VEKTORANALYS

HT 2022

CELTE / CENMI

ED1110 Vektoranalys 4.5 hp

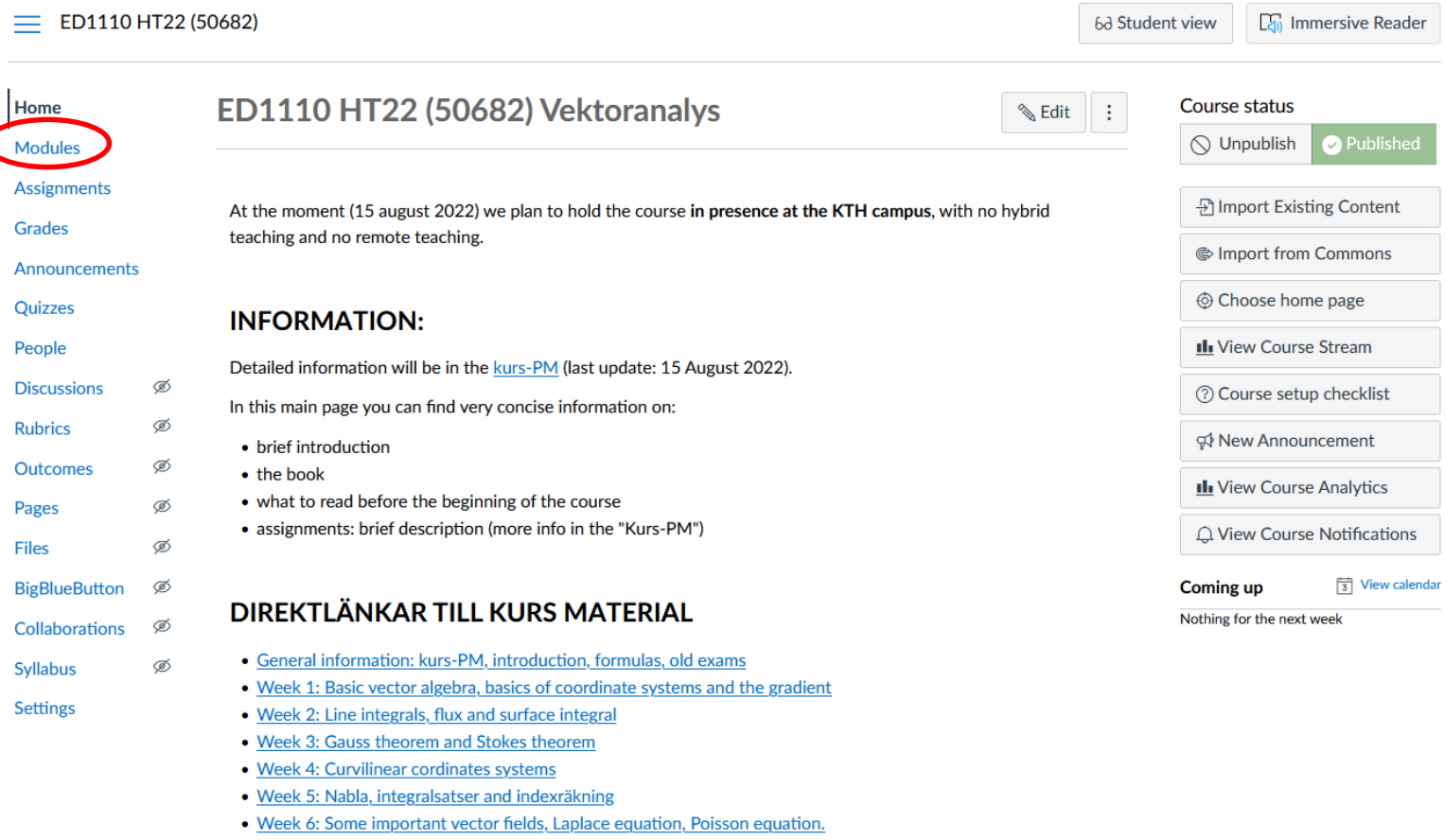
version: 16-aug-2022

1. THE COURSE WEBSITE: CANVAS

Address: https://canvas.kth.se/courses/34645

Information on the website:

- the kurs-PM (under “modules”)
- the slides of each lesson (under “modules”)
- earlier exams with solution (under “modules”)
- some solved exercises (under “modules”)



2. TEACHERS

Examiner and course responsible:

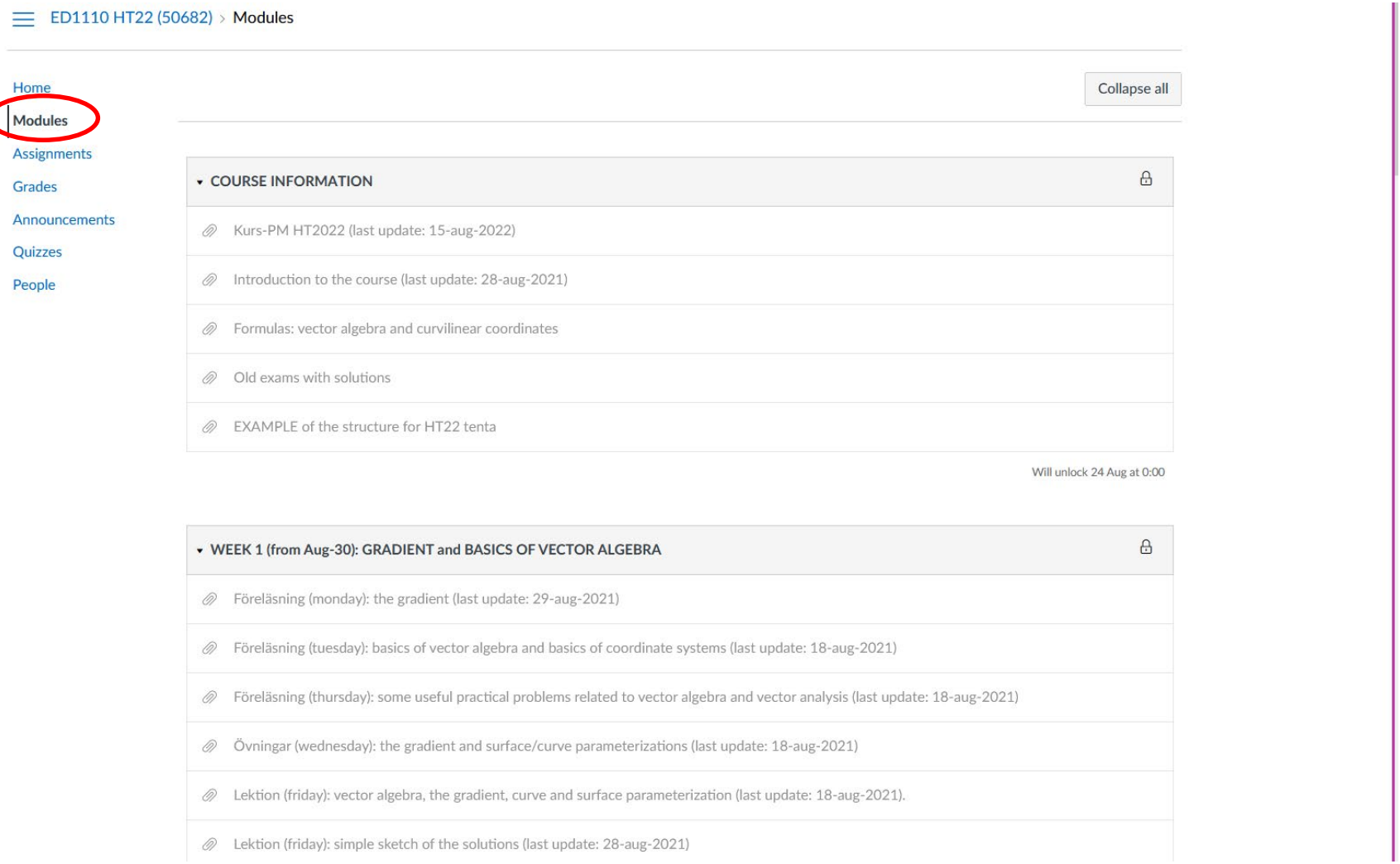
Lorenzo Frassinetti *e-mail: lorenzof@kth.se*

Teaching assistants

Erik Saad	*e-mail: esaad@kth.se*	*Group A*
Laura Dittrich	*e-mail: lauradi@kth.se*	*Group B*
Björn Zaar	*e-mail: bzaar@kth.se*	*Group B*
Hampus Nyström	*e-mail: hampusny@kth.se*	*Group C*

3. THE KURS-PM and other material

All the materials (slides of “föreläsning”, exercises, old exams) is on CANVAS:
https://canvas.kth.se/courses/34645/modules



4. THE BOOK

Title: Vektoranalys

Authors: L. Frassinetti, J. Scheffel

Editor: Liber

ISBN: 978-91-47-12617-0

Homepage: https://www.liber.se/serie/vektoranalys-28150

On the homepage you can download useful files:

- **Errata** (list of typos and minor errors in the book). Please, look at it carefully.
  https://www.liber.se/plus/E471261701.pdf
- **Hints** to solve the exercises of the book.
  https://www.liber.se/plus/E471261702.pdf
- **Full solutions** to the exercises of the book.
  https://www.liber.se/plus/E471261703.pdf
- **Appendix**: practical applications of the basic concepts.
  https://www.liber.se/plus/E471261704.pdf

KURSNÄMD

- Please, nominate three class "spokespersons".
- There is an important requirement: a representative from each gender.

> *"KTH Equal opportunities policy: All genders are given the opportunity of collaborating on equal conditions. All genders must have equal rights, obligations and opportunities at KTH."*

- Role of the "kursnämd"
  1. They will communicate suggestions/comments to the teacher in order to improve the course.
  2. In case of any problem, if you do not feel comfortable to contact directly the teachers, please contact the kursnämd. They will report to the problem to the teacher.

- Meetings with the "kursnämd"
  1. The teacher will meet the kursnämd twice: week 36 and week 38
  2. Likely, the meetings will be via zoom

CONTENT OF THE COURSE

Vecka 1

- Grundläggande vektoralgebra (Kapitel 1)
- Derivering och integration av vektorvärda funktioner i kartesiska, cylindriska och sfäriska koordinatsystem (Kapitel 2, 3)
- Gradienten och riktningsderivatan (Kapitel 4)
- Potentialen (Kapitel 5)

Vecka 2

- Linjeintegraler (Kapitel 6)
- Ytintegraler (Kapitel 7)

Vecka 3

- Divergensen och Gauss' sats (Kapitel 8)
- Rotationen och Stokes' satser (Kapitel 9)

Vecka 4

- Kroklinjiga koordinatsystem (Kapitel 10)

Vecka 5

- Nablaoperatorn och nablaräkning (Kapitel 11, 14)
- Indexräkning (Kapitel 12)
- Integralsatser (Kapitel 15)

Vecka 6

- Viktiga vektorfält och integration av dessa (Kapitel 16)
- Laplaces och Poissons ekvationer (Kapitel 17)

Vi kommer inte att läsa Kapitel 13 och Sektion 17.4

STRUCTURE OF THE COURSE

1. Föreläsningar. Teacher: Lorenzo Frassinetti (*lorenzof@kth.se*)

2. Övningar:

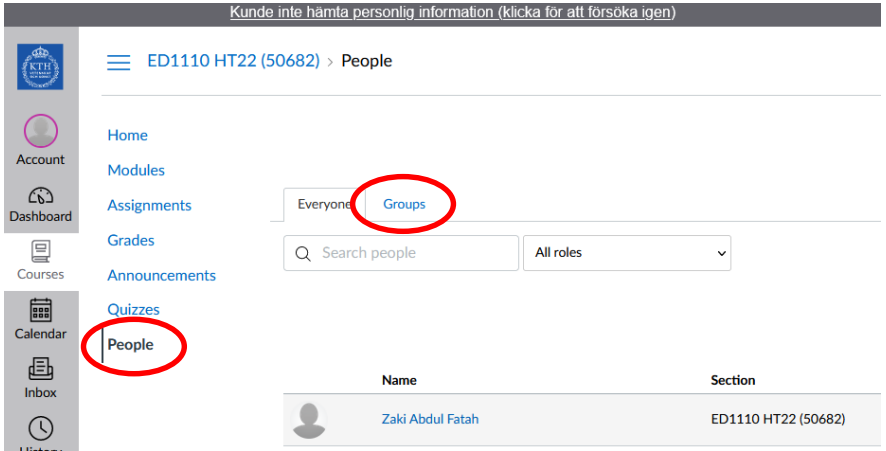
group A. Teacher: Erik Saad (*esaad@kth.se*)
group B. Teachers: Björn Zaar (*bzaar@kth.se*)
Laura Dittrich (*lauradi@kth.se*)
group C: Teacher: Hampus Nyström (*hampusny@kth.se*)

3. Lektion

group A. Teacher: Erik Saad (*esaad@kth.se*)
group B. Teachers: Björn Zaar (*bzaar@kth.se*)
Laura Dittrich (*lauradi@kth.se*)
group C: Teacher: Hampus Nyström (*hampusny@kth.se*)

To check the group you have been assigned to:

- Go in canvas and select ”people”
- Select ”group”



Föreläsningar (between 4h and 7h per week)

- Each week presents two main topics.
- Each topic starts with a "målproblem":
  - At the beginning of the lecture, the "målproblem" is introduced.
  - During the main part of the lecture, the mathematical tools to solve the "målproblem" are presented
  - At the end of the lecture, the "målproblem" is solved using these new mathematical tools.

Home assignment: 5 exercises (apart week 1, which has 10 exercises).

- The home assignment will give points to pass the exams. It is NOT compulsory.
- You can discuss the solution with other student, but :
  - You must write the solution by yourself using your own words
  - plagiarism is not allowed
  - if two or more students will have solutions too similar and we suspect plagiarism, we might report to KTH. So:
    - do not copy from other students
    - do not copy from the web
    - do not copy from any book.

- Often, the last exercise is on vector algebra.
- The home assignment must be handed at the beginning of the "föreläsning" of the following week.
- *More info later in this presentation.*

Övningar (typically 2h per week)

The aim is to:

- give practical applications of vector analysis
- train you to go from problem formulation to the final solution

PART 1:

The teacher solve some problems related to the topics discussed during the lecture.

- We start from a simple problem and at the end of the lesson we solve something more advanced.

PART 2: Last 30min of the second hour

- 25minuts for: **GROUP ASSIGNMENT**
  - you will be divided in small groups composed of 2 or 3 people in zoom breakout rooms (or in the class).
  - You have to discuss the solution of the assignment within your group.
  - You can use your notes. Not the book nor the web.
  - We accept only one solution per group (so we do not accept individual solutions)
- In the last 5min we show the solution on the board
  - We will hand out red pens and you are supposed to self-correct your own solution, before handing it in
- The assignment is NOT compulsory but can give points for the exam.

Lektion (typically 2h per week)

PART 1:

- You will be able to download from CANVAS some problems and then you are supposed to solve them by yourself.
- The teacher will be available for any question and clarification.

PART 2: Last 30min of the second hour

- 25minuts for: **INDIVIDUAL ASSIGNMENT**
  - You will solve individually a problem.
  - You can use your notes. Not the book nor the web.
- In the last 5min we show the solution on the board
  - We will hand out red pens and you are supposed to self-correct your own solution before handing it in.

- The assignment is NOT compulsory but can give points for the exam.

LÄRANDEMÅL (ILOs)

The course has 6 Intended Learning Outcomes (ILOs or ”lärandemål”). Each week is devoted to a specific ILO.

1. *tillämpa vektoralgebra och använda gradienten av skalärfält för att lösa elementära problem inom fysiken*
2. *utföra linje-, yt- och volymsintegration samt derivering av skalärfält och vektorfält*
3. *fysikaliskt tolka divergensen och rotationen och tillämpa dessa operatorer för att utföra yt- och linjeintegration med hjälp av Gauss’ och Stokes’ satser*
4. *identifiera det mesta lämpliga koordinatsystemet för ett givet problem och tillämpa gradienten, divergensen och rotationen i det utvalda koordinatsystemet*
5. *använda nablaräkning och indexräkning för att förenkla och utföra vektoranalytiska beräkningar*
6. *lösa Poissons ekvation med lämpliga randvillkor för problem med cylindriska och sfäriska symmetrier.*

To pass the course, all the ILOs must be fulfilled.
We will test 1 ILO per week.

CONTINUAL EXAMINATION (not compulsory)

- The **continual examination** is the set of:
  - (a) **home assignments**
    - they must be handed in at the beginning of the "föreläsning" of the following week (so you have 1 week)
    - Grade of each assignment: maximum 0.5 points.
    - The solutions must be:
      - Individual: you can discuss with other students, but you have to write your own solutions. **Plagiarism is not allowed**. Identical solutions from two students will not be accepted.
      - precise and exact: the correct logic is not sufficient for full points
      - well written and clear to read: if we cannot read the assignment → 0 points
      - use the standard and correct mathematical notation → each error on vector algebra notation is -0.05 points
  - (b) **group assignment** at the end of the "övning"
    - Duration: 25min. Two-three students per group (groups are made by the teacher)
    - Grade of each group assignment: maximum 0.5points.
    - You can use your notes. You cannot use the book nor the web.
  - (c) **individual assignment** at the end of the "lektion"
    - Duration: 25min.
    - Grade of each individual assignment: maximum 1 point.
    - You can use your notes. You cannot use the book not the web.

- We will have an home assignment, a group assignment and an individual assignment, each week. They will be used to test if you have fulfilled the ILO of the week.
- An ILO is considered to be fulfilled if you achieve **at least 1.5 points** when adding together the points from the **home assignment, the group assignment** and **the individual assignment**.
- To pass the course and reach grade E you need to fulfil all the six ILOs either via:
  - the continual examination
  - the final exam
- If you fulfil an ILO during the continual examination, you can skip the corresponding problem at the final exam.
- Each fulfilled ILO during the continual examination gives 1.5 points for the final exams.
- A non-fulfilled ILOs during the continual examination gives 0 points for the final exams.

Submission of assignments: general comments

- We accept only printed assignements:
  - **No submission via CANVAS** (unless covid obliged us to move to on-line teaching)
  - **No submission via e-mail**

- Write your name on the top of the paper. We disregard assignments with no name.

- Your handwriting must be clear and legible.

- **If the teacher can not read your solution, the assignment will not be graded.**

- use clear logic steps.

- highlight the solution (for example with a double line).

- simplify mathematical expressions (for example: 8/2 wtite 4, $9^{1/2}$ write 3)

- Remember: each notation error in the home assignment will lead to -0.05p.
  - be very careful and cross-check your home assignment several times
  - It is not uncommon that some students have perfect solutions but they get 0 points only due to notation errors.
  - You have been warned! Cross-check your home assignment several times.

TENTA

Do you need to attend the "tenta"?

You need to attend the "tenta" if:

- you have not attended the continual examination
- you have not fulfilled all the ILOs during the continual examination
- you have fulfilled all the ILOs but you want a grade higher than E

How is the tenta structured?

The tenta has 8 problems. **Each problem can give up to 3 points**.

The tenta will contain two types of problems

- 6 basic problems, one problem per ILO. Maximum 3 points per problem.
- 2 advanced problems, for those who want grade B or grade A. Maximum 3 points per problem.
- At least one problem will be theoretical where you have to prove one of the theorems done during lectures.

If you have passed only some ILOs during the continual examination, which problems should you solve?

To reach E, you need to

- solve the **problems corresponding to the ILOs that you have not yet fulfilled** in the continual examination **and** teach at least **1.5 points per problem**.
- **Example:**
  - Student "Zlatan Ibrahimovic" has fulfilled ILO 1, ILO 3, ILO 4 and ILO 5 during the continual examination. But he has not fulfilled yet ILO 2 and ILO 6.
  - To reach E, Zlatan needs to attend the tenta and:
    - solve at least problem 2 and problem 6.
    - reach at least 1.5 points in problem 2 and 1.5 points in problem 6.

After all the six ILOs have been fulfilled (either from the continual examination or from the tenta), you will have **1.5 points per ILO**. So, in total 9 points. With this you have grade E.

TENTA

What should you do to get a grade higher than E?

If you want an higher grade, you need to attend the "tenta".
The requirememnt for higher grades are the following:

- **Grade D**: same requirements **as grade E** and at least a total of **12 points**
- **Grade C:** same requirements **as grade E** and at least a total of **15 points**
- **Grade B**: same requirements **as grade E** and at least a total of **18 points** (with at least **2 points from problem 7 or problem 8**, which are the advanced problems)
- **Grade A**: same requirements **as grade E** and at least a total of **21 points** (with at least **2 points from problem 7 and 2 points from problem 8**, which are the advanced problems)

What happens if you do not fulfil all the ILOs even after the tenta?

If you do not fulfil all the ILOs even after the tenta, there are two possibilities:

- if you have **fulfilled 4 ILOs or less**, you need to attend the **omtenta**
- if you have **fulfilled at least 5 ILOs**, the grade is **FX**

Omtenta

- Only the ILOs fulfilled during the continual examination will be valid
- The ILOs fulfilled at the tenta will NOT be valid anymore.

How to complete the course if you got FX?

If you got FX you need to:

- contact the teacher (L. Frassinetti)
- the teacher will send you a problem for each of the not fulfilled ILOs
- within 6 weeks from the end of the course you need to solve the problems and send them to me
- if you get at least 2.5points over 3 points per each problem, your grade will be updated.

Plussning

There is only one way to improve the grade you have received at the tenta:

- attend the omtenta in December. However, note that the ILOs fulfilled at the tenta will not be valid anymore. Only the ILOs fulfilled in the continual examination will be valid.

TENTAMEN

week 42	Thursday 2021-10-21		
	14:00-18:00	Tentamen	ED1110
week 51	Wednesday 2021-12-19		
	8:00-12:00	Omtenta	ED1110

- **Duration 4h**
- **In presence (unless KTH will change regulations due to covid)**
- Do not forget to apply for the tenta (same rule of any KTH course)
- Funka students: please, contact funka for details
- More details will be uploaded on CANVAS 1-2 weeks before the tenta and send via a CANVAS announcement

GRADES on CANVAS

- Results of the continual examination will be uploaded on CANVAS:

  https://canvas.kth.se/courses/34645/grades

- It is rather complicated to transfer the grades to CANVAS:
  - Please, be patient
  - check weekly that we have stored the correct grades (if not send us a polite e-mail)

Name	Due	Score	Out of
Individual assignment 1		1 (P)	1
Group assignment 1		0.1	0.25
Home assignment 1	2 Sep by 15:00	0.7	1
Intended Learning Outcome 1		1.5 (P)	1.5
Individual assignment 2		0 (F)	1
Group assignment 2		0.25	0.25
Home assignment 2	9 Sep by 8:00	0.95	1
Intended Learning Outcome 2		0 (F)	1.5

Week 1	29.33%	1.10 / 3.75
Week 2	72%	2.70 / 3.75
Week 3	56%	2.10 / 3.75
Week 4	66.67%	2.50 / 3.75
Week 5	60%	2.25 / 3.75
Week 6	94.67%	3.55 / 3.75
Tenta	N/A	0.00 / 0.00
Total	63.11%	14.20 / 22.50

GRADES on CANVAS

- Results of the continual examination will be uploaded on CANVAS:

  https://canvas.kth.se/courses/34645/grades

- It is rather complicated to transfer the grades to CANVAS:
  - Please, be patient
  - check weekly that we have stored the correct grades (if not send us a polite e-mail)

Name	Due	Score	Out of
Individual assignment 1		1 (P)	1
Group assignment 1		0.1	0.25
Home assignment 1	2 Sep by 15:00	0.7	1
Intended Learning Outcome 1		1.5 (P)	1.5
Individual assignment 2		0 (F)	1
Group assignment 2		0.25	0.25
Home assignment 2	9 Sep by 8:00	0.95	1
Intended Learning Outcome 2		0 (F)	1.5

Week 1	29.33%	1.10 / 3.75
Week 2	72%	2.70 / 3.75
Week 3	56%	2.10 / 3.75
Week 4	66.67%	2.50 / 3.75
Week 5	60%	2.25 / 3.75
Week 6	94.67%	3.55 / 3.75
Tenta	N/A	0.00 / 0.00
Total	63.11%	14.20 / 22.50

Neglect this part:
It is created automatically by CANVAS asnd I cannot remove it

WHY VECTOR ANALYSIS?

VECTOR ALGEBRA — sum, subtraction, scalar product, cross product } of vectors

VECTOR ANALYSIS — derivation and integration } of combinations of scalars and vectors

Essential tool in many areas of engineering and physics

WHY VECTOR ANALYSIS?

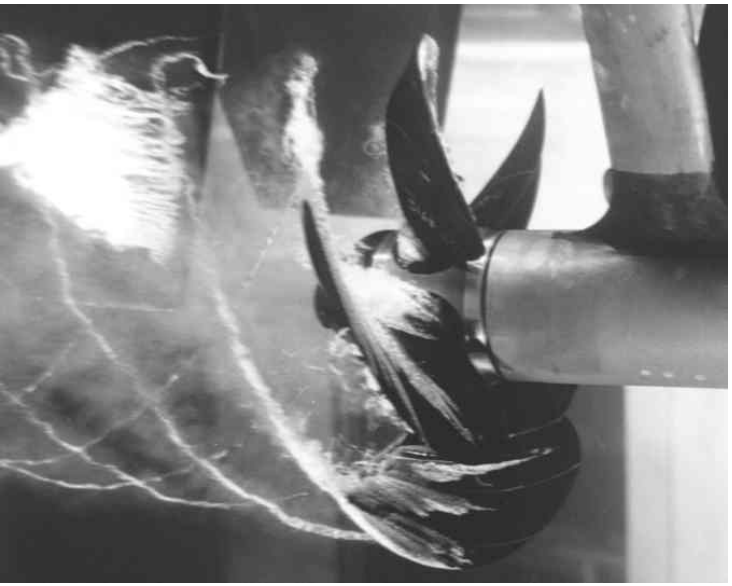
HYDRODYNAMIC: Navier-Stokes equations

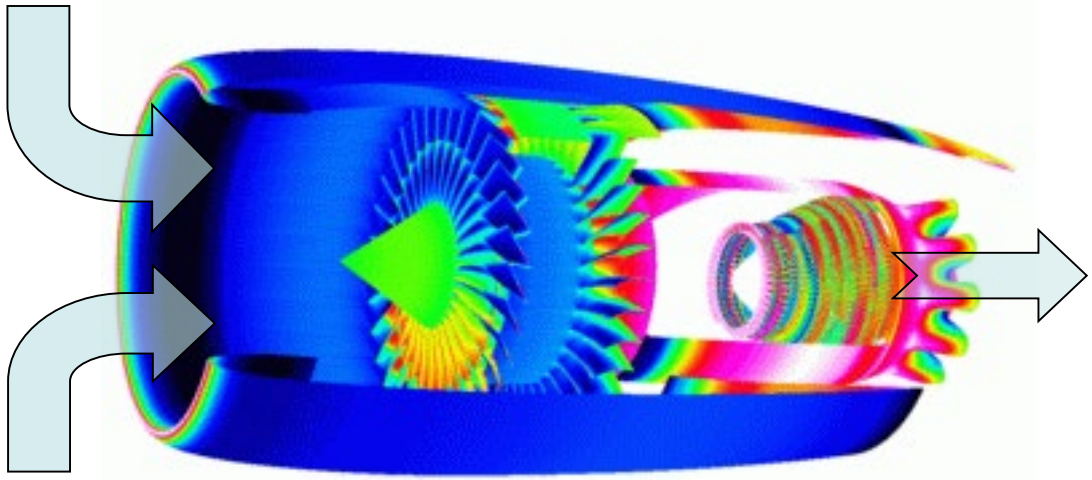
(meteorology, aero-space engineering, turbulence…)

$$\frac{\partial \rho}{\partial t} + \nabla \cdot \rho \overline{v} = 0$$

$$\nabla \cdot \overline{v} = 0$$

$$\rho\left(\frac{\partial \overline{v}}{\partial t} + \overline{v} \cdot \nabla \overline{v}\right) = -\nabla p + \mu \nabla^2 \overline{v} + \overline{f}$$





WHY VECTOR ANALYSIS?

THEORETICAL ELECTRONICS: Maxwell equations

(electronic engineering, telecommunications…)

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} - \vec{M}$$

$$\nabla \times \vec{H} = -\frac{\partial \vec{D}}{\partial t} + \vec{J}$$

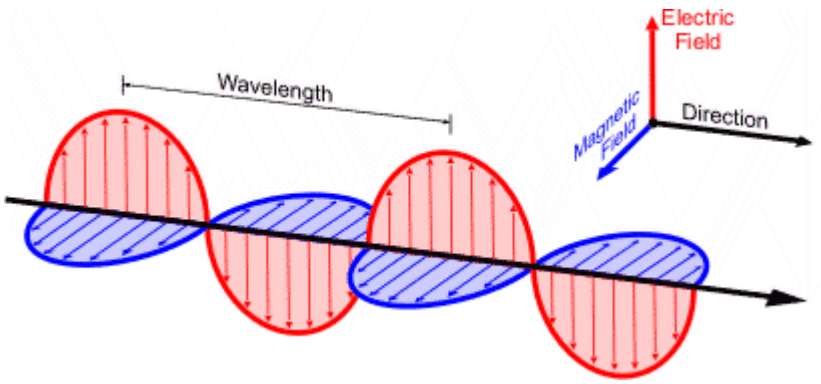
$$\nabla \cdot \vec{D} = \rho$$

$$\nabla \cdot \vec{B} = 0$$

Electromagnetic waves:

(electronic engineering, telecommunications…)

$$\nabla \times (\nabla \times \vec{E}) = -\mu_0 \varepsilon \frac{\partial^2 \vec{E}}{\partial t^2} - \mu_0 \frac{\partial \vec{j}}{\partial t}$$

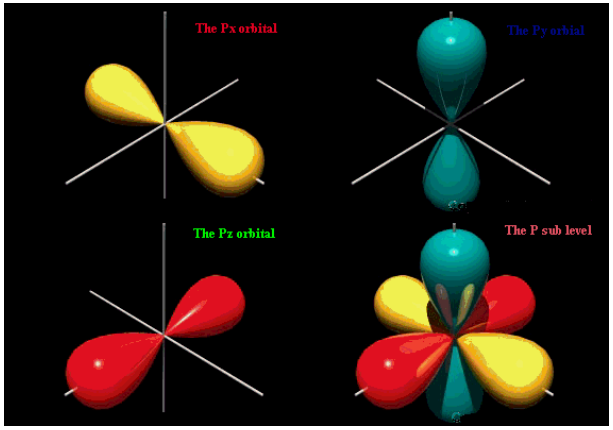


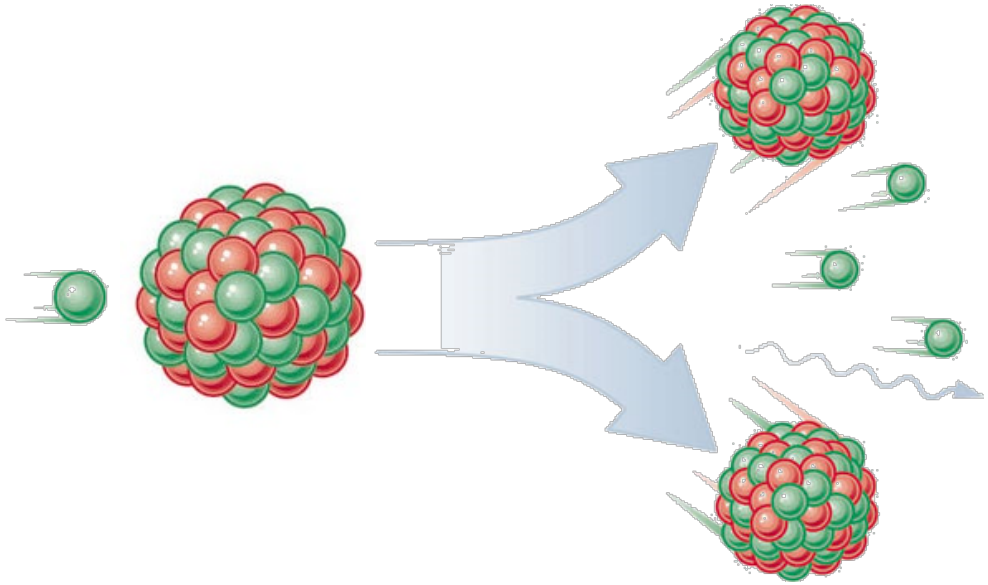
WHY VECTOR ANALYSIS?

MODERN PHYSICS: Schrödinger equation

(atom description, nuclear physics…)

$$i\hbar\frac{\partial}{\partial t}\psi = -\frac{\hbar^2}{2m}\nabla^2\psi + V\psi$$





WHY VECTOR ANALYSIS?

PLASMA PHYSICS: Magnetohydrodynamic equations

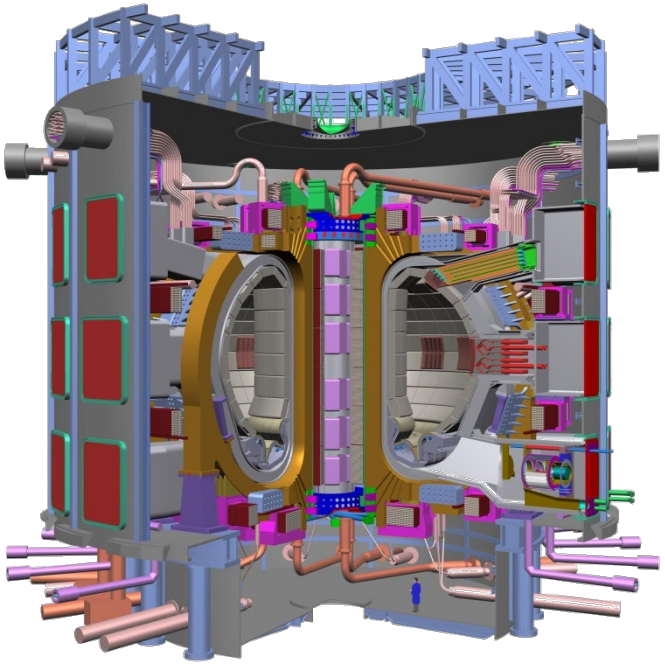
(dynamics of a electrically charged fluid "plasma": nuclear fusion, space physics…)

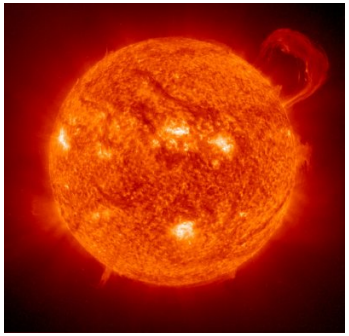
$$\rho\left[\frac{\partial \boldsymbol{v}}{\partial t} + (\boldsymbol{v}\cdot\nabla)\,\boldsymbol{v}\right] = \frac{1}{\mu}(\nabla\times\boldsymbol{B})\times\boldsymbol{B} - \nabla p,$$

$$\frac{\partial \boldsymbol{B}}{\partial t} = \nabla\times(\boldsymbol{v}\times\boldsymbol{B}) + \eta\nabla^2\boldsymbol{B},$$

$$\frac{\partial \rho}{\partial t} + \nabla\cdot(\rho\boldsymbol{v}) = 0,$$

$$\frac{\partial p}{\partial t} + (\boldsymbol{v}\cdot\nabla)\,p = -\gamma p\nabla\cdot\boldsymbol{v},$$





WHY VECTOR ANALYSIS?

EI1220 | 10.5 CREDITS

Subscribe

Course overview

News feed

Schedule

General

Kursmaterial

Course plan etc

Course wiki

Electromagnetic Theory E

Selection

Välkomment till Teoretisk elektroteknik E (TET-E)

Kursen ges under hösten 2016. Undervisningen **startar 28:a September**, en kursplan kommer upp i vecka dess förinnan, vi börjar första veckan med Kap. 3.1-3.3 samt kap 3.5 i Cheng.

Vi kommer att använda mycket information från vektoranalys, linjär algebra och differential-ekvationer och integration. Mycket av den matte som ingår i ingenjörsutbildningen används i kursen. Det är en bra ide att repetera före, och fundera igenom Greens sats, stokes sats, vektorer i sfäriska (cylindriska) koordinater, samt integraler av uttryck som (x^2+y^2)^(-1/2) mm. Lite repetition finns bla i kapitlen 2 i Cheng's Field and Wave Electromagnetics.

Vi kommer att använda **Cheng's Field and Wave Electromagnetics**, som lärobok tillsammans med **Gunnar Peterssons "Teoretisk Elektroteknik"** studie-häfte. Studiehäftet finns till försäljning på STEX och vid behov trycker vi upp ytterligare exemplar. Äldre elever som redan har Peterssons studie-häfte kan gärna använda dem. Det nya häftet har enstaka fel rättade, men stämmer i övrigt med de tidigare versionerna.

Mvh/Lars

REPORT ABUSE

▸ Course home page (in Swedish)

Teachers

Lars Jonsson
Examiner, Course responsible, Teacher

CELTE

WHY VECTOR ANALYSIS?

CENMI/ELP

ELECTROMAGNETIC THEORY, INTRODUCTORY COURSE FOR ENERGY AND ENVIRONMENT
EI1225 | 6.0 CREDITS

Subscribe

Course overview

News feed

Schedule

General

Course plan etc

Course wiki

KTH / COURSE WEB / ELECTROMAGNETIC THEORY, INTRODUCTORY COURSE FOR ENERGY AND ENVIRONMENT

Electromagnetic Theory, Introductory Course for Energy and Environment

Selection

Välkomment till Teoretisk elektroteknik ME (TET-ME)

Kursen ges under hösten 2015. Undervisningen startar 21:a September.

Vi kommer att använda Cheng's Field and Wave Electromagnetics, tillsammans med Gunnar Peterssons studie-häfte.

Kursen samundervisas med EI1220, och kursmaterial, kurspm mm kommer att finns på sidan EI1220-sidan

OBS! Hjälpmedel till tentan och kontrollskrivningar: 1 A4 med egna handskrivna anteckningar, samt beta formelsamling. Kursen EI1225 löper parallellt med EI1220 fram till och med 2:a kontrollskrivningen. Mvh/Lars

REPORT ABUSE

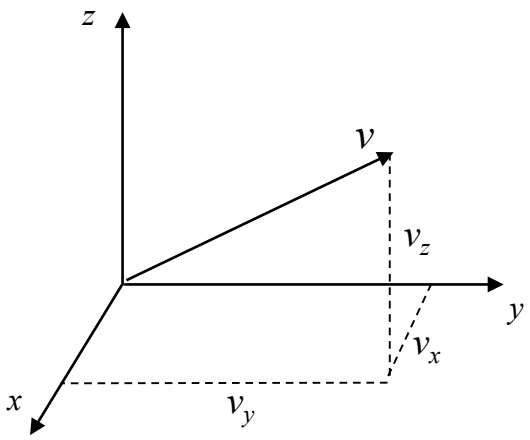
▸ Course home page (in Swedish)

Teachers

Lars Jonsson
Examiner, Course responsible, Teacher

VECTOR ALGEBRA

(A QUICK OVERVIEW)



$$\vec{v}=(v_x,v_y,v_z)$$

$$\boldsymbol{v}=(v_x,v_y,v_z)$$

$$\bar{v}=(v_x,v_y,v_z)$$

equivalent notations to identify a vector

always highlight that a variable is a vector!

Absolute value of a vector $\left|\bar{V}\right|=\sqrt{V_x^2+V_y^2+V_z^2}$

Sum $\bar{a}+\bar{b}=(a_x+b_x,a_y+b_y,a_z+b_z)$

Subtraction $\bar{a}-\bar{b}=\bar{a}+\left(-\bar{b}\right)=(a_x-b_x,a_y-b_y,a_z-b_z)$

Multiplication with a scalar c $c\bar{a}=(ca_x,ca_y,ca_z)$

Scalar product

$$\bar{a}\cdot\bar{b}=a_x\cdot b_x+a_y\cdot b_y+a_z\cdot b_z$$

$$\bar{a}\cdot\bar{b}=\left|\bar{a}\right|\left|\bar{b}\right|\cos\alpha$$

$$\bar{a}\cdot\bar{b}=0 \quad\Leftrightarrow\quad \bar{a}\perp\bar{b}$$

Basis vectors
in a Cartesian coordinate system:

$$\hat{e}_x=(1,0,0)$$

$$\hat{e}_y=(0,1,0)$$

$$\hat{e}_z=(0,0,1)$$

$$\Longrightarrow \bar{a}=a_x\hat{e}_x+a_y\hat{e}_y+a_z\hat{e}_z$$

Note that they have absolute value =1

poll 25

VECTOR ALGEBRA

(A QUICK OVERVIEW)

Cross product

$$\bar{a}\times\bar{b}=\begin{vmatrix}\hat{e}_x & \hat{e}_y & \hat{e}_z\\ a_x & a_y & a_z\\ b_x & b_y & b_z\end{vmatrix}$$

$$\left|\bar{a}\times\bar{b}\right|=\left|\bar{a}\right|\left|\bar{b}\right|\sin\alpha$$

$\bar{a}\times\bar{b}$ is a vector perpendicular to both $\bar{a}$ and $\bar{b}$

$$\bar{a}\times\bar{b}=-\bar{b}\times\bar{a}$$

$$\hat{e}_x\times\hat{e}_y=\hat{e}_z$$
$$\hat{e}_y\times\hat{e}_z=\hat{e}_x$$
$$\hat{e}_z\times\hat{e}_x=\hat{e}_y$$

VECTOR OR SCALAR?

(1) $a\,\overline{v}$ — vector

(2) $\overline{v}\,\overline{a}$ — wrong expression

(3) $\overline{k}\cdot\overline{n}$ — scalar

(4) $c\times\overline{n}$ — wrong expression

(5) $b\cdot\overline{a}$ — wrong expression

(6) $\overline{a}\times\overline{n}$ — vector

Which of these expressions is

a vector,

a scalar,

a wrong expression ?

Home assignments and final exam: -0.1 points each time you will write a wrong expression

Poll 4

VECTOR OR SCALAR?

(1) $\left(\left(c\,\bar{v}\right)\times\bar{b}\right)\cdot\bar{a}$ scalar

(2) $\left(\bar{v}\times\bar{a}\right)\bar{a}c$ wrong expression

(3) $\bar{b}\cdot\left(\bar{v}\times\bar{a}\right)c$ scalar

(4) $\left(\left(\left(\bar{c}\times\bar{n}\right)\times\bar{a}\right)\cdot\bar{b}\right)\bar{r}$ vector

(5) $\left(\bar{r}\cdot\bar{a}\right)\times\bar{n}\times\bar{v}$ wrong expression

(6) $\left(\left(\bar{a}\times\bar{n}\right)\cdot\bar{r}\right)\bar{v}\times\bar{n}\,d$ vector

Which of these expressions is

a vector,

a scalar,

a wrong expression ?

Home assignments and final exam: -0.1 points each time you will write a wrong expression