Electromagnetic Technologies

summer semester (January - February)

gregheins@ieee.org

Electromagnetic Technologies

We will:

- Understand
- Analyse
- Design
- Test

Electromagnetic devices

- Solenoids
- Motors
- Sensors

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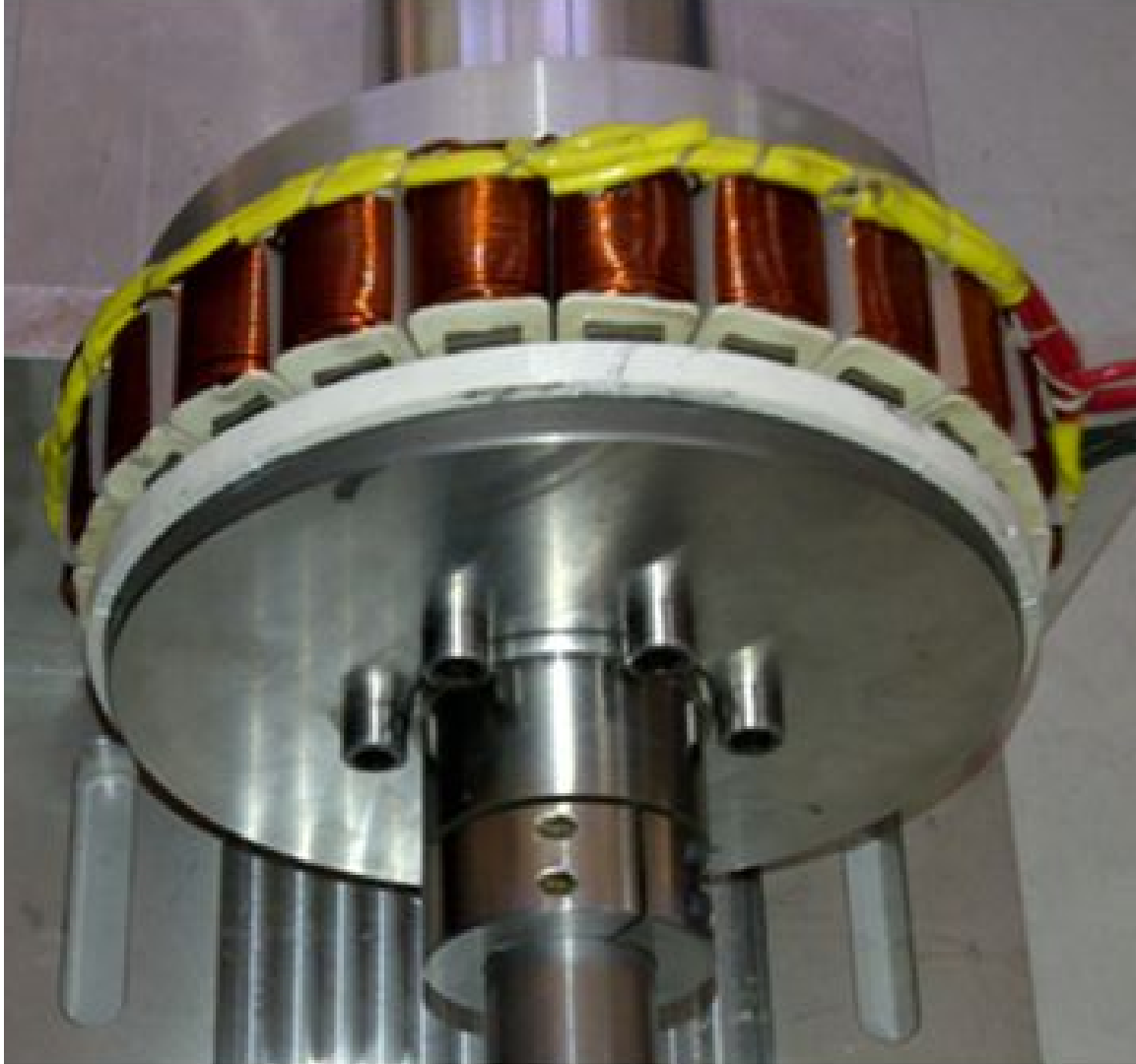


BOSCH


AURORA


CHARLES
DARWIN
UNIVERSITY


REGAL


POSTERA CRESCAM LAUDE
THE UNIVERSITY OF
MELBOURNE

https://www.regalbeloit.com/Products/Catalog?model=063T17FH5502

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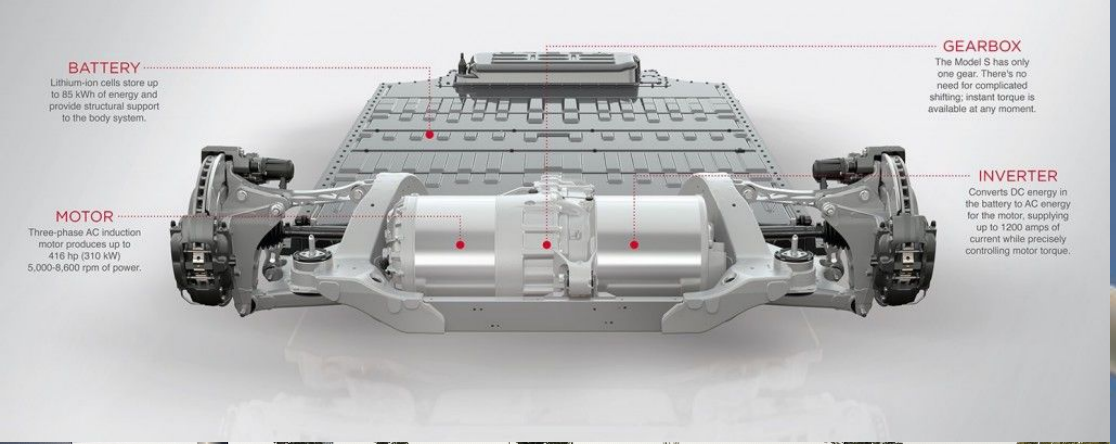
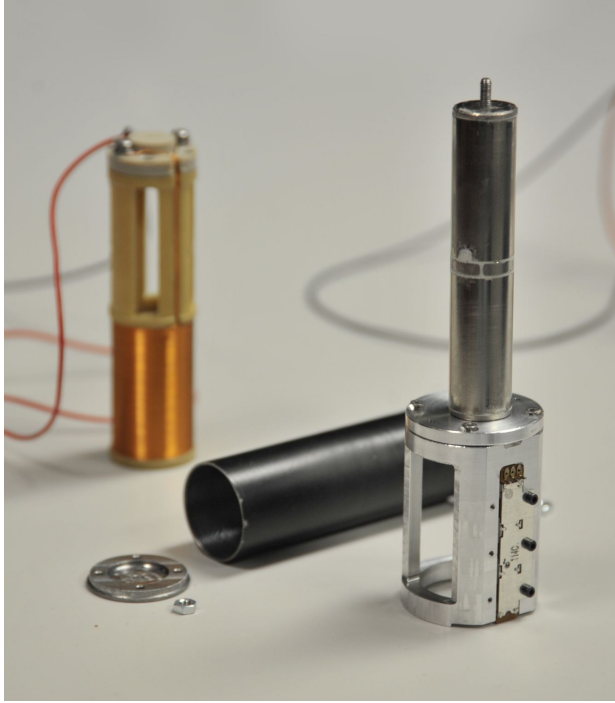

BATTERY
Lithium-ion cells store up to 85 kWh of energy and provide structural support to the body system.
GEARBOX
The Model S has only one gear. There's no need for complicated shifting; instant torque is available at any moment.
INVERTER
Converts DC energy in the battery to AC energy for the motor, supplying up to 1200 amps of current while precisely controlling motor torque.
MOTOR
Three-phase AC induction motor produces up to 416 hp (310 kW) 5,000-8,600 rpm of power.


Vestas



http://www.staradvertiser.com/wp-content/uploads/2016/10/web1_20161004-B5-HECO-Flywheel.jpg

Images courtesy of Bryan Ruddy (https://unidirectory.auckland.ac.nz/profile/brud999

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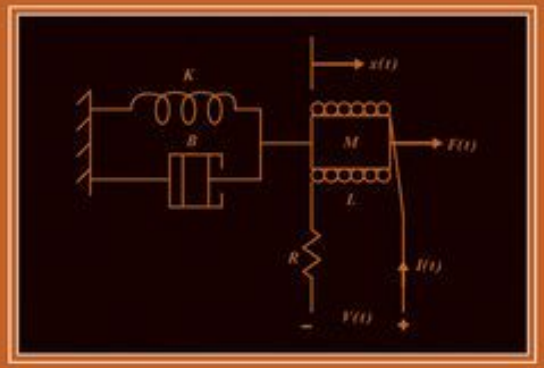
Second Edition

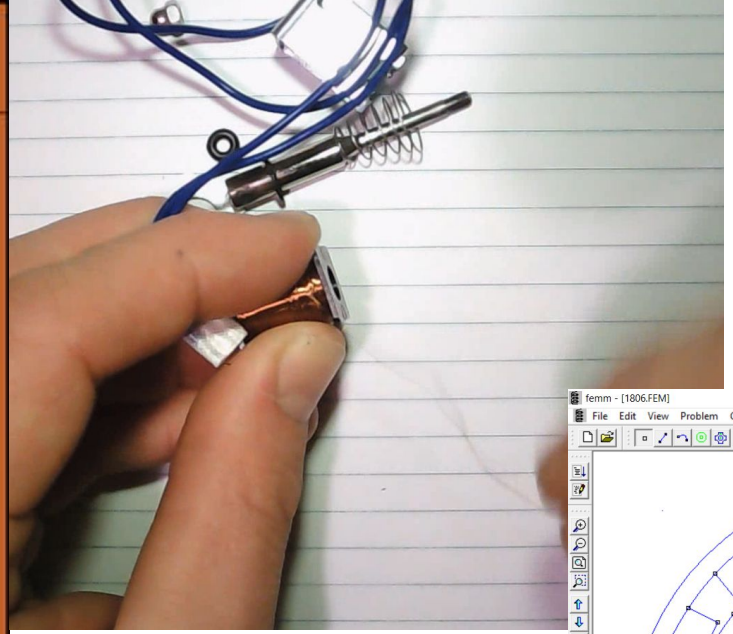
Magnetic Actuators and Sensors

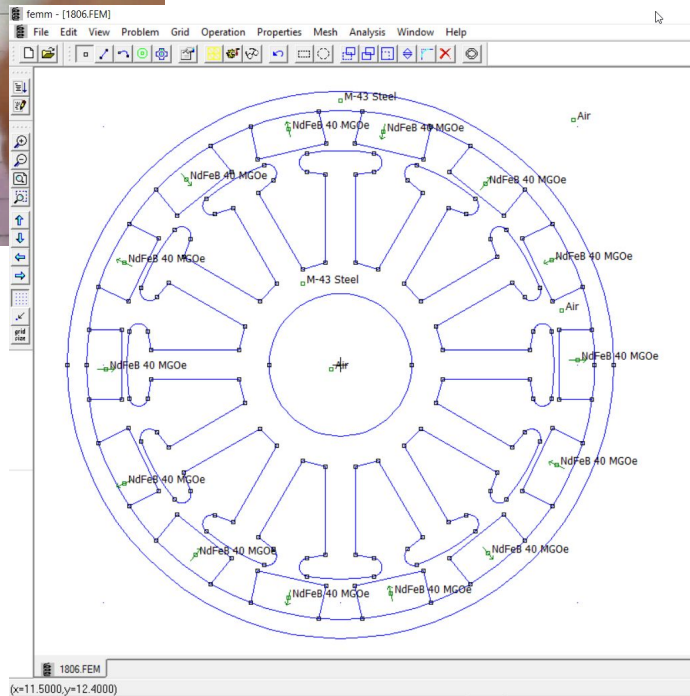


JOHN R. BRAUER

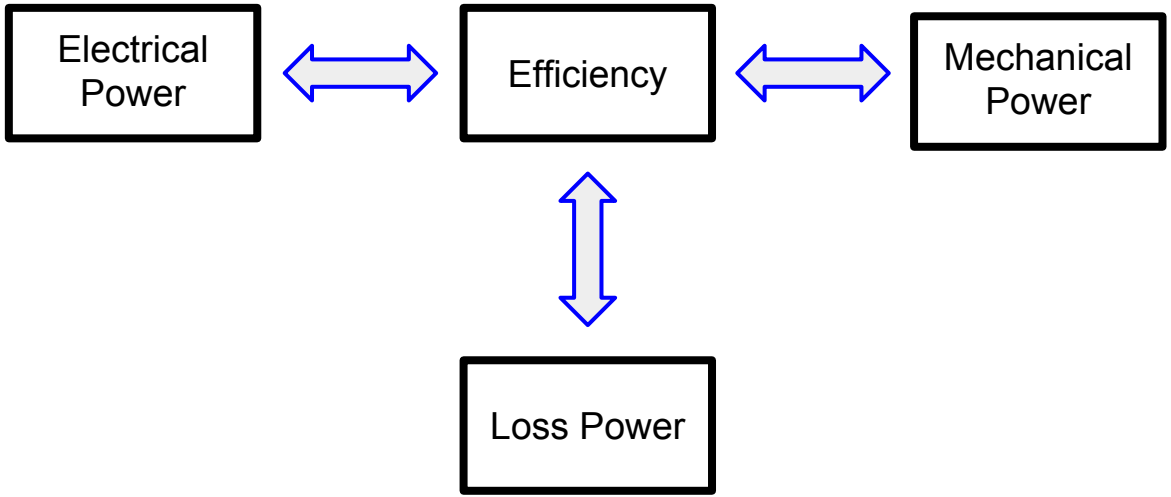
IEEE PRESS

WILEY





Course Goal



As engineers, there are 5 "real world" components we really care about:

- Voltage and Current (electrical power)
- Force and Velocity (mechanical power)
- Loss (heat power)

Other subjects (power electronics, analog electronics, dynamics, heat transfer) can help you convert those five components to other items but those 5 will be the primary focus of this course.

I don't really care about Flux Density, Magnetic Vector Potential etc by themselves.

As this is an industry focussed engineering course these are not the "end game"

However they are all critical stepping stones to help us calculate the five things we do care about.

Relationship between Electrical and Mechanical Engineering

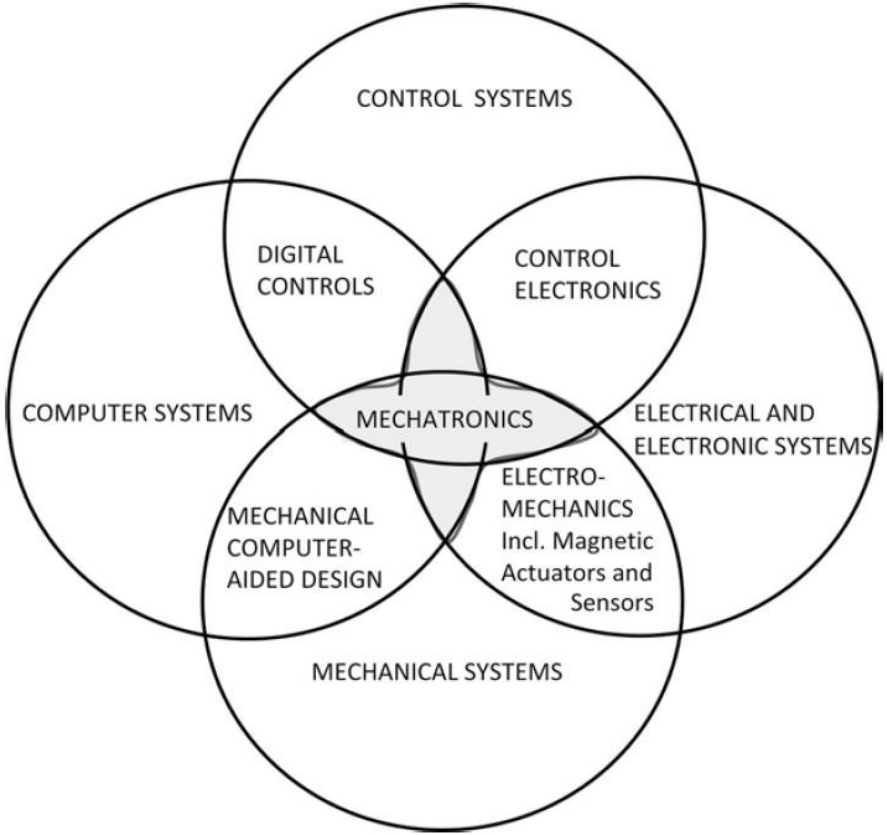


FIGURE 1.6 Venn diagram showing major engineering areas in mechatronics and how they relate to magnetic actuators and sensors.

Course overview

Background information

Week	Date	9 - 10am	10 - 11am	11 - 12noon	12 - 1pm	1 - 2pm	2 - 3pm	3 - 3.15pm	3.15 - 4.15pm	4.15 - 5.15pm
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2	15 January	Tutorial	Finite Element method (Ch 4)	Magnetic Force (Ch 5)	Lunch	Case study - Needleless injection	Acuators (DC) (Ch 7)	Break	Assignment introduction	Assignment introduction
3	22 January	Solenoind Assignment	Solenoind Assignment due	Other magnetic parameters (Ch 6)	Lunch	Case study - Denny	Acuators (AC) (Ch 8)	Break	Coil design (Ch 12)	Tutorial review
4	29 January	Quiz (wk 1 - 3)	Electric Machine Introduction	Electric Motor - Magnetic Design	Lunch	Case study - FSAE	Electric Motor - Electric Design	Break	Motor Analysis (FEA) + Motor test (inertia)	Motor Analysis (FEA) + Motor test (inertia)
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6	12 February	Motor Assignment due	Sensors (Ch 10)	Sensors FEA excersise	Lunch	Case study - LWS (steering wheel angle sensor)	Sensors (Ch 11)	Break	Tutorial reivew	Tutorial reivew

Assessment
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Case study

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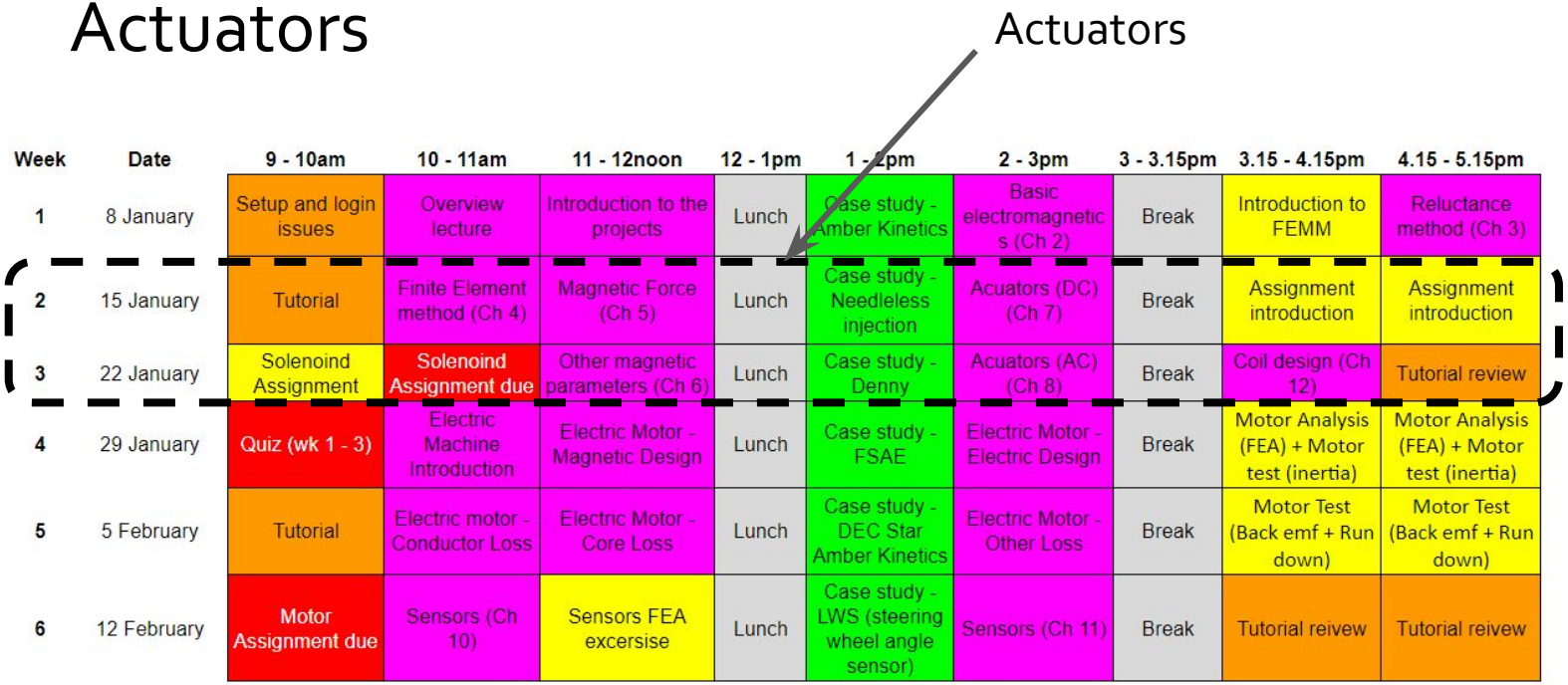
Actuators



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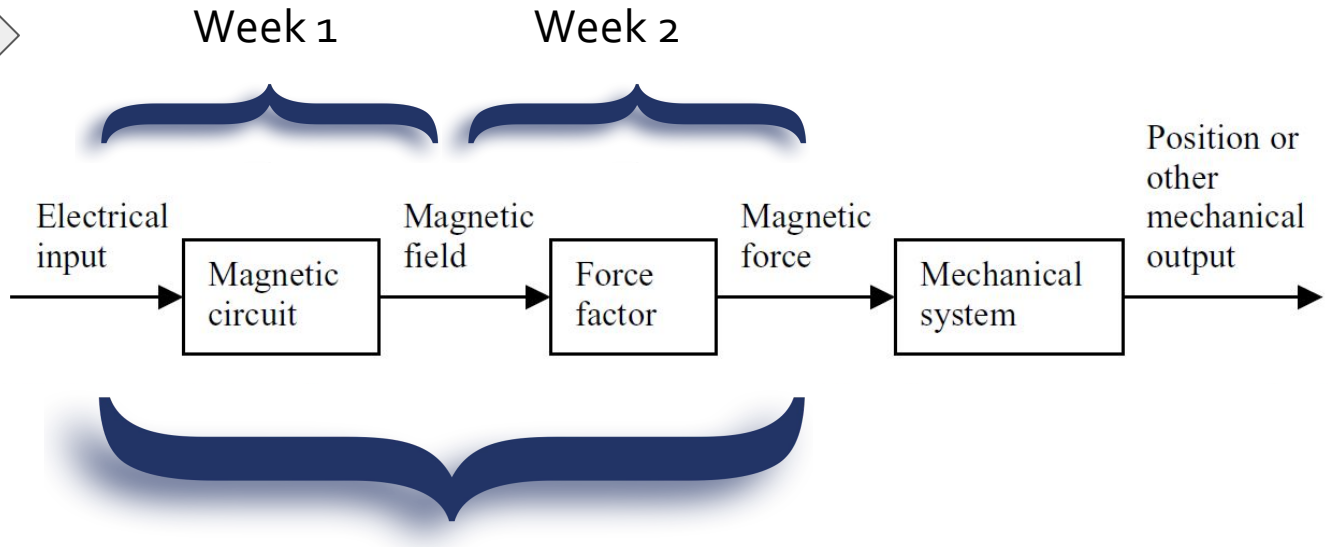
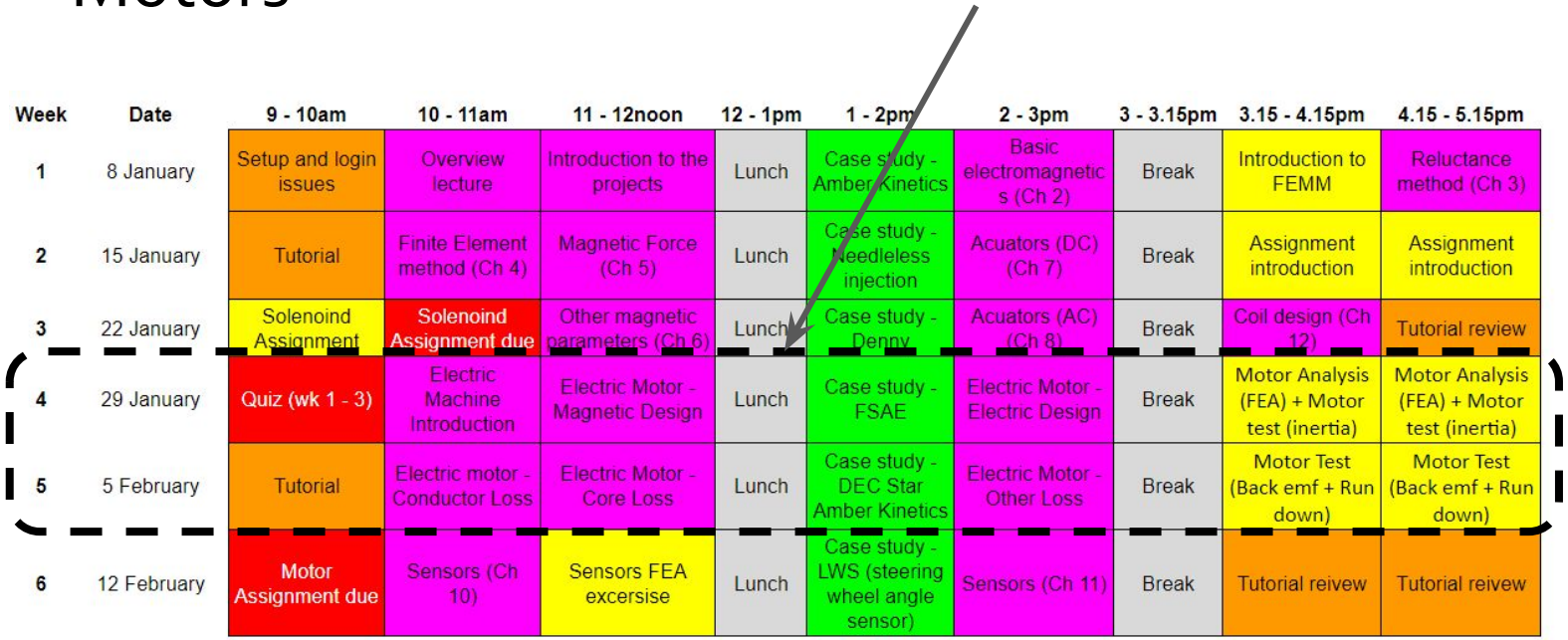
Actuator overview

Analytical



FEA

Motors



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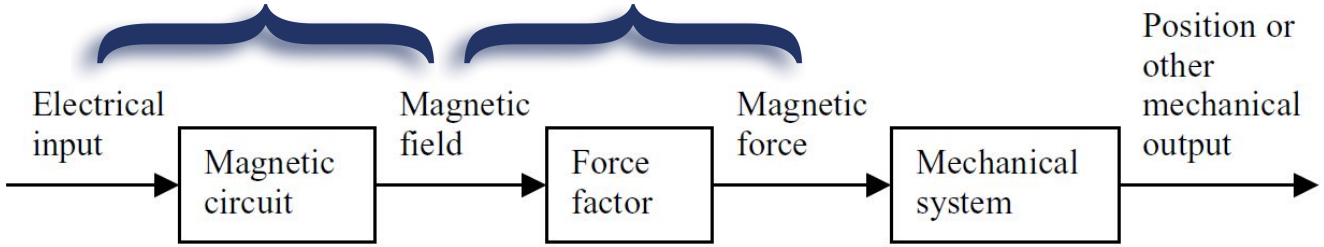
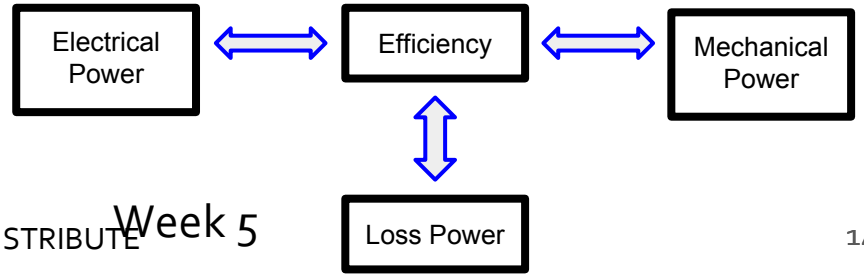
Motor overview

Analytical



FEA

Week 4



Week 5

Course overview

Sensors

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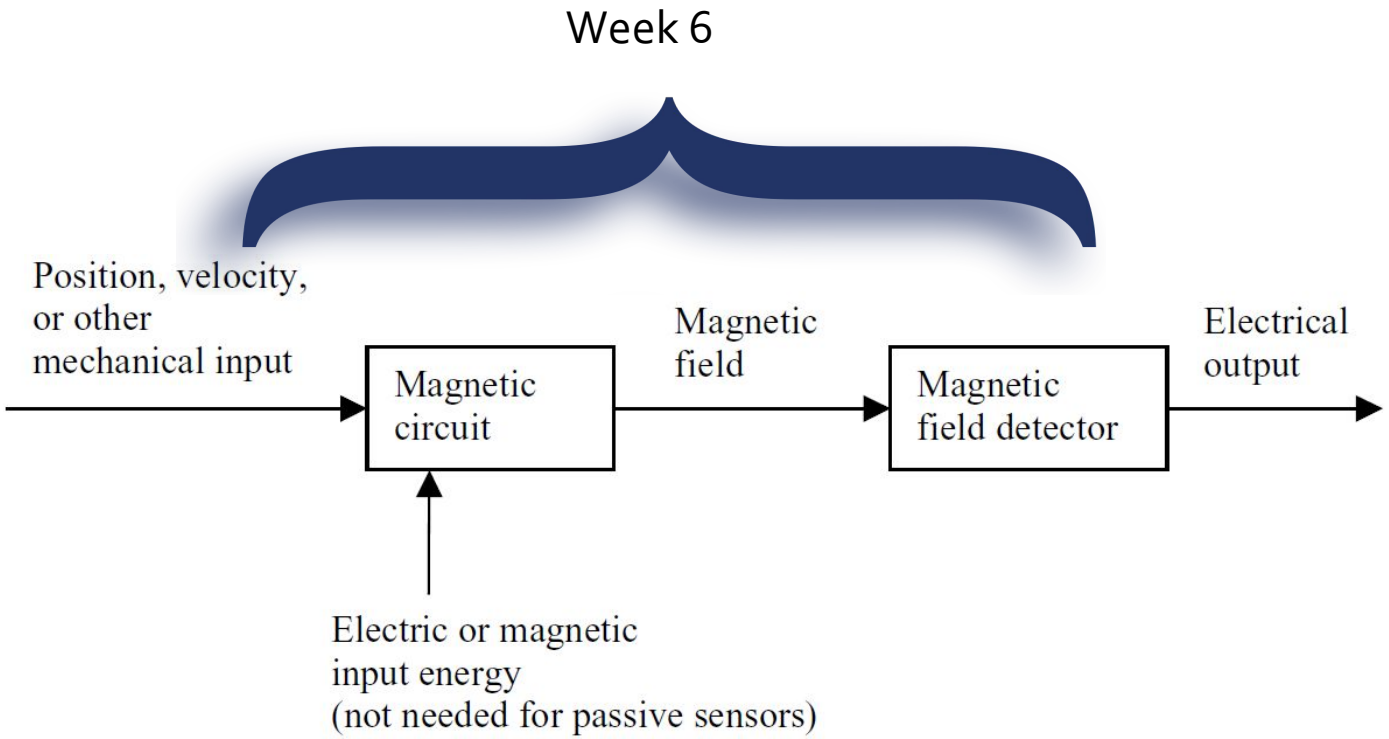
Sensor Overview



Course overview

Case Studies

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Assessment

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Tutorial

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Case study

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Goals of the "Case Study" Discussions

1. Introduced some people that have careers in Electromagnetic Technologies
2. Connect the learning in this course to the "real world" examples
3. Practice taking "real world" issues and distilling them to engineering design calculations.

Assessment - handbook

Description	Timing	Percentage
• Assignment 1	Week 3	15%
• Test	Week 4	15%
• Assignment 2	Week 6	20%
• Exam	End of semester	50%

Description

- Assignment 1 (15%), Solenoid actuator design and testing. Requires approximately 20 hours of work (not exceeding 10 pages). Due in week 3 of semester. Addresses Intended Learning Outcomes (ILOs) 1-7
- One hour quiz (15%). Duration 1 hour. Held in week 4 of 6. Addresses ILOs 1-7
- Assignment 2 (20%), Motor analysis and testing. Requires approximately 25 hours of work (not exceeding 10 pages). Due in week 6 of semester. Addresses ILOs 1-7
- Two hour final exam (50%). Held at the end of the teaching period. Addresses ILOs 1-7

Assessments

Assignments

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20% marks off 1 min late
20% marks off each week afterwards
100% marks off after exam (19th February)
Must be submitted via LMS (Blackboard)

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Assessments

Exams

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Final exam 10am Monday 19th February (venue TBA)

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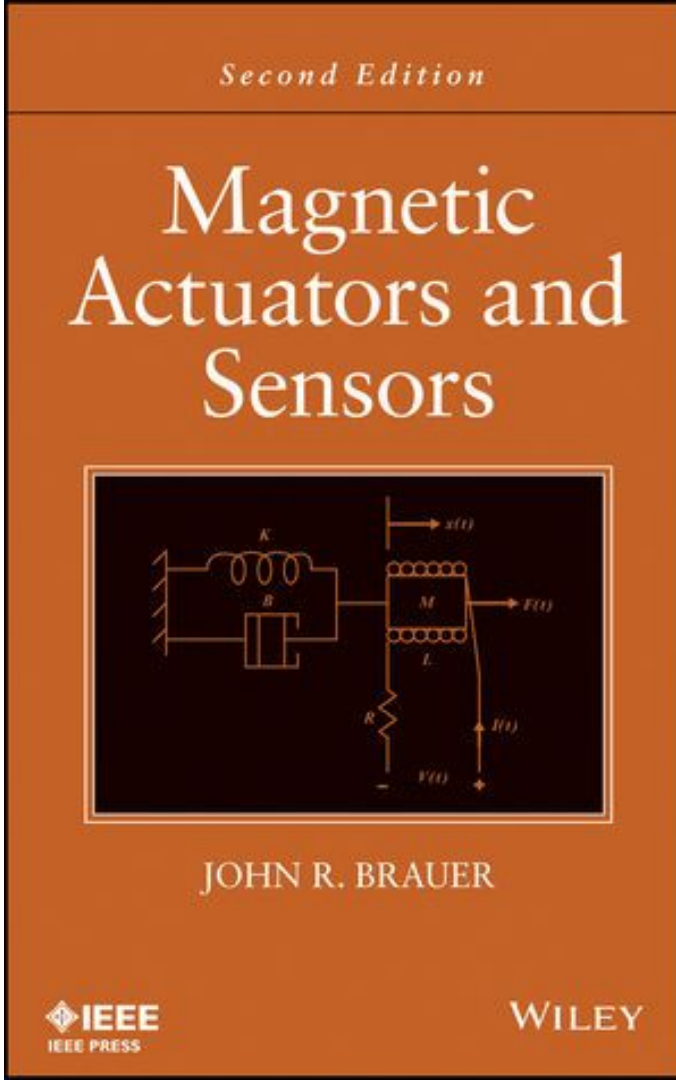
Textbook

- 2nd Edition (2014)
- Available in University Library (.pdf)
- Available online (paper and e-book)
- The lectures will closely follow this book
- Tutorial questions will be from the book
- All references in the lectures will come from this book unless otherwise stated



Online resources

The main site is on the University of Melbourne LMS (Blackboard) site

https://app.lms.unimelb.edu.au/webapps/blackboard/content/listContentEditable.jsp?content_id=_6421427_1&course_id=_367562_1&mode=reset

All submissions must be via this site

Most of the content is hosted on my own website:

https://sites.google.com/view/heins/course-outline

While this is publically available it is not indexed in search engines. Please do not distribute the content.

Assumed Knowledge

- Calculus
- Linear Algebra
- Unit vectors
- Basic Mechanical Engineering (eg $P = Fv$, $P = T\omega$, $KE = 1/2J\omega^2$,$PE = mgh$, $W = Fd$)
- Basic Electrical Engineering (eg $P= VI$, $V = IR$)

To get the most of of attending

1. Attend :)
2. Have a book ready for taking notes/ sketching
3. Have a computer ready to run FEMM
4. Ask questions
5. Answer questions
6. Review the notes/ videos afterwards (I will try to record all the lectures and upload to the website)
7. Tell me ASAP if there is something I can do to improve your learning experience