provide the students with basic knowledge and practice in handling and processing data to build AI applications for the manufacturing industry.

Learning outcomes

Upon completion of the course shall the student be able to:
1. Understand the basic concepts of big data and machine learning
2. Understand the most important prerequisites and challenges in using big data and machine learning within the manufacturing industry
3. Understand and use suitable tools for the analysis of big data and explain the result
4. Demonstrate the ability to practically and theoretically translate his / her knowledge within applied AI in manufacturing industry applications

Course content

The course contains lectures, project work, assignments and laboratory sessions to enable the student to get knowledge of:
- Basics of big data and machine learning
. Machine learning algorithms and tools

- Application of big data and machine learning to the manufacturing industry

Specific requirements
75 credits in mechanical engineering, production engineering, product and process development, computer engineering and/or computer science or equivalent or 40 credits in engineering/technology and at least 2 years' experience in full-time employment in a relevant area within industry.
In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Assignment (INL1), 1 credit, marks Fail (U) or Pass (G) (examines learning outcomes 1-2)
Project (PRO1), 1 credit, marks Fail (U), 3, 4 or 5 (examines learning outcome 4)
Laboratory work (LAB1), 1 credit, marks Fail (U) or Pass (G) (examines learning outcome 3)

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SECURITY IN COMPUTER NETWORKS

With the constant growth of connectivity and networks becoming more heterogeneous, flexible and opened, security is of utmost importance. In this course you will get an introduction to network security!

About the course

This course provides an introduction into network security and covers core security concepts such as, e.g., firewalls, authentication, certificate management, encryption, "stateful packet inspection", VPN and others. During the course you are provided with slide and video materials as well as a set of practical assignments and thus gain both theoretical and practical knowledge and skills needed for the installation, troubleshooting, and monitoring of network devices to maintain the integrity, confidentiality, and availability of data and devices.

You will learn to

implement a perimeter security by configuring firewalls and routers

explain and implement IP-sec and VPN solutions

demonstrate a thorough knowledge of how to secure the switches and routers in a computer network and have a good understanding of the various threats and attacks towards network resources

understand and explain the basics of cryptography and hashing

understand and explain the Public Key Infrastructure (PKI) and understand the importance of and be able to create policies and documentation for an organization.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

The course provides theoretical and practical knowledge in network security.

Learning outcomes

After completing the course, the student shall be able to:

1. implementing a perimeter security by configuring firewalls and routers
2. explain and implement IP-sec and VPN solutions
3. demonstrate a thorough knowledge of how to secure the switches and routers in a computer network
4. demonstrate a good understanding of the various threats and attacks towards network resources
5. understand and explain the basics of cryptography and hashing
6. understand and explain the Public Key Infrastructure (PKI)
7. understand the importance of and be able to create policies and documentation for an organization

Course content

Certificate Management, Encryption, ACL, "stateful packet inspection" and VPN.

Tuition
Tutorials, labs and other learning activities.

Specific requirements
Confidence within routing and switching. This can be achieved by finishing the course Computer Networks I 7,5 ECTS credits or corresponding.

Examination
Laboratory work (LAB1), 2,5 credits, examines the learning outcomes 1-5 and 7, marks Fail (U) or Pass (G).
Examination at home (HEM1), 5 credits, examines the learning outcomes 1-7, marks Fail (U), 3, 4 or 5.

A student who has a certificate from MDU regarding a disability has the opportunity to submit a request for supportive measures during written examinations or other forms of examination, in accordance with the Rules and Regulations for Examinations at First-cycle and Second-cycle Level at Mälardalen University (2020/1655). It is the examiner who takes decisions on any supportive measures, based on what kind of certificate is issued, and in that case which measures are to be applied.

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CYBERSECURITY WITHIN INDUSTRIAL AUGMENTED REALITY
Do you want to learn how to ensure securse management of AR technology within an industrial context?

About the course
Given that the complexity of IT systems is increasing, there is also an increased risk of vulnerability. This leads to a situation where it is becoming increasingly important to take cyber security and potential threats seriously. This is particularly important when we are trying to apply AR in the context of an industry 4.0 system. With the integration of AR in industrial environments, new attack surfaces are emerging that malicious actors can exploit.

You will learn how to assess industrial AR threats, their potential impact on the facilities and employees, and how to mitigate these threats.

The course will also provide opportunities to apply new knowledge in use-cases of industrial relevance.

You will learn to
Describe specific threat attack surfaces in Industry 4.0 environments connected to Augmented Reality
Analyze the potential impact of the attacks involving AR on the Industry 4.0 environment.
Apply methods in order to prevent potential cyber-attacks.
Demonstrate how modeling and design can be used to ensure the security of AR applications.
Requirements
Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.
Objectives
Within this course, the students will learn how to assess industrial AR threats, their potential impact on the facilities and employees, and how to mitigate these threats. The course will also provide opportunities to apply new knowledge in use-cases of industrial relevance.

Learning outcomes
After completing the course, the student shall be able to:
1. Describe specific threat attack surfaces in Industry 4.0 environments connected to Augmented Reality.
2. Analyze the potential impact of the attacks involving AR on the Industry 4.0 environment.
3. Apply methods in order to prevent potential cyber-attacks.
4. Demonstrate how modeling and design can be used to ensure the security of AR applications.

Course content
* Cybersecurity risk assessment of Augmented Reality devices within Industry 4.0 environments.

* Mitigation strategies for building secure Augmented Reality applications.
* Scenarios of AR applications and relevant use-cases from industry.

Specific requirements
120 credits whereof 60 credits in computer science. In addition Swedish B/Swedish 3 and English A/English 6. For courses given entirely in English exemption is made from the requirement in Swedish B/Swedish 3.

Examination
Laboratory work (LAB1), A set of practical exercises,1 credit, examines the learning outcomes 3 and 4, marks Fail (U) or Pass (G)
Seminar (SEM1), Seminar presentation of the relevant concepts,1.5 credits, examines the learning outcomes 1-3, marks Fail (U) or Pass (G)

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COMPUTER NETWORKS II

In the rapid development of both computers and networks, there is an increasing need for people with knowledge in these areas.

About the course

This course will provide a detailed theoretical and practical knowledge in the art of configuring and securing computer networks and create network topologies. Together with Computer Networks I, distance course (Datakommunikation i nätverk I, distanskurs) you will be covering most, but not all, of the content that are part of a Cisco Certified Network Associate (CCNA) certificate. The certificate is not part of this course.

The course covers configuration of routers and switches, hierarchical network design, various routing protocols, STP, OSPF, NAT, ACL, QoS concepts, link aggregation, VPN, network management, and various WAN technologies.

You will learn to

as part of an assignment put up a company network practically and theoretically describe it
describe and apply the basics of various Spanning Tree Protocol (STP)
describe and implement virtual private networks (VPNs), and various WAN technologies
design, manage and troubleshoot the networking operations.
understand SDN and APIs for configuration and management tools
understand the importance of network security and practice best security practices.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

This course will provide theoretical and practical knowledge in the art of designing and configuring computer networks.

Learning outcomes

The student should after the course be able to:

- As part of an assignment put up a company network practically and theoretically describe it
- Describe and apply the basics of various Spanning Tree Protocol (STP)
- Describe and apply depressions in different routing techniques
- Describe and implement virtual private networks (VPNs), and various WAN technologies

Course content

Configuration of routers and switches, hierarchical network design, depressions in various routing protocols, STP, link aggregation, VPN, network management, and various WAN technologies.

Tuition

Mainly web-based material. Laboratory, feedback from teachers and compulsory assignments.

Specific requirements

Basic knowledge of the OSI reference model, TCP/IP, IPv4, IPv6, IP networks including IP subnets, VLSM and CIDR, Ethernet, router and switch configuration, static and dynamic routing, routing protocols, switching, VLANs, VTP, Inter-VLAN routing, NAT, network media, network components, network terminology and traffic filtering. This can be achieved after completing the course in Computer Networks 1 in 7,5 ECTS credits.

Examination

Laboration (LAB2), 3,5 credits, marks Fail (U) or Pass (G).
Examination at home (HEM1), 4 credits, marks Fail (U), 3, 4 eller 5.

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SECURITY IN COMPUTER NETWORKS

With the constant growth of connectivity and networks becoming more heterogeneous, flexible and opened, security is of utmost importance. In this course you will get an introduction to network security!

About the course

This course provides an introduction into network security and covers core security concepts such as, e.g., firewalls, authentication, certificate management, encryption, "stateful packet inspection", VPN and others. During the course you are provided with slide and video materials as well as a set of practical assignments and thus gain both theoretical and practical knowledge and skills needed for the installation, troubleshooting, and monitoring of network devices to maintain the integrity, confidentiality, and availability of data and devices.

You will learn to

implement a perimeter security by configuring firewalls and routers
explain and implement IP-sec and VPN solutions
demonstrate a thorough knowledge of how to secure the switches and routers in a computer network and have a good understanding of the various threats and attacks towards network resources
understand and explain the basics of cryptography and hashing
understand and explain the Public Key Infrastructure (PKI) and understand the importance of and be able to create policies and documentation for an organization.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

The course provides theoretical and practical knowledge in network security.

Learning outcomes

After completing the course, the student shall be able to:

1. implementing a perimeter security by configuring firewalls and routers
2. explain and implement IP-sec and VPN solutions
3. demonstrate a thorough knowledge of how to secure the switches and routers in a computer network
4. demonstrate a good understanding of the various threats and attacks towards network resources
5. understand and explain the basics of cryptography and hashing
6. understand and explain the Public Key Infrastructure (PKI)
7. understand the importance of and be able to create policies and documentation for an organization

Course content
Certificate Management, Encryption, ACL, "stateful packet inspection" and VPN.

Tuition
Tutorials, labs and other learning activities.

Specific requirements
Confidence within routing and switching. This can be achieved by finishing the course Computer Networks I 7,5 ECTS credits or corresponding.

Examination
Laboratory work (LAB1), 2,5 credits, examines the learning outcomes 1-5 and 7, marks Fail (U) or Pass (G).
Examination at home (HEM1), 5 credits, examines the learning outcomes 1-7, marks Fail (U), 3, 4 or 5.

A student who has a certificate from MDU regarding a disability has the opportunity to submit a request for supportive measures during written examinations or other forms of examination, in accordance with the Rules and Regulations for Examinations at First-cycle and Second-cycle Level at Mälardalen University (2020/1655). It is the examiner who takes decisions on any supportive measures, based on what kind of certificate is issued, and in that case which measures are to be applied.

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QUALITY ASSURANCE - CERTIFICATION OF SAFETY-CRITICAL (SOFTWARE) SYSTEMS
The aim of this course is to give students insight about certification and about what it means to certify/self-assess safety- critical systems with focus on software system and to create a safety case, including a multi-concern perspective when needed and reuse opportunities, when appropriate.

About the course
The course includes three modules:

Module 1 - Introduction to safety certification
This module is expected to:

give an introduction to certification of safety-critical systems;

transfer knowledge and skills on process vs product/ component vs system/ single system vs family of systems certification/qualification. It will also explain the relation between the following concepts: safety-critical systems, safety culture, development processes according to supplier and manufacturer perspective, certification," the safety case". Challenges concerning reuse of certification artifacts and its systematization will be highlighted via reuse scenarios.
Module 2: Standards, certification, and compliance
This module is expected to:

give an overview of standards used as a baseline for certification;

transfer knowledge and skills on various standards (focus on 1 standard e.g., ISO 26262) and their role in the certification process;

state of the art overview on compliance management. The usage of some selected and open-source tools enabling provision of compliance-related artifacts will be illustrated, if appropriate.
Module-3: Modelling methods
This module is expected to:

give an overview of modelling methods needed for the provision and reuse of certification artifacts;

transfer knowledge and skills on various modelling methods for the provision of certification artifacts (process as well as product related) of safety-critical systems. The usage of some selected and open-source tools enabling provision and reuse of certification artifacts will be illustrated.
You will learn to
explain fundamental concepts related to safety certification
create process-related compliance management artifacts

apply modelling methods stemming from state-of-the-art safety standards for developing reusable certification artifacts for safety-critical (software) systems.

Requirements

Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

Objectives

The aim of this course is to give students insight about certification and about what it means to certify/self-assess safety-critical systems with focus on software system and to create a safety case, including a multi-concern perspective when needed and reuse opportunities, when appropriate.

Learning outcomes

After the course, the student shall be able to:

1. explain fundamental concepts related to safety certification
2. create process-related compliance management artifacts
3. apply modelling methods stemming from state-of-the-art safety standards for developing reusable certification artifacts for safety-critical (software) systems

Course content

Module-1-Introduction to safety certification

This module is expected to: 1) give an introduction to certification of safety-critical systems; 2) transfer knowledge and skills on process vs product/ component vs system/ single system vs family of systems certification/qualification. It will also explain the relation between the following concepts: safety-critical systems, safety culture, development processes according to supplier and manufacturer perspective, certification, "the safety case". Challenges concerning reuse of certification artifacts and its systematization will be highlighted via reuse scenarios.

Module-2 Standards, certification, and compliance

This module is expected to: 1) give an overview of standards used as a baseline for certification; 2) transfer knowledge and skills on various standards (focus on 1 standard e.g., ISO 26262) and their role in the certification process; 3) state of the art overview on compliance management.

The usage of some selected and open-source tools enabling provision of compliance-related artifacts will be illustrated, if appropriate.

Module-3 Modelling methods

This module is expected to: 1) give an overview of modelling methods needed for the provision and reuse of certification artifacts; 2) transfer knowledge and skills on various modelling methods for the provision of certification artifacts (process as well as product related) of safety-critical systems.

The usage of some selected and open-source tools enabling provision and reuse of certification artifacts will be illustrated, if appropriate.

Specific requirements
120 credits where at least 22,5 credits are in computer science and 7,5 credits in software engineering or equivalent.
In case of at least 18 months of documented work experience in software development an exemption is made from 7,5 credits software engineering.
In addition, Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Module 1: Introduction to certification
Written assignment 1 (INL1), 2.5 credits, examines the learning outcome 1, marks Fail (U) or Pass (G).

Module 2: Standards, certification, and compliance
Project (PRO3), 2.5 credits, examines the learning outcome 2, marks Fail (U), 3, 4 or 5.

Module 3: Modelling methods
Project (PRO4), 2.5 credits, examines the learning outcome 3, marks Fail (U), 3, 4 or 5.

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Suspicions of attempting to deceive in examinations (cheating) are reported to the Vice-Chancellor, in accordance with the Higher Education Ordinance, and are examined by the University's Disciplinary Board. If the Disciplinary Board considers the student to be guilty of a disciplinary offence, the Board will take a decision on disciplinary action, which will be a warning or suspension.

QUALITY ASSURANCE - THE APPLIED SCIENCE OF SOFTWARE TESTING
This course provides an understanding of the fundamental problems in software testing, as well as solid foundation in the practical methods and tools for a systematic state-of-the-art approach to testing of software.

About the course
The course includes five modules:

Introduction to software testing and test design
Unit testing, test design and automation
Testing at integration and system level
Static and dynamic analysis
Advanced test design
You will learn
After the course, the participants are expected to:

understand the fundamental goals, challenges and limitations of software testing, and its relation to other software engineering activities, such as requirements engineering, design and implementation.
have a working knowledge and experience in applying the major established test design techniques.
have a working knowledge and experience in static and dynamic code analysis.
have an overview knowledge in more advanced testing methods (such as model-based testing, mutation testing and search-based testing), and in the state-of-the-art in software testing research.
Related industrial challenges addressed in the course
Finding problems earlier in the development process and integration chain.
Avoiding quality deficiency costs.
Evaluating the quality of software and systems, and knowing when to release.
Understanding problems and gaps in the development process for continuous improvement.
Requirements
Below you find the entry requirements for the course. If you do not fulfill the requirements, you can get your eligibility evaluated based on knowledge acquired in other ways, such as work experience, other studies etcetera. Read more in Application information below.

The course is given in the spring semester. Application opens mid-September.

Objectives
The course will provide participants with an understanding of fundamental problems, practical methods and tools for systematic software testing.

Learning outcomes
After completing the course, the student shall be able to:

1. understand the basic objectives and challenges in software testing,
2. show knowledge in and ability to apply basic test design techniques,
3. show knowledge in and ability to apply static and dynamic analysis, and
4. have an overview of the state-of-the-art in software testing.

Course content
The course covers the following areas:
1. Code, integration and system testing, and their basic objectives and problems,
2. Test processes (including process models, standards and test levels),
3. Different metrics for quality measurement of code and test,
4. Test Design Techniques (for example, coverage-based techniques, equivalence partitioning and model-based testing) and
5. Static and dynamic analysis.

The course is divided into five modules:
Module 1: Introduction to Software testing
Module 2: Testing at the unit level
Module 3: Testing the integration level
Module 4: Static and dynamic analysis
Module 5: Advanced test design

Tuition
Flexible teaching supplemented by laboratory work and seminars.

Specific requirements
100 credits, out of which 70 credits are within technology or information technology, with at least 15 credits in programming or software development.
In addition Swedish course B/Swedish course 3 and English course A/English course 6 are required. For courses given entirely in English exemption is made from the requirement in Swedish course B/Swedish course 3.

Examination
Written assignment (INL1), (Module 1), 0,5 credit, marks Fail (U) or Pass (G)
Written assignment (INL2), (Module 1), 1 credit, marks Fail (U) or Pass (G)
Written assignment (INL3), (Module 2), 0,5 credit, marks Fail (U) or Pass (G)
Written assignment (INL4), (Module 2), 1 credit, marks Fail (U) or Pass (G)
Written assignment (INL5), (Module 3), 0,5 credit, marks Fail (U) or Pass (G)
Written assignment (INL6), (Module 3), 1 credit, marks Fail (U) or Pass (G)
Written assignment (INL7), (Module 4), 0,5 credit, marks Fail (U) or Pass (G)
Written assignment (INL8), (Module 4), credit, marks Fail (U) or Pass (G)
Written assignment (INL9), (Module 5), 0,5 credit, marks Fail (U) or Pass (G)
Written assignment (ÖVN1), (Module 5), 1 credit, marks Fail (U) or Pass (G)

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