

Linear Systems

Programme course

8 credits

Linjära system

TSBB32

Valid from: 2022 Spring semester

Determined by

Board of Studies for Computer Science and
Media Technology

Date determined

2021-09-01

Revision date

2021-05-05

Main field of study

Information Technology, Applied Mathematics, Electrical Engineering

Course level

First cycle

Advancement level

G2X

Course offered for

- Master of Science in Information Technology

Prerequisites

Calculus and linear algebra.

Fundamental knowledge in some programming language, for example Matlab, for generating simple graphs.

Intended learning outcomes

The course will give basic knowledge about time and frequency analysis of continuous-time signals and continuous-time linear systems. Some application areas are exemplified, in particular within electrical circuits and mechanical oscillation systems. The course will also give knowledge about the mathematical tools used in the course.

In short, after completed course the student should be able to:

- Determine, interpret and mathematically handle time domain properties of deterministic signals and linear systems.
- By using Fourier series, the Fourier transform and the Laplace transform determine, interpret and mathematically handle frequency domain properties and general transform representations of both signals and systems – in particular simple electrical circuits/systems and mechanical oscillation systems of order 2.
- Define various properties of linear systems and, in connection with problem solving, handle the consequences of these properties.
- By using appropriate methods, for a given input signal calculate the output signal from a linear time-invariant system, and also give an account of the possibilities

and limitations of different methods.

- Give a well structured and logically coherent account – using adequate terminology – of the connections between different concepts in the course.

There is also an element of report writing, after which the student is expected to write a longer technical project report according to principles related to scientific texts.

Course content

- Written communication, technical reports, technical and mathematical language.
- Signal properties, system properties.
- Basic properties of passive electric circuits.
- Linearization of non-linear systems. Particular application focus on mechanical oscillation systems.
- Differential equation representation of linear systems.
- Impulse response and step response. Convolution.
- Fourier series analysis of periodic signals.
- Fourier transform analysis of signals and systems. Frequency spectrum. The frequency response function.
- Laplace transform analysis of signals and systems. The transfer function, Pole-zero diagrams.
- Continuous-time passive frequency selective filters.

Teaching and working methods

Mainly lectures and voluntary so called TRP lessons, where the students solve problems on the whiteboard. The students also work in groups in a project, and the result is presented in the form of a technical report, requiring a good level of report design and content.

Most of the lectures are given in the form of "flipped classroom", where the students are expected to have watched related videos before the lectures.

For the MSc programme in Information Technology, the course applies problem-based learning.

The course runs over the entire spring semester.

Examination

UPG1	Communication	U, G	2 credits
UPG2	Group assignment	U, 3, 4, 5	3 credits
KTR1	Voluntary assignments	U, G	0 credits
TEN1	Written examination	U, 3, 4, 5	3 credits

At TEN1 and UPG2, approved students can receive either grades 3 or 5 and the course's

final grade will be the average grade for these two.

Throug an active participation on the lessons, the students can get credited points for the written exam. Detailed information about this can be found on the course web page.

Grades

Four-grade scale, digits, U, 3, 4, 5

Department

Institutionen för systemteknik

Director of Studies or equivalent

Lasse Alfredsson

Examiner

Lasse Alfredsson

Course website and other links

<https://www.cvl.isy.liu.se/education/undergraduate/TSBB32/>

Education components

Preliminary scheduled hours: 56 h

Recommended self-study hours: 157 h

Course literature

Rekommenderad bok är preliminärt "Tidskontinuerliga Signaler & System", Sune Söderkvist (Tryckeriet Erik Larsson) samt examinatorns övningsbok. Därutöver finns kompletterande material av examinatorn på kurswebbsidan.

Common rules

Course syllabus

A syllabus must be established for each course. The syllabus specifies the aim and contents of the course, and the prior knowledge that a student must have in order to be able to benefit from the course.

Timetabling

Courses are timetabled after a decision has been made for this course concerning its assignment to a timetable module.

Interruption in and deregistration from a course

The LiU decision, Guidelines concerning confirmation of participation in education (Dnr LiU-2020-02256), states that interruptions in study are to be recorded in Ladok. Thus, all students who do not participate in a course for which they have registered must record the interruption, such that the registration on the course can be removed. Deregistration from or interrupting a course is carried out using a web-based form: <https://www.lith.liu.se/for-studenter/kurskomplettering?f=en>.

Cancelled courses and changes to the course syllabus

Courses with few participants (fewer than 10) may be cancelled or organised in a manner that differs from that stated in the course syllabus. The Dean is to deliberate and decide whether a course is to be cancelled or changed from the course syllabus.

Guidelines relating to examinations and examiners

For details, see Guidelines for education and examination for first-cycle and second-cycle education at Linköping University, Dnr LiU-2020-04501 (<http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592>).

An examiner must be employed as a teacher at LiU according to the LiU Regulations for Appointments, Dnr LiU-2021-01204

(<https://styrdokument.liu.se/Regelsamling/VisaBeslut/622784>). For courses in second-cycle, the following teachers can be appointed as examiner: Professor (including Adjunct and Visiting Professor), Associate Professor (including Adjunct), Senior Lecturer (including Adjunct and Visiting Senior Lecturer), Research Fellow, or Postdoc. For courses in first-cycle, Assistant Lecturer (including Adjunct and Visiting Assistant Lecturer) can also be appointed as examiner in addition to those listed for second-cycle courses. In exceptional cases, a Part-time Lecturer can also be appointed as an examiner at both first- and second cycle, see Delegation of authority for the Board of Faculty of Science and Engineering.

Forms of examination

Principles for examination

Written and oral examinations and digital and computer-based examinations are held at least three times a year: once immediately after the end of the course, once in August, and once (usually) in one of the re-examination periods. Examinations held at other times are to follow a decision of the board of studies.

Principles for examination scheduling for courses that follow the study periods:

- courses given in VT1 are examined for the first time in March, with re-examination in June and August
- courses given in VT2 are examined for the first time in May, with re-examination in August and October
- courses given in HT1 are examined for the first time in October, with re-examination in January and August
- courses given in HT2 are examined for the first time in January, with re-examination in March and in August.

The examination schedule is based on the structure of timetable modules, but there may be deviations from this, mainly in the case of courses that are studied and examined for several programmes and in lower grades (i.e. 1 and 2).

Examinations for courses that the board of studies has decided are to be held in alternate years are held three times during the school year in which the course is given according to the principles stated above.

Examinations for courses that are cancelled or rescheduled such that they are not given in one or several years are held three times during the year that immediately follows the course, with examination scheduling that corresponds to the scheduling that was in force before the course was cancelled or rescheduled.

When a course is given for the last time, the regular examination and two re-examinations will be offered. Thereafter, examinations are phased out by offering three examinations during the following academic year at the same times as the examinations in any substitute course. If there is no substitute course, three examinations will be offered during re-examination periods during the following academic year. Other examination times are decided by the board of studies. In all cases above, the examination is also offered one more time during the academic year after the following, unless the board of studies decides otherwise. In total, 6 re-examinations are offered, of which 2 are regular re-examinations. In the examination registration system, the examinations given for the penultimate time and the last time are denoted.

If a course is given during several periods of the year (for programmes, or on different occasions for different programmes) the board or boards of studies determine together the scheduling and frequency of re-examination occasions.

Retakes of other forms of examination

Regulations concerning retakes of other forms of examination than written examinations and digital and computer-based examinations are given in the LiU guidelines for examinations and examiners,

<http://stydokument.liu.se/Regelsamling/VisaBeslut/917592>.

Registration for examination

In order to take an written, digital or computer-based examination, registration in advance is mandatory, see decision in the university's rule book <https://stydokument.liu.se/Regelsamling/VisaBeslut/622682>. An unregistered student can thus not be offered a place. The registration is done at the Student Portal or in the LiU-app during the registration period. The registration period opens 30 days before the date of the examination and closes 10 days before the date of the examination. Candidates are informed of the location of the examination by email, four days in advance.

Code of conduct for students during examinations

Details are given in a decision in the university's rule book:

<http://styrdokument.liu.se/Regelsamling/VisaBeslut/622682>.

Retakes for higher grade

Students at the Institute of Technology at LiU have the right to retake written examinations and digital and computer-based examinations in an attempt to achieve a higher grade. This is valid for all examination components with code "TEN", "DIT" and "DAT". The same right may not be exercised for other examination components, unless otherwise specified in the course syllabus.

A retake is not possible on courses that are included in an issued degree diploma.

Grades

The grades that are preferably to be used are Fail (U), Pass (3), Pass not without distinction (4) and Pass with distinction (5).

- Grades U, 3, 4, 5 are to be awarded for courses that have written or digital examinations.
- Grades Fail (U) and Pass (G) may be awarded for courses with a large degree of practical components such as laboratory work, project work and group work.
- Grades Fail (U) and Pass (G) are to be used for degree projects and other independent work.

Examination components

The following examination components and associated module codes are used at the Faculty of Science and Engineering:

- Grades U, 3, 4, 5 are to be awarded for written examinations (TEN) and digital examinations (DIT).
- Examination components for which the grades Fail (U) and Pass (G) may be awarded are laboratory work (LAB), project work (PRA), preparatory written examination (KTR), digital preparatory written examination (DIK), oral examination (MUN), computer-based examination (DAT), home assignment (HEM), and assignment (UPG).

- Students receive grades either Fail (U) or Pass (G) for other examination components in which the examination criteria are satisfied principally through active attendance such as tutorial group (BAS) or examination item (MOM).
- Grades Fail (U) and Pass (G) are to be used for the examination components Opposition (OPPO) and Attendance at thesis presentation (AUSK) (i.e. part of the degree project).

In general, the following applies:

- Mandatory course components must be scored and given a module code.
- Examination components that are not scored, cannot be mandatory. Hence, it is voluntary to participate in these examinations, and the voluntariness must be clearly stated. Additionally, if there are any associated conditions to the examination component, these must be clearly stated as well.
- For courses with more than one examination component with grades U,3,4,5, it shall be clearly stated how the final grade is weighted.

For mandatory components, the following applies (in accordance with the LiU Guidelines for education and examination for first-cycle and second-cycle education at Linköping University, <http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592>):

- If special circumstances prevail, and if it is possible with consideration of the nature of the compulsory component, the examiner may decide to replace the compulsory component with another equivalent component.

For possibilities to alternative forms of examinations, the following applies (in accordance with the LiU Guidelines for education and examination for first-cycle and second-cycle education at Linköping University, <http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592>):

- If the LiU coordinator for students with disabilities has granted a student the right to an adapted examination for a written examination in an examination hall, the student has the right to it.
- If the coordinator has recommended for the student an adapted examination or alternative form of examination, the examiner may grant this if the examiner assesses that it is possible, based on consideration of the course objectives.
- An examiner may also decide that an adapted examination or alternative form of examination if the examiner assessed that special circumstances prevail, and the examiner assesses that it is possible while maintaining the objectives of the course.

Reporting of examination results

The examination results for a student are reported at the relevant department.

Plagiarism

For examinations that involve the writing of reports, in cases in which it can be assumed that the student has had access to other sources (such as during project work, writing essays, etc.), the material submitted must be prepared in accordance with principles for acceptable practice when referring to sources (references or quotations for which the source is specified) when the text, images, ideas, data, etc. of other people are used. It is also to be made clear whether the author has reused his or her own text, images, ideas, data, etc. from previous examinations, such as degree projects, project reports, etc. (this is sometimes known as “self-plagiarism”).

A failure to specify such sources may be regarded as attempted deception during examination.

Attempts to cheat

In the event of a suspected attempt by a student to cheat during an examination, or when study performance is to be assessed as specified in Chapter 10 of the Higher Education Ordinance, the examiner is to report this to the disciplinary board of the university. Possible consequences for the student are suspension from study and a formal warning. More information is available at

<https://www.student.liu.se/studenttjanster/lagar-regler-rattigheter?f=en>.

Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU's rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva.

