Course Outlines
1st Semester
MACHINE LEARNING
The main purpose of the course is to introduce theory and methods from machine learning and real-world applications from data mining. The technological development has increased our dependency on databases for storage and processing of information. The number and size of these databases grow rapidly. Due to this growth, it becomes more difficult to manually extract useful information. We therefore need semiautomatic and automatic methods to use, aggregate, analyze, and extract such information. Methods and techniques from machine learning, data mining, and artificial intelligence have been shown to be useful for these purposes.

1. Decision

This course is established by Dean 2022-05-03. The course syllabus is approved by Head of Department of Computer Science
2023-03-01 and applies from 2023-08-28.

2. Entry requirements

Admission to the course requires completed course in Algorithms and Data Structures, 6 credits and taken course in Applied
Artificial Intelligence, 6 credits.

3. Objective and content

3.1Objective

The main purpose of the course is to introduce theory and methods from machine learning and real-world applications
from data mining. The technological development has increased our dependency on databases for storage and processing
of information. The number and size of these databases grow rapidly. Due to this growth, it becomes more difficult to
manually extract useful information. We therefore need semiautomatic and automatic methods to use, aggregate,
analyze, and extract such information. Methods and techniques from machine learning, data mining, and artificial
intelligence have been shown to be useful for these purposes.

3.2Content

The course comprises the following themes:

• Current and future learning systems: motivation, goals, theories, and existing methods as well as basic research and
application trends.
• Development of learning systems: planning, design, implementation, and testing of learning systems.
• Directions and areas within learning systems: supervised learning, unsupervised learning, classification, meta learning.
• Evaluation of learning systems: approaches, methods, and measures for evaluation and validation of learning systems.

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1Knowledge and understanding
On completion of the course, the student will be able to:
• exhaustively define and describe solvable and tractable learning problems.
• broadly explain and summarize results from the application and evaluation of learning systems.
4.2Competence and skills
On completion of the course, the student will be able to:
• exhaustively modify or create and apply learning systems to different learning problems.
• exhaustively plan and execute experiments to evaluate and compare learning systems.
4.3 Judgement and approach
On completion of the course, the student will be able to:
• exhaustively evaluate and compare learning systems for different learning problems given various evaluation criteria.
• exhaustively evaluate and compare methods and measures for evaluation of learning systems.
5. Learning activities
The education comprises lectures and laboratory sessions that together contribute to the theoretical understanding and
practical ability required to analyze, implement, and evaluate learning systems. The purpose of the laboratory sessions is to
introduce platforms, tools and APIs for machine learning. The acquired knowledge is evaluated and increased through
assignments, where subject-related problems must be solved either by implementing custom learning systems or by applying
existing tools. In addition, the course includes team project of at least a two-students in which a subject-related problem
must be defined theoretically and solved practically according to the state-of-practice and state-of-the-art. The solution, or
solutions, must be evaluated/compared experimentally and the results must be analyzed and summarized in a project report.
If existing theory, methods, or tools are used, they must be clearly identified by motivation, citation, and description in the
assignment submission or project report. This course uses a learning platform for publication of course contents and
information. The platform also hosts discussion forums, assignment and project submission, and feedback.
6. Assessment and grading
Modes of examinations of the course
Code Module Credits Grade
2310 Written assignment 1 1 credits GU
2320 Written assignment 2 1 credits GU
2330 Project 5.5 credits AF
The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Fail, supplementation required, F

Fail.

The information before a course occasion states the assessment criteria and make explicit in which modes of examination
that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with
a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

NETWORK AND SYSTEM SECURITY

1. Descision

This course is established by Dean 2022-12-21. The course syllabus is approved by Head of Department of Computer Science 2023-03-01 and applies from 2023-03-01.

2. Entry requirements

Admission to the course requires completed courses in Data- and Telecommunications or Data communication 7.5 credits Completed course in Programming 7.5 credits. English 6.

3. Objective and content

3.1 Objective

The aim of the course is for students to learn how data, computer systems and networks can be protected against unauthorized access.

3.2 Content

The key elements of the course are:

• Overall description of computer hacking, malicious software (malware) and denial-of-service attacks
• Introduction to crypto, key management and digital certificates
• Vulnerabilities and security functions for applications and operating systems
• Firewalls
• Authentication for data, users and systems
• Security for wireless networks
• IP security
• Virtual private network (VPN) systems
• Security for e-mail, web, and other applications
• Cloud security
• Introduction to intrusion detections systems (IDSs)

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

On completion of the course, the student will be able to:

Elaborate on different security threats against network equipment
Describe different encryption methods and cryptography algorithms
Elaborate on different types of VPN systems, such as IPsec

4.2. Competence and skills

On completion of the course, the student will be able to:

Configure a firewall
Create and administrate digital certificate

Configure and operate a VPN system
Configure and operate an IDS system
4.3. Judgement and approach
On completion of the course, the student will be able to:

Evaluate different security solutions for systems and networks that protect against specific threats
5. Learning activities
The course contains lectures and seminars where theoretical aspect of the course are presented, and lab work where practice applying the theory. The written assignments consists of various reports, announced when the course starts. The reports should help the students to perform and write descriptive text about used and learned techniques and methods in the course.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2310	On-campus examination	4 credits	AF
2320	Written assignment	3.5 credits	GU

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

7. Course evaluation
The course evaluation should be carried out in line with BTH:s course evaluation template and process.

8. Restrictions regarding degree
The course can form part of a degree but not together with another course the content of which completely or partly corresponds with the contents of this course.

9. Course literature and other materials of instruction
William Stallings, ”Cryptography and Network Security: Principles and Practice”, 8ed, 2023 (Global Edition). ISBN: 9781292437484. 8th US edition from 2020 can also be used.

10. Additional information
This course replaces ET2595

APPLIED ARTIFICIAL INTELLIGENCE

1. Descision

This course is established by Dean 2021-12-01. The course syllabus is approved by Head of Department of Computer Science 2022-02-01 and applies from 2022-03-01.

2. Entry requirements

Admission to the course requires 12 completed credits in programming (Python or similar), as well as 6 completed credits in data structures and algorithms.

3. Objective and content

3.1 Objective

Artificial Intelligence (AI) exists in different forms in an increasingly bigger part of the computerized systems we use - AI techniques in optimisation techniques, decision support systems, imaging algorithms, and robots. The purpose of the course is to introduce students to the field of artificial intelligence and some of its applications.

3.2 Content

The course includes a historical overview of AI-field development, with emphasis on major milestones from an application perspective. Areas covered include

introduction to AI,
knowledge representation,
expert systems,
graphs, search and heuristics,
agent system,
data mining and knowledge discovery,
machine learning, including different learning paradigms such as deep learning, and modern applications of AI e.g., use of AI methods in NLP, machine vision and games.

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

individually explain AI and key subject areas
understand real world applications of AI
individually reason about the potential and limits of AI methods
individually explain ethical and sustainability-related issues

4.2. Competence and skills

in written form communicate strengths and weaknesses of the different AI methods
propose suitable AI method(s) for a given problem
design, develop and implement AI solutions to relevant problems using a programming language

4.3. Judgement and approach

critically review the potential of different AI methods
evaluate the performance of basic as well as advanced AI applications

5. Learning activities
The course is taught in form of lectures given in hybrid fashion (mix of distance and on-campus) which provide a foundation in knowledge-related learning, objectives, exercises, and laboratory work carried out in smaller groups, which gives students the opportunity to train general abilities and skills and approaches (according to learning outcomes).

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2210	On-campus Examination	3 credits	AF
2220	Written assignment 1	1 credits	GU
2230	Written assignment 2	2 credits	AF
2240	Written assignment 3	1.5 credits	GU

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

Assignments 1 and 3 receive the grade G Pass, UX Insufficient, supplementation required, U Fail. The final grade is based on a weighting of the written examination's and assignment 2's grades where the extent (in credit points) affects how weight is given to a component.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

7. Course evaluation
The course evaluation should be carried out in line with BTH:s course evaluation template and process.

8. Restrictions regarding degree
The course can form part of a degree but not together with another course the content of which completely or partly corresponds with the contents of this course.

9. Course literature and other materials of instruction
Main Book:
Artificial Intelligence: A Guide to Intelligent Systems (3rd Edition) 3rd Edition
Author: Michael Negnevitsky
Publisher: Addison-Wesley
Utgiven: 2011
ISBN: 9781408225745

Other Materials:
Artificial Intelligence – A modern approach, 4th edAuthors: Stuart Russell & Peter Norvig
Publisher: Prentice Hall
Utgiven: 2020, Antal sidor: 1136
ISBN-10: 0-13-461099-7

10. Additional information
This course replaces DV2557

PROGRAMMING IN UNIX ENVIRONMENT

1. Descision

This course is established by School of Computer Science and Communication 2013-05-21. The course syllabus is approved by School of Computer Science and Communication 2013-05-21 and applies from 2013-05-21.

2. Entry requirements

3. Objective and content

3.1 Objective

The aim of the course is to enable students to acquire specialised understanding of UNIX-based systems and for programming close to the operating system. This involves, among other things, being able to program at the most abstract level of the operating system, close to the user, and down through the levels of abstraction to the lowest level, system calls. The course trains students in designing software that interacts with the computer through the operating system UNIX (and operating systems similar to or based on UNIX such as Linux and MacOS). It provides a foundation for continued studies in other fields (such as computer security) demanding a practical understanding of the technology involved. The objective of the course is achieved by the student through gaining practical experience of developing programs in a UNIX environment in a series of laboratory exercises.

3.2 Content

The course covers the following specific levels of abstraction in UNIX programming in greater detail:

• Commands and scripting language

The scripting language is a way of making what is normally perceived as user interaction automatic, i. e. interactively commanding the computer to load files, sort the contents and print them. Scripting languages (exemplified with Bourne shell) are thus very powerful but also less general than ordinary programming languages.

• Program development in C

C is the mainstay in programming of UNIX applications and major parts of UNIX systems are often written in C. Advanced UNIX programming, such as for the implementation of network services, is often executed in C with the help of system and library calls to the operating system.

• Program development in the assembly language

High-level programming languages such as C are sometimes not sufficiently expressive or include undesired or unnecessary functions that can affect performance. Such cases can make it necessary/ important to communicate “directly” with the computer in its own language, i. e. the assembly language. An important advantage of being able to program close to the machine is an increased understanding of how the computer works.

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

On completion of the course, the students shall be able to:

demonstrate understanding of the main components of the UNIX system and their connections
demonstrate basic knowledge of programming in scripting languages
demonstrate basic knowledge of the interaction between programs written in C and the operating system in a UNIX environment
demonstrate basic knowledge of programming in the assembly language and interaction of software and hardware at the level of the machine

4.2. Competence and skills

On completion of the course, the students shall be able to:

use the command line interface of the UNIX system
write programs with the building blocks of the UNIX programming interface
develop programs in C and an assembly language that can be run in a UNIX environment

4.3. Judgement and approach

On completion of the course, the students shall be able to:

determine the appropriate abstraction level of programming for a specific assignment
justify, discuss and assess their own solutions in speech and writing

5. Learning activities

The theoretical foundations of the course is presented in lectures and / or exercises. The student is also expected to independently assimilate theoretical knowledge through self study of relevant literature. The theoretical knowledge is applied and deepened in practical laboratory work / project assignments in which topic-related problems should be solved through the implementation of the current system. Each exercise is presented in writing and orally.

6. Assessment and grading

Modes of examinations of the course

Code	Module	Credit	Grade
1310	Shell script programming	2.5 credits	AF
1320	UNIX Programming in C	2.5 credits	AF
1330	Assembly Programming	2.5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

7. Course evaluation

The course evaluation should be carried out in line with BTH:s course evaluation template and process.

8. Restrictions regarding degree
The course can form part of a degree but not together with another course the content of which completely or partly corresponds with the contents of this course.

9. Course literature and other materials of instruction
10. Additional information
The main programming languages are C and Bourne Shell. Students are expected to have learnt these programming languages earlier or be able to learn them on their own during the course.
Replaces DV1305 and DV1425.

2nd Semester
ADVANCED NETWORKING
1. Descision
This course is established by Dean 2020-06-09. The course syllabus is approved by Head of Department of Computer Science 2023-03-01 and applies from 2024-01-15.

2. Entry requirements
Admission to the course requires at least 7.5 credits completed in Data- and Telecommunications or Data communication and at least 7.5 credits completed in Programming.

3. Objective and content
3.1 Objective
The aim of the course is to provide in-depth theoretical and applied knowledge in advanced and complex network technologies. This includes understanding of methods, protocols and mechanisms so that the student can explain and compare advanced and basic networking technologies.

3.2 Content
• Repetition of basic network and Internet concepts
• Foundation of public telephone networks (including cellular mobile networks) and the Internet
• Advanced IP-based multimedia protocols
• Introduction into data center networking
• Introduction into 3/4/5G mobile networks and their components
• Introduction into Cloud networking
• Overview on concept for the Future Internet
• Performance metrics for communication networks
• Design pattern for communication network architectures
• Testing and operation of network

4. Learning outcomes
The following learning outcomes are examined in the course:

4.1. Knowledge and understanding
On completion of the course, the student will be able to:

describe the fundamental principles of link, network and communication protocols
describe in general the differences between wired and wireless networks
describe different communication network architectures, as well as their advantages and disadvantages
explain and describe different data transmission quality metrics for link, network and communication protocols.
Skills and Abilities

On completion of the course, the student will be able to:

determine which protocols are appropriate for multimedia communication in wired and wireless networks
make decisions regarding the choices for network architectures
select and suggest network architectures, link and communication protocols.
4.2. Judgement and Approach
On completion of the course, the student will be able to:

discuss the advantages and disadvantages of different wired and wireless networks technologies
match simple requirements from applications to network functionality.
5. Learning activities
The course is organized around a number of lectures in which the theoretical part of the course is presented. There are also a number of exercises with assignments where the students deepen and apply the knowledge from the lectures.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2205	Written assignment	2.5 credits	GU
2215	Written examination	5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

7. Course evaluation
The course evaluation should be carried out in line with BTH:s course evaluation template and process.

8. Restrictions regarding degree
The course can form part of a degree but not together with another course the content of which completely or partly corresponds with the contents of this course.

9. Course literature and other materials of instruction
Huvudlitteratur

Larry Horner, Kurt Tutschku, Andrea Fumagalli, and Priya Ramanathan - Virtualizing 5G and Beyond 5G Mobile Networks, ISBN-13 for print book: 978-1-63081-930-9, ISBN-13 for ebook: 978-1-63081-931-6, Publisher: Artech House, 2023.

Computer Networking: A Top-Down Approach (2017), Seventh Edition, Global Edition. Författare: James F. Kurose and Keith W. Ross Förlag: Pearson, ISBN 978-1-292-15359-9.
Referenslitteratur
I. Grigorik: High Performance Browser Networking: What every web developer should know about networking and web performance", O'Reilly & Associates, 2013; ISBN-10: 1449344763; ISBN-13: 978-1449344764.

A. Tanenbaum, D. Wetherall, "Computer Networks", Pearson, 5th edition, 2010, ISBN-13: 9780133072624.
M. Olsson, C. Mulligan: EPC and 4G Packet Networks: Driving the Mobile Broadband Revolution, Academic Pr Inc; 2nd Edt., 2012; ISBN-10: 012394595X, ISBN-13: 978-0123945952.
R. Seifert, J. Edwards: The All-New Switch Book: The Complete Guide to LAN Switching Technology, Wiley Publishing, 2008, ISBN:0470287152 9780470287156.
10. Additional information
This course replaces ET2597

ADVANCED MACHINE LEARNING

1. Descision

This course is established by Dean 2022-05-03. The course syllabus is approved by Head of Department of Computer Science 2022-09-01 and applies from 2023-01-16.

2. Entry requirements

Admission to the course requires completed courses in Applied Artificial Intelligence, 6 credits and Machine Learning, 6 credits.

3. Objective and content

3.1 Objective

The main purpose of the course is to introduce students to advanced methods from machine learning and data mining. The current technological development and integration of AI and the Internet of Things (IoT) require new and intelligent solutions for processing and analyzing heterogeneous, multi-dimensional data coming from multiple sources. In order to cope with these new challenges, hybrid and advanced techniques are required, e.g., semi-supervised learning, federated learning, data stream mining, and many others. In addition, it is important that these models are easy to understand and analyze (Explainable AI) and do not treat individuals unfavorably (Ethics and Fairness). The course will cover such methods and provide the necessary skills for the students, broaden their knowledge, and prepare them to deal with real-world industrial challenges.

3.2 Content

The course comprises the following topics, with intention to have at most a lecture per topic:

- overview of the data cleaning, reduction and transformation, and dimensionality reduction
- introducing the problem of association pattern mining and identifying relationships between different attributes.
- introducing the concept of semi-supervised learning and its potential in enhancing the classification process.
- overview of outlier analysis and its application in different application domains, and outlier validation methods
- overview of processes and methods that allow humans to understand and trust the results created by AI models while describing the model's expected impact and potential biases.
- introducing the problem of data biases and model inaccuracies that can lead to models treating individuals unfavorably
- overview of algorithms for stream mining and challenges related to steams such as high volume and concept drift

4. Learning outcomes

The following learning outcomes are examined in the course:

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

On completion of the course, the student will be able to:

define and describe advanced solvable machine learning and data mining problems
select suitable machine learning and data mining method for the ML tasks determined by the defined problems
explain and summarize results from the application and evaluation of the studied problems
4.2. Competence and skills
On completion of the course, the student will be able to:

identify the key components of the machine learning and data mining pipeline and describe how they are related
design and execute experiments while considering ethical aspects concerns the machine learning and data mining problems
design and execute experiments to evaluate and compare advanced machine learning and data mining methods
4.3. Judgement and approach
On completion of the course, the student will be able to:

evaluate and compare the performance of different machine learning and data mining solutions using proper evaluation criteria
identify and reason about potential sources of biases while building machine learning models
analyze and interpret the experimental results from the evaluation of machine learning and data mining solutions
5. Learning activities
The content of this course will be discussed in several lectures. Students are expected to acquire additional knowledge through the self-study of relevant literature. In addition to the lectures, a few seminars will be held, allowing students to discuss and present machine learning and data mining applications in solving real-world challenges.
The students will demonstrate their knowledge in writing a project plan where they will motivate their project idea and will discuss the project implementation details. Upon the project proposal's approval, the students will design and develop the discussed solution for the desired problem, which they evaluate and compare the performance of the proposed solution and analyze and interpret the experimental results.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2305	Seminar	1 credits	GU
2315	Project Plan	1 credits	GU
2325	Project assignment	5.5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Insufficient, supplementation required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

7. Course evaluation
The course evaluation should be carried out in line with BTH:s course evaluation template and process.

8. Restrictions regarding degree
The course can form part of a degree but not together with another course the content of which completely or partly corresponds with the contents of this course.

9. Course literature and other materials of instruction
Data Mining: The Textbook
Author: Charu C. Aggarwal
Publisher: Springer International Publishing Switzerland
Published: 2015, Number of Pages: 746
ISBN: 978-3-319-14141-1

Semi-Supervised and Unsupervised Machine Learning: Novel Strategies
Author: Albalate, Amparo; Minker, Wolfgang
Publisher: Springer International Publishing Switzerland
Published: 2011, Number of Pages: 256
ISBN: 978-1-848-21203-9

Molnar, C. (2022). Interpretable Machine Learning:
A Guide for Making Black Box Models Explainable (2nd ed.).
Open access via: christophm.github.io/interpretable-ml-book/

10. Additional information
This course replaces DV2584

USABILITY AND INTERACTION DESIGN

The aim of the course is to provide students with knowledge of the design of interaction systems to improve usability and support the user's needs. The course focuses on methods and concepts for the assessment of usability and interaction design. Furthermore, the course provides an introduction to the field of HCI (human-computer-interaction) and different development methods.

1. Descision

This course is established by Head of Department of Creative Technologies on Delegation from the Dean of the Faculty of Computing 2015-09-01. The course syllabus is approved by Head of Department of Computer Science 2024-08-27 and applies from 2024-08-27.

2. Entry requirements

7.5 hp completed course in the subject area computer science

3. Objective and content

3.1 Objective

The aim of the course is to provide students with knowledge of the design of interaction systems to improve usability and support the user's needs. The course focuses on methods and concepts for the assessment of usability and interaction design. Furthermore, the course provides an introduction to the field of HCI (human-computer-interaction) and different development methods.

3.2 Content

The mental models of users (cognition, learning etc)
Methods for needs analysis (e.g. GOMS, HTA, AT, heuristic evaluation)
Principles for interaction design of graphic user interfaces and evaluation of usability
Development methods

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

account for basic concepts within usability and interaction design
account for different development methods used in design and usability tests

4.2. Competence and skills

conduct a project aiming to understand and highlight the needs of users
design and evaluate different types of user interface
justify and apply usability principles for different types of user interface

4.3. Judgement and approach

understand and communicate (in speech and writing) usability and interaction design

5. Learning activities

The teaching consists of lectures and seminars providing the students with the theoretical foundations. Furthermore, the students complete a project in groups evaluating the usability of an existing interactive system. The theoretical component must be presented individually in a

report. The project is to be presented in groups in a written report. Instructions for lectures, reading and assignments are available in the learning management system at BTH.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2505	Written report	4 credits	AF
2515	Project[1]	3.5 credits	GU

[1] Determines the final grade for the course, which will only be issued when all components have been approved.

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

7. Course evaluation
The course evaluation should be carried out in line with BTH:s course evaluation template and process.

8. Restrictions regarding degree
The course can form part of a degree but not together with another course the content of which completely or partly corresponds with the contents of this course.

9. Course literature and other materials of instruction
10. Additional information
This course replaces DV1467

USABILITY AND INTERACTION DESIGN

The aim of the course is to provide students with knowledge of the design of interaction systems to improve usability and support the user's needs. The course focuses on methods and concepts for the assessment of usability and interaction design. Furthermore, the course provides an introduction to the field of HCI (human-computer-interaction) and different development methods.

1. Descision

This course is established by Head of Department of Creative Technologies on Delegation from the Dean of the Faculty of Computing 2015-09-01. The course syllabus is approved by Head of Department of Computer Science 2024-08-27 and applies from 2024-08-27.

2. Entry requirements

7.5 hp completed course in the subject area computer science

3. Objective and content

3.1 Objective

The aim of the course is to provide students with knowledge of the design of interaction systems to improve usability and support the user's needs. The course focuses on methods and concepts for the assessment of usability and interaction design. Furthermore, the course provides an introduction to the field of HCI (human-computer-interaction) and different development methods.

3.2 Content

The mental models of users (cognition, learning etc)
Methods for needs analysis (e.g. GOMS, HTA, AT, heuristic evaluation)
Principles for interaction design of graphic user interfaces and evaluation of usability
Development methods

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

account for basic concepts within usability and interaction design
account for different development methods used in design and usability tests

4.2. Competence and skills

conduct a project aiming to understand and highlight the needs of users
design and evaluate different types of user interface
justify and apply usability principles for different types of user interface

4.3. Judgement and approach

understand and communicate (in speech and writing) usability and interaction design

5. Learning activities

The teaching consists of lectures and seminars providing the students with the theoretical foundations. Furthermore, the students complete a project in groups evaluating the usability of an existing interactive system. The theoretical component must be presented individually in a

report. The project is to be presented in groups in a written report. Instructions for lectures, reading and assignments are available in the learning management system at BTH.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2505	Written report	4 credits	AF
2515	Project[1]	3.5 credits	GU

[1] Determines the final grade for the course, which will only be issued when all components have been approved.

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

7. Course evaluation
The course evaluation should be carried out in line with BTH:s course evaluation template and process.

8. Restrictions regarding degree
The course can form part of a degree but not together with another course the content of which completely or partly corresponds with the contents of this course.

9. Course literature and other materials of instruction
10. Additional information
This course replaces DV1467

NETWORK AND SERVICE OPERATIONS

The purpose of this course is to provide knowledge in processes, methods and technologies for installation, operations and management of communication networks, and associated services. The course problematizes the challenges due to the number of network components, services and users. The course provides also an overview of network and service configuration, as well as the monitoring of these.

1. Descision

This course is established by Dean 2020-06-09. The course syllabus is approved by Head of Department of Computer Science 2021-09-01 and applies from 2022-01-17.

2. Entry requirements

För tillträde till kursen krävs minst 7,5 hp avklarade i datakommunikation och minst 7,5 hp avklarade i objektorienterad programmering, 7,5 hp.

3. Objective and content

3.1 Objective

The purpose of this course is to provide knowledge in processes, methods and technologies for installation, operations and management of communication networks, and associated services. The course problematizes the challenges due to the number of network components, services and users. The course provides also an overview of network and service configuration, as well as the monitoring of these.

3.2 Content

The course has two parts:

Part A

- Basics, concepts and concepts for the operation of communication networks.
- Repetition of network principles (architecture / topology, technology and protocols).
- The basics of IEEE 802; VLAN, Link aggregation, switching, security
- Basic protocols in the interface between layers 2 and 3.
- Overview of management goals, procedures, models and protocols.
- Introduction to virtualization using "Containers"
- Overview and review of automation and orchestration systems.

Part B

- Operation of communication networks: configuration, error handling, measurement and analysis of performance in networks and services, as well as security.

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

On completion of the course, the student will be able to:

suggest and argue for an architecture for a communication network
describe the problems that may arise when modifying an existing communication network
explain the challenges that exist due to network scaling

4.2. Competence and skills

On completion of the course, the student will be able to:

design and implement a simple communication network
put into operation a monitoring system of networks and network services
use basic tools to manage networks and related services

4.3. Judgement and approach

On completion of the course, the student will be able to:

evaluate the problems that may arise in the administration and management of large network systems.

5. Learning activities

The course contains lectures, seminars and exercises. During lectures / seminars, the student goes through the theories which they then apply during exercises. The course exercises must be carried out individually or in groups. The student must also individually write a reflective report on the course content

6. Assessment and grading

Modes of examinations of the course

Code	Module	Credit	Grade
2205	Assignment 1	2 credits	GU
2215	Assignment 2	2 credits	GU
2225	Assignment 3	2 credits	GU
2235	Written Report	1.5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

SOFTWARE METRICS

To understand, assess and control software and software development projects, one must be able to measure various aspects of software and its development. The measurement may concern for example the software's quality, the efficiency of processes and tools, or the productivity of the staff. Measurements make it possible to detect and diagnose problems and to follow up whether various actions have had the desired effect.
The goal of the course is to provide students with the fundamentals of software measurement. Students will acquire knowledge of how measurements can be used to control, manage and predict software development processes. Students will also acquire a basic understanding of measurement processes and an awareness of the problems associated with software measurement, as well as experience in creating measurement models and carry out measurements.

1. Descision

This course is established by Dean 2016-08-30. The course syllabus is approved by Head of Department of Software Engineering 2024-11-01 and applies from 2024-11-01.

2. Entry requirements

Completed courses of at least 120 ECTS credits including completed courses in Programming, Data structures and Algorithms, and Software Engineering or Team Software Engineering Project. In addition completed courses in Mathematics of at least 15 credits are required.

3. Objective and content

3.1 Objective

To understand, assess and control software and software development projects, one must be able to measure various aspects of software and its development. The measurement may concern for example the software's quality, the efficiency of processes and tools, or the productivity of the staff. Measurements make it possible to detect and diagnose problems and to follow up whether various actions have had the desired effect.
The goal of the course is to provide students with the fundamentals of software measurement. Students will acquire knowledge of how measurements can be used to control, manage and predict software development processes. Students will also acquire a basic understanding of measurement processes and an awareness of the problems associated with software measurement, as well as experience in creating measurement models and carry out measurements.

3.2 Content

The course comprises the following modules:

Basics of measurement: the need for measuring, measurement frameworks. This includes measurement theory (scales, validation and meaningfulness), Goal-Question-Metric (GQM) paradigm, collection and analysis of data, classification of software metrics.

Metrics for Software: internal product attributes, external product attributes, resource measurements, quality models (ISO/IEC 9126 and 25010).
Processes for software measurement: process models (ISO/IEC 15939), introducing measuring program.

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

On completion of the course the student should be able to:

present and discuss the basics of measuring software,
present, argue and discuss in a professional manner, how metrics can be used in software development processes.

Skills and abilities

On completion of the course the student should be able to:

apply the GQM framework in a real context,
apply measurements in a professional manner in a real context.

Values and attitudes

On completion of the course the student should be able to:

Present, argue and discuss issues related to software measurement in a professional manner.

5. Learning activities

The teaching consists of lectures in which students are expected to take active part through discussion, questions and personal experiences. The course also comprises mandatory exercises with fixed deadlines.
The course commences with an introductory lecture and continues with a series of lectures where a number of subjects (see Contents) is introduced. Each lecture includes time for discussions and exercises.
The course comprises three mandatory examinations: an assignment, a project and a written exam. The assignment and the project require that students immerse themselves in an assigned topic related to metrics and measurement, and to apply the acquired knowledge in a given
context / project.

6. Assessment and grading

Modes of examinations of the course

Code	Module	Credit	Grade
1705	Review assignment	2 credits	AF
1715	Project Assignment	4 credits	AF
1725	Written exam	1.5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The examiner may carry out oral follow-up of written examinations.

To get a passing grade for the course, all modules must be approved. The final grade of the course is the unweighted, rounded average of the grades of the modules.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

MATHEMATICAL STATISTICS

The purpose of the course is to obtain knowledge in probability theory as well as statistical theory and methods. Emphasis lies in probability theory and stochastic processes with technical applications.

1. Descision

This course is established by Head of Department of Mathematics and Natural Science 2015-09-30. The course syllabus is approved by Head of Department of Mathematics and Natural Science 2017-09-04 and applies from 2017-09-04.

2. Entry requirements

15 ECTS in Mathematics accomplished.

3. Objective and content

3.1 Objective

The purpose of the course is to obtain knowledge in probability theory as well as statistical theory and methods. Emphasis lies in probability theory and stochastic processes with technical applications.

3.2 Content

Combinatorics
Discrete and continuous stochastic variables in one dimension
Orientation about multivariate stochastic variables, independence
Various distributions, especially geometric, binomial, exponential, Poisson and normal (Gaussian) distributions as well as approximations
Expected value, variance, standard deviation, covariance, correlation
Markov chains
Markov processes in continuous time with applications in reliability theory
Point estimation including the ML-method
Interval estimation
Hypothesis testing
Simple linear regression
Applications in different technical fields

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

After completion of the course, the student should:

master fundamental calculations with common one- and two-dimensional distributions, normal approximation included, as calculation of the mean, variance, standard deviation and hazard function.
master the calculation of reliability of series and parallel circuits.

know basic probability theory including basic theory for Markov processes.
know statistical principles for point and interval estimation, tests of hypotheses and linear regression.
know some of the most important applications of probability theory and statistical theory.
Skills and abilities

After completion of the course, the student should:

be able to solve simple problems in reliability theory.
be able to formulate and solve statistical problems in written form.
know some of the most important terms of probability theory and statistical theory.
4.2. Judgement and approach
After completion of the course, the student should:

be able to analyse, perform synthesis and to evaluate the results from a reasonability perspective.
5. Learning activities
Teaching is conducted through lectures and exercises. The course assumes that the student independently solves exercises throughout the course.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
1705	Examination	7.5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

DECISION SUPPORT SYSTEMS

Decision-making is central to many human activities and often requires the use of computerized decision support systems. A decision can be described as a choice between different options, made by estimating the value of each option. Supporting decision-making means assisting individuals or groups in the process of gathering relevant facts, developing options, and making decisions. The purpose of the course is for participants to deepen their understanding of concepts, methods, and processes used in the development and use of decision support systems.

1. Descision

This course is established by Dean 2016-09-28. The course syllabus is approved by Head of Department of Computer Science and Engineering 2016-10-01 and applies from 2016-10-01.

2. Entry requirements

To be admitted to the course, students must have completed courses in programming (15 ECTS) and databases (7.5 ECTS).

3. Objective and content

3.1 Objective

Decision-making is central to many human activities and often requires the use of computerized decision support systems. A decision can be described as a choice between different options, made by estimating the value of each option. Supporting decision-making means assisting individuals or groups in the process of gathering relevant facts, developing options, and making decisions. The purpose of the course is for participants to deepen their understanding of concepts, methods, and processes used in the development and use of decision support systems.

3.2 Content

The course covers the following:

Overview of computer science and mathematical techniques (methods) used as components in decision support systems.
In-depth study of common processes and methods for developing and applying decision support systems.
Practical application of the theory behind decision support systems through the design and implementation of a decision support system by applying one or more of the components taught in the course. The components of the course include decision-making theory, group decision-making, development using techniques and methods from AI (artificial intelligence), and modeling, optimization, and simulation.

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

After completing the course, the student should:

Understand the historical development of the field of decision support systems.
Understand how to methodically develop and use different types of decision support systems.
Have knowledge of how different types of computer science and mathematical techniques (e.g., learning systems, simulation, and optimization) can be used within decision support systems.
Be able to identify relevant techniques and methods that can be used to build decision support systems for real-world problems and justify which techniques and methods are most appropriate for a specific problem.
Evaluate and explain the advantages and disadvantages of different classes of decision support systems in relation to specific decision situations.
4.2. Competence and skills
After completing the course, the student should:

Be able to design and implement different types of decision support systems.
5. Learning activities
The course is conducted in the form of lectures, group teaching, study visits (e.g., to companies or hospitals), and a seminar where students present their projects. At the end of the course, there will be a mandatory seminar with project presentations, where students have the opportunity to actively participate, analyze, and present their work. Oral presentations will be conducted, practicing both argumentation about decision support systems and presentation techniques.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
1705	Written exam	3.5 credits	AF
1715	Project	4 credits	GU

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

DEEP MACHINE LEARNING

Deep machine learning methods are extensively used in a wide variety of applications in different fields such as speech understanding, computer vision, natural language processing, robotics etc. The purpose of the course is to introduce students to deep learning, from discussing basics of machine learning and neural networks, to understand how Convolutional Neural Networks (CNNs) and recent important advances in deep learning models, such as Deep Recurrent and Recursive Networks, Autoencoders, Generative Adversarial Networks (GAN), Long Short-Term Memory (LSTM), VGG, Resnet and DensNet are designed and work.

1. Descision

This course is established by Dean 2018-05-18. The course syllabus is approved by Head of Department of Computer Science 2022-09-01 and applies from 2023-01-16.

2. Entry requirements

Admission to the course requires taken course Machine learning 6 credits.

3. Objective and content

3.1 Objective

Deep machine learning methods are extensively used in a wide variety of applications in different fields such as speech understanding, computer vision, natural language processing, robotics etc. The purpose of the course is to introduce students to deep learning, from discussing basics of machine learning and neural networks, to understand how Convolutional Neural Networks (CNNs) and recent important advances in deep learning models, such as Deep Recurrent and Recursive Networks, Autoencoders, Generative Adversarial Networks (GAN), Long Short-Term Memory (LSTM), VGG, Resnet and DensNet are designed and work.

3.2 Content

- Introduction to basics of Artificial Neural Networks,
- Activation functions, regularization, cost functions, optimization, and data normalization,
- Deep machine learning,
- CNNs: operators, drop out, convolutional layers,
- Deep Recurrent, Long Short-Term Memory, and Recursive Networks,
- Deep Belief Networks,
- Advanced Deep classification methods: VGG, Resnet and DensNet,
- Autoencoders: encoding and decoding,
- Adversarial Learning and Generative Adversarial Networks (GANs),
- Applications of deep learning methods in different domains, e.g., use of deep learning methods in natural language processing and computer vision.

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

On completion of the course, the student will be able to:

explain fundamentals of deep machine learning and key subject areas
understand and possess advanced knowledge within the area of deep machine learning
understand real world applications of deep machine learning methods

4.2. Competence and skills

On completion of the course, the student will be able to:

design, develop and apply deep machine learning methods when carrying out research and development activities for the relevant problems
train, validate, test and tune hyperparameters of deep machine learning methods
implement deep machine learning solutions to relevant problems using a programming language

4.3. Judgement and approach

On completion of the course, the student will be able to:

evaluate the performance of basic and advanced deep machine learning applications
critically review the relevant literature of basic and advanced deep machine learning methods

5. Learning activities

The course is taught in form of lectures which provide a foundation in knowledge-related learning. The exercises, laboratory and project, gives students the opportunity to train general abilities and skills and approaches (according to learning outcome descriptions).

6. Assessment and grading

Modes of examinations of the course

Code	Module	Credit	Grade
2305	Written assignment I	2 credits	GU
2315	Written assignment 2	2 credits	AF
2325	Project	3.5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The final grade is based on a weighting of the project's and the Written assignment II's grades where the extent (in credit points) affects how weight is given to a component. The Written assignment I has to be completed in order for a final grade to be issued.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

RESEARCH METHODOLOGY

1. Descision

This course is established by Dean 2024-08-16. The course syllabus is approved by Head of Department of Computer Science 2024-10-29 and applies from 2024-10-29.

2. Entry requirements

Admission to the course requires completed courses of an amount of 120 credits in technology, computer science, software engineering, electrical engineering or equal, of which at least 12 credits in mathematics. English 6.

3. Objective and content

3.1 Objective

3.2 Content

Content The course introduces information retrieval, scientific research methods, scientific writing, and evaluation of research. Elements included in the course include an introduction to research, searching and critically evaluating scientific literature, formulating scientific questions/problems, selecting appropriate research methods, research ethics, collecting and analysing data, threats to validity, and scientific writing practices. The course also includes the study of cutting-edge research in an area relevant to the programme.

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

On completion of the course, the student will be able to:

describe different research methods, and the collection and analysis of data
make use of current research articles relevant to the programme

4.2. Competence and skills

On completion of the course, the student will be able to:

use scientific databases and search engines to identify relevant research articles based on search strings
collect and analyse data in a small research study and compare the results with relevant research articles
describe orally and in writing state-of-the-art techniques in a field relevant to the programme

4.3. Judgement and approach

On completion of the course, the student will be able to:

evaluate and relate to scientific concepts and use them in a small research study
discuss and assess work/studies with regard to ethical and societal aspects
demonstrate an understanding of the possibilities and limitations of science, its role in society and people's responsibility for how it is used

5. Learning activities

The course begins with lectures in research methodology and is later conducted in two main stages, article analysis (seminars) and report. Article analysis is conducted in seminar form where current research articles in the field are presented, opposed and discussed by the students under the supervision of teachers. The articles presented have different technical themes selected through information search by students and teachers, and distributed to the students before the seminar. The students presenting the articles prepare a research-based presentation that clearly highlights the chosen technical area. Other students must have read the material before the seminar in order to participate in the discussions. The opponents are given a special role before the presentations, which should adopt a critical attitude to the research and technology presented in order to initiate a good discussion. The report is an in-depth study of a current technology, where report writing follows scientific practice. The report should be centered on a scientific question or problem formulation and apply scientific methods for an initial technical solution, data collection and analysis, and comparison with relevant literature.

6. Assessment and grading

Modes of examinations of the course

Code	Module	Credit	Grade
2505	Seminar	2 credits	GU
2515	Report	5.5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

In this context, seminars refer to the learning activity of analysing articles.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

13rd Semester

CAPACITY ANALYSIS

The course aims for the student to acquire knowledge in queue theory to solve dimensioning and optimization problems that arise in communication systems. In addition, the student acquires the ability to use mathematical tools to determine the number of resources (links, conversation channels, buffers, processing power, etc.). Resources that are required for a system to achieve a certain quality of service at a minimal cost to the operator and thus the customer.

MALWARE ANALYSIS

The aim of the course is to enable students to learn how to analyse harmful and malicious software in a safe way. Such analysis is the first step in a systematic approach to prevent or neutralise malware. The focus is on analysis of the advanced methods used in the manufacturing of so-called “cyber arms” and the practical countermeasures to detect and neutralise them.

1. Descision

This course is established by Dean 2017-12-20. The course syllabus is approved by Head of Department of Computer Science and Engineering 2018-03-01 and applies from 2018-03-01.

2. Entry requirements

Admission to the course requires completed courses in Programming, 12 credits, Realtime Systems and Operating Systems, 6 credits, Computer Networking, 6 credits. Attended course in Computer Security, 7.5 credits or Network Security, 8 credits.

3. Objective and content

3.1 Objective

The aim of the course is to enable students to learn how to analyse harmful and malicious software in a safe way. Such analysis is the first step in a systematic approach to prevent or neutralise malware. The focus is on analysis of the advanced methods used in the manufacturing of so-called “cyber arms” and the practical countermeasures to detect and neutralise them.

3.2 Content

- Different techniques to attack and infect systems with malware
- Extortion programs (ransomware/scareware)
- Botnets
- Mobile threats to Android and iOS
- Vulnerabilities online and in social networks
- Rootkits and bootkits
- Antivirus techniques
- Data mining for the detection and analysis of malware

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

On completion of the course, the students shall be able to

describe the classification of different types of malware and know their history

explain and exemplify the behaviour of malicious software, antivirus technologies and security architectures in Windows, Android and iOS

4.2. Competence and skills

On completion of the course, the students shall be able to

perform reverse engineering of software for ARM and x86 processor architectures
perform static and dynamic analysis of malicious codes in Windows, Android and iOS
compile and document analyses of malicious codes in accordance with established standards

4.3. Judgement and approach

On completion of the course, the students shall be able to

use a completed analysis to assess a threat
identify and implement appropriate countermeasures

5. Learning activities

The course is given on campus and includes lectures and laboratories (including laboratory reports). Theoretical aspects of the course are presented in the lectures and students should apply the content of the lectures in the course labs.

6. Assessment and grading

Modes of examinations of the course

Code	Module	Credit	Grade
1810	Laboratory Exercise 1	2.5 credits	GU
1820	Laboratory Exercise 2	1.5 credits	GU
1830	Laboratory Exercise 3	1.0 credits	GU
1840	Exam	2.5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

APPLIED CLOUD COMPUTING AND BIG DATA

The mobile and connected world of today generates a large amount of data that needs to be managed, analysed, and linked on the cloud. In this course you get a wide background in designing, developing, and managing a cloud computing solution.

You will also get practical experience in solving a big data software engineering problem in different ways, and to evaluate and evolve your solution towards a more scalable cloud computing solution.

1. Descision

This course is established by Dean 2019-11-25. The course syllabus is approved by Head of Department of Software Engineering 2024-05-16 and applies from 2024-05-16.

2. Entry requirements

At least 90 credits in a technical subject of which at least 30 credits in in one or more of the following areas: Programming, Object-oriented Systems, Software Design, Data Structures and Algorithms, Database Technology, Data Communications, Real Time Systems, Operating Systems. or At least 90 credits within technology and a minimum of 2 years professional experience in software development (shown by, for example, a work certificate from an employer).

3. Objective and content

3.1 Objective

The mobile and connected world of today generates a large amount of data that needs to be managed, analysed, and linked. This is often done on the cloud. The development, deployment, and management of this is called Cloud Computing. The purpose of this course is to offer a wide background about designing, developing, deploying, testing, and monitoring a cloud solution, specifically with a focus on big data problems.

3.2 Content

The course offers an overview of popular cloud platforms and provisioning and deployment of cloud applications, including cloud-based storage. The course also discuss challenges solutions for Big Data analytics. The course is divided into three themes:

- Provisioning and Deployment
- Big Data Analytics
- The Business Case for Cloud Computing

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

On completion of the course, the student will be able to:

In depth be able to describe challenges with Big Data Analysis
In depth be able to describe different types of cloud platforms
In depth be able to describe different reasons for adopting a cloud solution, and the challenges with these different reasons.
In depth be able to reason about solutions to the common challenges with the cloud solutions.
4.2. Competence and skills
On completion of the course, the student will be able to:

Independently be able to set up a development environment consisting of local machine configurations and cloud based servers.
Independently be able to implement and configure a big data analysis, including configuring the cloud platform and (if applicable) database.
4.3. Judgement and approach
On completion of the course, the student will be able to:

Be able to evaluate different reasons for choosing a cloud solution and select a suitable solution accordingy accordingly.
Be able to evaluate a problem description for a big data analysis and evaluate the potential to create a scalable cloud solution.
5. Learning activities
The teaching is done in the form of written material, literature, lectures, and research literature. The examination is done through written reports and computer based lab exercises.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2010	Writtten Assignment 1	3.0 credits	GU
2020	Written Assignment 2	3.0 credits	GU
2030	Written Report	1.5 credits	GU

The course will be graded G Pass, UX Failed result, a little more work required, U Fail.

The examiner may conduct oral follow-up of written examinations.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

PERFORMANCE OPTIMIZATION

Performance is an important aspect of all software. To develop good and high-performance software, it is essential that students have a good understanding of and can apply the different methods and techniques to analyze and optimize the performance of a software system.

1. Descision

This course is established by Dean 2022-12-16. The course syllabus is approved by Head of Department of Computer Science 2023-03-01 and applies from 2023-03-01.

2. Entry requirements

Admission to the course requires completed course in Programming, 12 credits and Datastructures and Algorithms, 6 credits, Computer communication 4 credits and Operating systems 6 credits.

3. Objective and content

3.1 Objective

Performance is an important aspect of all software. To develop good and high-performance software, it is essential that students have a good understanding of and can apply the different methods and techniques to analyze and optimize the performance of a software system.

3.2 Content

The course includes the following elements:
- overview of the factors that impact the performance of a system.
- the hardware and software platform components that impact the performance of the software
- methods for performance measurements and instrumentation
- methods for performance and scalability testing
- introduction to performance principles, performance patterns, and performance anti-patterns
- application of high-level and low-level software optimization techniques
- techniques for analyzing and improving the memory management and streaming I/O functionality
- overview of multiprocessors and methods for improving software performance and scalability through multithreading.

4. Learning outcomes

The following learning outcomes are examined in the course:

4.1. Knowledge and understanding

Provide an overview of modern computer system construction and its impact on performance
Provide a detailed account of different ways to test and measure software performance and scalability
Provide a detailed account of different techniques to improve the performance and scalability of software systems, including utilization of multi-core processing units

4.2. Competence and skills

Test, measure, and analyze the performance of a software system to identify performance bottlenecks
Apply appropriate optimizations to improve the performance and scalability, including parallelization of applications to utilize the available resources of modern processors
4.3. Judgement and approach
Explain and justify their solutions of project assignments in both speech and writing
Independently and critically evaluate their own and others' solutions
5. Learning activities
The lectures present the theoretical basics of the course. The student is also expected to gain theoretical knowledge through independent study of relevant literature. Theoretical knowledge is then applied in teacher-led mandatory laboratory exercises, and in project assignments carried out individually or in groups within a given time frame.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2310	Project assignment 1	2.5 credits	AF
2320	Project assignment 2	2.5 credits	AF
2330	On-campus examination	2.5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

SOFTWARIZED NETWORKS

The aim of the course is to provide a comprehensive understanding of technologies, capabilities and applications of softwarized communication networks. The course will teach networking, switching, virtualization, algorithm, software-engineering and security concepts for softwarized communication networks, Clouds., and Network Function Virtualization (NFV).

1. Descision
This course is established by Dean 2020-06-09. The course syllabus is approved by Head of Department of Computer Science 2023-03-01 and applies from 2023-03-01.

2. Entry requirements
Admission to the course requires taken course Advanced Networking, 7.5 credits.

3. Objective and content
3.1 Objective
The aim of the course is to provide a comprehensive understanding of technologies, capabilities and applications of softwarized communication networks. The course will teach networking, switching, virtualization, algorithm, software-engineering and security concepts for softwarized communication networks, Clouds., and Network Function Virtualization (NFV).

3.2 Content
• Introduction to SDN and NFV: origin and motivations, split of data and control plane, network and service orchestration
• Virtualization techniques and Cloud computing for SDN and NFV
• Software engineering and open source concepts for SDN and NFV
• SDN and NFV security: aims, vulnerabilities, opportunities, bring-your-own device, SDN- and NFV-based protection concepts
• Hardware support and switching technologies for SDN: OpenFlow, P4, NIC support for SDN
• SDN controllers
• SDN in the data center
• Software platforms for SDN and NFV
• Algorithms and data structure for synchronization and control of SDN and NFV
• SDN and NFV applications and environments
• Performance, optimization and testing of SDN and NFV

4. Learning outcomes
The following learning outcomes are examined in the course:

4.1. Knowledge and understanding
On completion of the course, the student will be able to:

describe and explain the general concept of related to softwareized networks
describe the relationship of SDN and Cloud systems

understand the hardware and software support for softwareized networks
understand the requirements on algorithms and data structures for SDN and NFV
understand software engineering for SDN and NFV
understand performance and security issues and capabilities for SDN and NFV
4.2. Competence and skills
On completion of the course, the student will be able to:

write and present laboratory results in a short report
select, configure and run/lunch a small-scale SDN system
test specific security issues of SDN and NFV
4.3. Judgement and approach
On completion of the course, the student will be able to:

know the main SDN and NFV technologies
judge the advantages and disadvantages of the main networking, switching, and virtualization models for SDN and NFV
select an appropriate software engineering concepts for SDN and NFV
judge the performance and security of SDN and NFV
5. Learning activities
The course comprises lectures and laboratories including a small project which is completed by a seminar. The lectures will provide the main technical content and deepen the theoretical understanding of the students. The technical content and the theories will be applied in the labs and the project. The labs and the project are conducted in small groups.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2210	Laboration	2.5 credits	GU
2220	Project	2.5 credits	GU
2230	Written examination	2.5 credits	AF

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

SOFTWARE SECURITY

The main purpose of the course is to understand and manage various software security problems in a safe and controlled environment. Risky programming patterns that can be exploited for nefarious purposes can cause significant financial losses and reputational damage to organizations that use or develop vulnerable products. The knowledge and skills imparted during the course are intended to limit the above-mentioned risks and are therefore important for companies and organizations where professional software is being developed.

1. Descision
This course is established by Dean 2021-12-03. The course syllabus is approved by Head of Department of Computer Science 2022-03-01 and applies from 2022-03-01.

2. Entry requirements
För tillträde till kursen krävs 90 hp varav 40 hp inom det tekniska området varav en avklarad kurs på minst 6 hp inom programmering i C, C++ eller minst 120 hp varav minst 90 hp inom det tekniska området och minst 2 års yrkeserfarenhet inom område som är relaterat till mjukvaruintensiv produkt och/eller tjänsteutveckling (visas exempelvis genom intyg från arbetsgivare).

3. Objective and content
3.1 Objective
The main purpose of the course is to understand and manage various software security problems in a safe and controlled environment. Risky programming patterns that can be exploited for nefarious purposes can cause significant financial losses and reputational damage to organizations that use or develop vulnerable products. The knowledge and skills imparted during the course are intended to limit the above-mentioned risks and are therefore important for companies and organizations where professional software is being developed.

3.2 Content
The student will learn to understand the adversary’s “modus operandi” and to identify risky programming patterns to be avoided. During the course, the student will become familiar with various security mechanisms built into operating systems or provided by specific development tools. The student will also learn to use tools for both code and binaries for purpose to understand exploitation techniques as well as protect software. The course includes the following elements:

• Background to software security and causes of vulnerabilities in software
• Quick introduction to assembler programming for x86-32/64 bit microprocessors
• Handling vulnerabilities in memory management, in system calls and calls to library functions
• Methods and measures to counter unsafe handling of input data
• Tools for analyzing source code and binaries
• Introduction to threat modeling

4. Learning outcomes
The following learning outcomes are examined in the course:

4.1. Knowledge and understanding
explain how software vulnerability exploitation techniques work.
explain how protection against specific exploitation techniques in software works.
explain techniques and implementation choices that lead to safe handling of input data.
4.2. Competence and skills
apply the tools for analysis of source code and binaries presented during the course.
4.3. Judgement and approach
evaluate limitations of selected measures and protection mechanisms in relation to a specific vulnerability or lack of security.
5. Learning activities
The teaching takes place in the form of lectures, recorded video material, as well as own studies of fundamentals literature, research literature and other written material. During the course, communication, feedback and discussions with teachers and other participants take place via e-mail, the course's learning platform and via physical or online meetings.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2210	Written Assignments 1	2.5 credits	GU
2220	Written Assignments 2	3.5 credits	GU
2230	Written Assignments 3	1.5 credits	GU

The course will be graded G Pass, UX Failed result, a little more work required, U Fail.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

ADVANCED TOPIC IN COMPUTING

The aim of the course is to enable students to develop specialised knowledge and understanding within a specific area within Computer Science. The course is a direct preparation for a future Master’s degree project.

MASTER'S THESIS

The aim of the course is to enable students to practise their ability to define, plan, execute and report an independent research study. The students are expected to apply knowledge previously acquired on the programme in order to specialise in one or more specific areas within the main field of computer science. The goal of the student is to report the results of their research study in speech and writing and to critically review and publicly discuss the degree project of another student. The report is to satisfy the requirements and criteria of academic papers.

1. Descision

This course is established by Head of the Department of Computer Science and Computer Systems Engineering on delegation from the Dean of the Faculty of Computer Sciences 2016-08-30. The course syllabus is approved by Dean 2023-09-01 and applies from 2023-09-01.

2. Entry requirements

Admission to the course requires a minimum of 90 higher education credits in Computer Science, including at least 30 credits at the advanced level. In addition, students must have successfully completed a course in Research Methodology in Software Engineering and/or Computer Science for 7.5 credits.

3. Objective and content

3.1 Objective

The aim of the course is to enable students to practise their ability to define, plan, execute and report an independent research study. The students are expected to apply knowledge previously acquired on the programme in order to specialise in one or more specific areas within the main field of computer science. The goal of the student is to report the results of their research study in speech and writing and to critically review and publicly discuss the degree project of another student. The report is to satisfy the requirements and criteria of academic papers.

3.2 Content

The course consists of four components:

1. Preliminary study and planning

2. Implementation of

a. research

b. supervision

c. written report

3. Oral presentation and defence

4. Critical review

a. written review

b. oral review

The preliminary study and planning involve drafting a project plan including a time plan for the project. During the implementation phase the student is to execute the project and provide documentation in the academic report in accordance with the time plan. During the oral presentation, the student is to defend their degree project. Each student is also to critically review another student's degree project.

4. Learning outcomes
The following learning outcomes are examined in the course:

5. Learning activities
The students are to work in pairs of at least two and are responsible for ensuring that the degree project is completed within predetermined time frames and the available resources for supervision, and is of a sufficiently high quality. Exemptions for individual projects are to be approved by the examiner.

Each thesis is to be supervised by an academic supervisor at the institute. In addition to the academic supervisor, the students can have an external supervisor from business and industry or another higher education institution.

There is a thesis idea pitch seminar before the course starts. The course starts with a set of introductory seminars. This is followed by independent work in the form of planning, execution and reporting of a degree project, and critical review of another student's degree project. Throughout the project work, the student is to maintain an e-portfolio on the learning platform of the course by regularly describing the status and development of the degree project.

The final, revised report is assessed by the examiner after the oral presentation. The examiner awards a grade on the academic report based on his or her own assessment and the results of a peer review. The assessment of the project plan is also to be made by the examiner with the support of peer review.
The requirements for the degree project to be presented and defended are (i) that the project plan has been approved, and (ii) that the academic supervisor has informed the examiner that the quality of the degree project is sufficient for it to be presented and defended. The assessment of the supervisor does not automatically entail that the academic report is awarded a Pass. The grading is made by the examiner after the presentation and critical review.

The project plan, the oral presentation and defence, the oral and written critical review, and the academic report are to comply with the instructions and templates provided in the Instructions for Degree Projects available at the Faculty of Computing.

The course is taught on campus, if nothing else is stated. The student is expected to be available for supervision. It is the responsibility of the student to make time-efficient use of the supervision. Supervision is only provided during semesters.

Students who fail to complete their degree projects during the current semester will receive further supervision to a limited extent only and for no longer than the start of the next course occasion. The examiner has the right to discontinue the supervision when all the time available for supervision has been used. However, students are always entitled to have their degree projects assessed at the next available examination opportunity. A student re-registering on the course is not automatically entitled to new hours for supervision.

6. Assessment and grading
Modes of examinations of the course

Code	Module	Credit	Grade
2405	Essay/Thesis	26 credits	AF
2415	Defence	1 credits	GU
2425	Project Plan	2 credits	GU
2435	Public Discussion and Examination	1 credits	GU

The course will be graded A Excellent, B Very good, C Good, D Satisfactory, E Sufficient, FX Failed result, a little more work required, F Fail.

The grading is carried out by the examiner after taking into account the results of the peer review. The students are assessed individually, even when they write the thesis in pairs. A student who by the end of the course has not submitted a project plan is given the grade U (Fail) for these assignments, since the student did not demonstrate adequate ability to perform tasks within specified timeframes. A student, who has not submitted an academic report of sufficient quality to be presented and defended within 12 (16) months from the start of the course, can at most receive grade B (C), since the student did not demonstrate adequate ability to perform tasks within specified timeframes. The oral presentation and defence of the thesis and oral opposition shall take place on campus, if nothing else is stated. The number of times that a student may be examined to get a passing grade on each of the examination components of the course is limited to five. The information before a course occasion states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed. An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.

The information before the start of the course states the assessment criteria and make explicit in which modes of examination that the learning outcomes are assessed.

An examiner can, after consulting the Disability Advisor at BTH, decide on a customized examination form for a student with a long-term disability to be provided with an examination equivalent to one given to a student who is not disabled.