

# Analysis in Mechanical Engineering II

## EML 5061

### Syllabus

Dr. Leon van Dommelen

Fall 2015

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## 1 Credit Hours

3

## 2 Course Type

EML 4930: Technical Elective, no track. EML 5061: Core Graduate.

Note: 4930 is a catch-all number used for multiple classes. Make sure you signed up for the right section of 4930!

## 3 Terms Offered

Fall.

## 4 Catalog Description

This course familiarizes students with applications of vector calculus and partial differential equations in mechanical engineering.

## 5 Prerequisites

EML 5060, Analysis in Mechanical Engineering I or equivalent.

## 6 Instructor

Dr. Leon Van Dommelen<sup>1</sup>

**Office hours** MW 5–6:15 pm, or by appointment, in A242 CEB. I also give a help session MW 10:30–11:30 in TBA, which is open to all my classes.

**Phone** (850) 410-6324. I tend to forget to check my voice mail.

**E-mail** <mailto:dommelen@eng.fsu.edu>

**Web page** <http://www.eng.fsu.edu/~dommelen/index.html>

**Contact information** <http://www.eng.fsu.edu/~dommelen/contact>

## 7 Teaching Assistant

None.

## 8 Class Schedule

Class times: MWF 9:30-10:20 pm in A223 CEB (A building).

We will start with vector analysis, then proceed to partial differential equations.

The below schedule is subject to change.

- 08/24/15 M Vectors and scalars. Fields. Vector analysis.
- 08/26/15 W Products of vectors and their interpretation.
- 08/28/15 F Vector differentiation in Cartesian and polar coordinates.
- 08/31/15 M Intro to curve geometry. The twisted cubic.
- 09/02/15 W Frenet-Serret Formulae.
- 09/04/15 F Due: HW 1. Grad. Total derivatives.
- 09/07/15 M LABOR DAY ===== .
- 09/09/15 W Geometry of planes and lines. Div, curl.
- 09/11/15 F Due: HW 2. Interpretation. Conservative fields.
- 09/14/15 75 min M Helmholtz theorem. Vector integration. Surface integrals. Flux.
- 09/16/15 75 min W Divergence and Stokes theorems.
- 09/18/15 F No lecture.
- 09/21/15 M Due: HW 3. Coordinate changes: Jacobian matrix. Orthogonal coordinates.

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<sup>1</sup><http://www.eng.fsu.edu/~dommelen/contact>

- 09/23/15 W PDE. Orthogonal coordinates. Partial derivatives.
- 09/25/15 F Due: HW 4. Domains and their boundaries. Simple BC. Properly posedness.
- 09/28/15 M Properly posedness example. Properties of the heat equation.
- 09/30/15 W Properties of the Laplace equation.
- 10/02/15 F Due: HW 5. Properties of the wave equation. Improperly posed Laplace problem.
- 10/05/15 M Improperly posed wave equation problem. Classification of 2D second order equations. Example.
- 10/07/15 W Classification of nD second order equations. Example. Coordinate changes.
- 10/09/15 F Due: HW 6. Diagonalization by rotation of the coordinate system.
- 10/12/15 M Diagonalization by rotation of the coordinate system.
- 10/14/15 W Characteristic coordinates. Characteristics. General solution of the 1D wave equation.
- 10/16/15 F Due: HW 7. 2D parabolic and elliptic transformations.
- 10/19/15 M Uniqueness. Energy methods for the Laplace equation.
- 10/21/15 W Remarks on variational methods. Energy methods for the heat and wave equation.
- 10/23/15 F Due: HW 8. Introduction to Green's functions. Green's function solution of the one-dimensional Poisson equation in infinite space. Green's function solution of the two-dimensional Poisson equation in infinite space. Start of finite domain case. Finite domain integral.
- 10/26/15 M Finite domain. Panel methods. Start of Poisson integral formulae. Poisson integral formulae.
- 10/28/15 W Mid term review.
- 10/30/15 F Mid Term Exam
- 11/02/15 M Mean value theorem. Smoothness. Maximum/minimum property. First order equations.
- 11/04/15 W Example linear first order equation. SKIP: One-way traffic: conservation law, characteristics. Shocks. Expansion shocks. Entropy condition. Burger's equation. Need for the viscous equation to determine the conservation law.
- 11/06/15 F Due: HW 9 and 10. D'Alembert solution of the wave equation. Method of images.
- 11/09/15 M Laplace transform solution. Unidirectional viscous flow.
- 11/11/15 W VETERANS DAY =====

- 11/13/15 F Due: HW 11. Laplace transform solution. Steady supersonic flow.
- 11/16/15 M Intro to separation of variables: comparison with systems of ordinary differential equations.
- 11/18/15 W Separation of variables. Solution of the Sturm-Liouville eigenvalue problem.
- 11/20/15 F Due: HW 12. Finding the solution.
- 11/23/15 M Separation of variables: dealing with inhomogeneous boundary conditions.
- 11/25/15 W Thanksgiving.
- 11/27/15 F Thanksgiving.
- 11/30/15 M Due: HW 13. Inhomogeneous boundary conditions concluded. Solution due to unit-impulse initial condition. Solution of the inhomogeneous partial differential equation: Duhamel principle.
- 12/02/15 W Sturm-Liouville theorem. Application to a problem with convection.
- 12/04/15 F Due: HW 14. Finish problem with convection. Multi-dimensional unsteady problems in cylindrical coordinates.
- 12/10/15 Thursday 3-5 pm FINAL EXAM (in the usual classroom)
- 12/15/15 Grades due FAMU/FSU 5:00/4:00 pm
- 12/16/15 Grades available online

## 9 Textbooks

1. Spiegel, Murray S., Lipschutz, Seymour, & Spellman, Dennis, *Vector Analysis* Schaum's Outline Series (McGraw-Hill) 2nd Ed 2009. ISBN 978-0-07-161545-7.
2. DuChateau, Paul & Zachmann, David W, *Partial Differential Equations* Schaum's Outline Series (McGraw-Hill) 1986. ISBN 0-07-017897-6
3. Spiegel, Murray R, & Liu, John, *Mathematical Handbook of Formulas and Tables* Schaum's Outline Series (McGraw-Hill) 2nd edition 1999. ISBN 0-07-038203-4. (Recommended, but any mathematical handbook is allowed.)

References:

1. *Advanced Engineering Mathematics* by Peter V. O'Neil. Thomson-Engineering; 6th edition, 2007. ISBN: 0-534-55208-0.
2. *Advanced Engineering Mathematics* by Dennis G. Zill and Warren S. Wright. 5th Ed., 2014. Jones and Bartlett. ISBN-13: 9781449691721.

## 10 Science/Design

Engineering Science: 100%

## 11 Course Topics

- *Vector calculus.* Vector calculus and its application to geometry, boundary conditions, computational procedures.
- *Systems governed partial differential equations.* Partial differential equations and their application to solid and fluid mechanics, electromagnet fields, and quantum mechanics.

## 12 Assessment Tools

The course grade will be computed as:

- 20% Homework (See requirements below.)
- 40% Midterm
- 40% Final

Historically, the B/B– boundary has been at 75%.

Grading is at the discretion of the instructor.

You can miss two homeworks, their grades will be taken from the average of your other grades. You still need to know the material for the exams, but you can study the posted solutions.

See the exam calculator policy.<sup>2</sup>

## 13 Course Objectives

This course has several objectives, including:

1. Show how vector calculus and partial differential equations fit in the real-life world encountered by a mechanical engineer [1].
2. Explain the qualitative properties of partial differential equations [1].
3. Show how to solve the problem mathematically [1].

Numbers in square brackets refer to the departmental student program outcomes:

[http://www.eng.fsu.edu/me/undergrad/ed\\_objective.html](http://www.eng.fsu.edu/me/undergrad/ed_objective.html)

## 14 Student Learning Outcomes

The specific desired outcomes for the undergraduate students are:

1. Distill the mathematical part of a given problem containing a full mathematical problem in the areas of vector calculus or partial differential equations covered in class [1].

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<sup>2</sup><http://www.eng.fsu.edu/~dommelen/courses/aim/calc>

2. Determine whether a meaningful solution exists [1,2]
3. Solve the problem mathematically [3].

Samples of specific problems are in the lecture notes, old exams, and in homework assignments.

Numbers in square brackets refer to the Course Objectives above.

## 15 Methods of Instruction

Lectures, problem solving sessions, examinations, web-based information.

## 16 Computer Requirements

Students must have an E-mail address and daily check their E-mail. Students must be able to use a Web browser such as Firefox. The class web page can be accessed at:

<http://www.eng.fsu.edu/~dommelen/courses/aim2>

If you are taking this class remotely, contact the FEEDS office<sup>3</sup> for requirements.

## 17 Important Regulations

### 17.1 Must Check Dates Immediately

Immediately check all dates listed in this syllabus for any conflicts.

### 17.2 Homework

Homework should be neat. Questions must be answered in the order asked or 0 will be assigned.

Homework must be handed in at the *start* of the lecture at which it is due. It may *not* be handed in at the departmental office or at the end of class. Homework that is not received at the start of class on the due date listed above cannot be made up unless permission to hand in late has been given *before* the homework is due, or it was not humanly possible to ask for such permission before the class. If there is a chance you may be late in class, hand the homework in to the instructor the day before it is due. (Shove it under his door if necessary.) This also applies to Web students: they must E-mail the homework before the time the class starts.

### 17.3 Copying is Never Allowed

You must write *your own* homework solution *all by yourself*. You may not allow anyone else to see your solution. You must compute your own results. In case of evidence of copying, of homework all parties involved will receive 0 for the homework.

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<sup>3</sup><http://www.eng.fsu.edu/feeds>

However, working together with other students on homework, to figure out *how* to solve the problems is encouraged, as you will learn more with more points of view. But afterwards, you must apply the procedures yourself, in your own way, and determine the answers and any numerical values individually.

Exams should be made by each student separately. In case of evidence of copying in an exam, a zero grade will be assigned for the exam. It will in addition be pursued as a violation of your university honor policy. This may lead to other actions, such as expulsion from the program. Please see the separate section on your honor code below.

Students should take care during exams that other students cannot get visual or other access to their work. This too is required by your university honor policy, and violations will be pursued.

## 17.4 Attendance Policy

### 17.4.1 Initial attendance

FSU students are dropped if not present the first day of classes. FAMU students are dropped if not attending at the end of the first week.

### 17.4.2 Excused absences

*You should contact the instructor as soon as possible when the need for an excused absence arrives.*

Excused absences include documented illness, deaths in the immediate family and other documented crises, call to active military duty or jury duty, religious holy days, and official University activities. Accommodations for these excused absences will be made and will do so in a way that does not penalize students who have a valid excuse. Consideration will also be given to students whose dependent children experience serious illness. See however the notification requirements below.

Please note that the College of Engineering has a restrictive interpretation of what is considered a valid excuse for an absence. See:

<http://www.eng.fsu.edu/current/undergraduate/guide.html>

If an absence is to be excused, make sure you check beforehand. In case of excused absence, the instructor will work with you to help you make up for missed time and catch up, subject to the notification requirements below.

*Classes are not suspended at the College of Engineering unless they are suspended at both institutions. If you are required to attend a university event, you can receive an excused absence. Otherwise, your absence is considered unexcused.*

You must notify me in the first week of the semester if you will need an excused absence during a scheduled examination for observance of a religious holy day. If you will need such an absence for a planned event, you must notify me at the start of the semester, or the day that the event is scheduled if later. If an emergency prevents you from attending a scheduled examination, you must notified me at your earliest opportunity, by e-mail (check that you get a timely response from me), phone, or in person. Please provide official documentation of event or emergency. In case the notification procedures are not followed, no make up examination will be given and a zero will be assigned.

### **17.4.3 Unexcused absences**

A student having more than four unexcused absences will be dropped from the course and assigned the grade F. No exceptions. Tests and exams missed because of unexcused absence receive the grade 0. No exceptions.

Other projects and activities missed completely receive the grade 0 for those projects or activities. No exceptions except as may be noted elsewhere in this syllabus. Homework handed in after the due date and time will receive a zero or greatly reduced credit depending on circumstances and any regulations elsewhere in this syllabus.

### **17.4.4 Initial and daily e-mail checks required**

Students must daily check their e-mail at the address they provided at the start of class. They must ensure that they receive an welcome e-mail at the beginning of the semester, or contact the instructor to correct their recorded e-mail address immediately.

### **17.4.5 Consequential loss of credit**

Failure to properly complete homework, tests, assignments, etcetera due to changes in date, assignment, etcetera, that you did not know about due to failure to check e-mail, unexcused absence, lateness, or inattentiveness will not be excused and cannot be made up.

## **17.5 Extract of ME Departmental Policy**

An undergraduate student may continue in the B.S. in ME degree program unless one or more of the following conditions arise;

1. A grade below C in the second attempt of the same engineering course.  
[http://www.eng.fsu.edu/me/resources/pdf/ME\\_Prerequisite\\_Policy.pdf](http://www.eng.fsu.edu/me/resources/pdf/ME_Prerequisite_Policy.pdf)
2. More than three (3) repeat attempts in engineering courses.  
[http://www.eng.fsu.edu/me/resources/pdf/ME\\_Excessive\\_Repeat\\_Policy.pdf](http://www.eng.fsu.edu/me/resources/pdf/ME_Excessive_Repeat_Policy.pdf)
3. Violation of academic honor code as defined in university bulletin or catalog
4. Use of grade forgiveness (currently available for FAMU students only) in more than two (2) courses.

Non-ME undergraduate students should contact their home department for corresponding regulations.

## **17.6 Extract of College Policy**

It is the policy of the College not to assign “plus and minus (+/-)” grades for undergraduate engineering courses.

<http://www.eng.fsu.edu/current/undergraduate/guide.html>

Any student who has repeated attempts in one or more engineering courses may be subject to academic sanctions including but not limited to warning, probation, suspension, or dismissal from their engineering program. Students should contact the department of their engineering major for more information regarding this policy.

## 17.7 Learning outcomes/compacts

Mechanical engineering student outcomes:

[http://www.eng.fsu.edu/me/undergrad/ed\\_objective.html](http://www.eng.fsu.edu/me/undergrad/ed_objective.html)

Engineering program outcomes/student learning outcomes:

<http://www.eng.fsu.edu/outcomes>

Engineering academic learning compact:

<http://www.eng.fsu.edu/about/accreditation/outcomes.html>

Florida State University academic learning compact:

<http://learningforlife.fsu.edu/smalcs/learningCompact.cfm?smalcId=57339>

## 17.8 Honor Policy

Students are expected to uphold their University Student Code of Conduct and/or Academic Honor Code. You must read this code if you have not yet done so.

- Florida A&M University is committed to academic honesty and its core values which include scholarship, excellence, accountability, integrity, fairness, respect, and ethics. These core values are integrated into its academic honesty policy. Being unaware of the Academic Honesty Policy is not a defense to violations of academic honesty. Academic Honesty Policy violations shall be reported and appropriate actions taken by the department chair and associate dean for student affairs and curriculum. The complete Florida A&M Student Code of Conduct - Regulation 2.012 (10) (s) can be found at

<http://www.famu.edu/index.cfm?judicialAffairs&StudentCodeofConduct>

- The Florida State University Academic Honor Policy outlines the University's expectations for the integrity of students' academic work, the procedures for resolving alleged violations of those expectations, and the rights and responsibilities of students and faculty members throughout the process. Students are responsible for reading the Academic Honor Policy and for living up to their pledge to "... be honest and truthful and ... [to] strive for personal and institutional integrity at Florida State University." The complete Florida State University Academic Honor Policy can be found at

<http://fda.fsu.edu/Academics/Academic-Honor-Policy>

Possible sanction for violations of your code of conduct and/or honor code include but are not limited to:

1. a failing grade on an exam or assignment,
2. a failing grade in the course,
3. dismissal from the academic program,
4. dismissal from the university.

## 17.9 Americans with Disabilities Act

Students with disabilities needing academic accommodation should:

- Register with and provide documentation to the appropriate university office. For FAMU students, this is the Learning Development and Evaluation Cen-

ter (LEDC). For FSU students this is the Student Disability Resource Center (SDRC);

- Bring a letter to the instructor indicating the need for accommodation and what type.

This should be done during the first week of class.

For more information about services available to students with disabilities:

- FAMU Students should contact:

Learning Development and Evaluation Center (LDEC)  
677 Ardelia Court  
Florida A&M University  
Nathaniel Holmes, Director  
Donna Shell, Asst. Director  
(850) 599-3180 (voice)  
(850) 561-2512 (fax)  
(850) 561-2783 (TDD)  
<http://www.famu.edu/index.cfm?a=EOP&p=ADA>

- FSU Students should contact:

Student Disability Resource Center (SDRC)  
874 Traditions Way  
108 Student Services Building  
Florida State University  
Tallahassee, FL 32306-4167  
(850) 644-9566 (voice)  
(850) 644-8504 (TDD)  
[sdrc@admin.fsu.edu](mailto:sdrc@admin.fsu.edu)  
<http://www.disabilitycenter.fsu.edu/>

## 17.10 Non-Discrimination Policy Statement

- The Florida A&M University statement can be found at:  
<http://www.famu.edu/index.cfm?EOP&NON-DISCRIMINATIONPOLICYSTATEMENT>
- The Florida State University statement can be found at:  
[http://www.hr.fsu.edu/PDF/Publications/diversity/EEO\\_Statement.pdf](http://www.hr.fsu.edu/PDF/Publications/diversity/EEO_Statement.pdf)

## 17.11 Exceptions

The instructor might wave some regulation on a case-by-case basis depending on his subjective determination of fairness and appropriateness. This will occur only under exceptional circumstances and should not be assumed. Especially, never assume that a seemingly minor regulation will be waived because the instructor has waived it in the past. A second appeal to waive a minor regulation will probably indicate to the instructor that the regulation is not being taken seriously and most likely refused. Any appeal to the instructor will further be refused a priori unless it is made at the earliest possible moment by phone and/or by E-mail. Do not wait until you are back in town, say.

## **17.12 Syllabus Change Policy**

Except for changes that substantially affect implementation of the evaluation (grading) statement, this syllabus is a guide for the course and is subject to change with advance notice.