MATH-3270 Advanced Mathematics for Engineers
Fall 2016

Course Information

Course Name: Advanced Mathematics for Engineers
Course Number: MATH-3720
Course Description: Vector algebra; matrix algebra; system of linear equations; eigenvalues
                            and eigenvectors; system of differential equations; vector differential
                            calculus; divergence, gradient and curl; vector integral calculus; integral
                            theorems; Fourier series with applications to partial differential equations.
Meeting times: MW 14:30-15:45
Semester: Fall 2016
Credit hours: 3
Prerequisite(s):   MATH-3550 Differential Equations.

Instructor Information

Name: Carlos Quesada González
Office hours: MW 15:45-16:45 and by appointment
                    Math Office: Padre Arrupe Hall, 1st fl. Science and Engineering Office
Contact: quesadagonzalez@slu.edu
Biography: Terminal Degree: Ph.D. Mathematics (Universidad Complutense de Madrid)

Course Objectives

The main objectives of this advanced Math course is to deepen on vector differential calculus
and its applications. Also, as a second course on Differential Equations, students will be faced
with more realistic modelling problems, thus introducing Fourier Series. This course is
appropriate for students majoring in engineering.

Mathematics Program Objectives

A. Demonstrate the ability to solve a variety of mathematical problems.
B. Demonstrate an ability to recall important mathematical definitions and results (for example,
theorems).
C. Demonstrate an ability to apply mathematical reasoning, including formulating definitions.
D. Demonstrate an ability to apply the methods of direct and indirect proof.
E. Demonstrate an ability to communicate mathematical ideas and concepts clearly in written
problem solutions.
F. Demonstrate an ability to perform statistical analyses.
G. Demonstrate an ability to write computer programs to analyze data and perform calculations

Student Learning Outcomes

Program Objectives	Student Learning Outcomes	Assessment Method
A	A.1 Identify basis of vector subspaces. A.2 Demonstrate the ability to apply matrix techniques to solve linear equations. Use Gauss elimination to reduce the matrix associated to the linear system to its Row Echelon Form. Also, be able to solve a system by the use of the inverse of a matrix.	Midterms, class discussions, group work, final exam.

	A.3. Recognize the properties of some special matrices and how this helps when finding eigenvalues and eigenvectors. A.4 Apply standard techniques of matrices to solve systems of linear equations, both homogeneous and non-homogeneous. A.5 Deepen on vector differential calculus, applying Stocks' Theorem. A.6 Calculate the coefficients of the Fourier series for a variety of functions, and use them to solve some ordinary differential equations. A.7 Apply the computational and conceptual principles of calculus to the solutions of various scientific applications.	
B	B.1 Recall definitions of divergence and curl seen on Calculus III B.2 Recall the main theorems of vector differential calculus, namely Green's and Gauss'	Midterms, class discussions, group work, final exam.
C	C.1. Apply Mathematical reasoning to translate basic definitions of Calculus, Linear Algebra and Differential Equations to this combined course.	Class exercises
E	E.1 Students will be able to communicate mathematical ideas effectively in both written and oral context. To this end, they will resort to the appropriate Mathematical results to justify their answers.	Midterms, class discussions, group work, final exam.

Required and recommended reading

Required reading: Advanced Engineering Mathematics, by Peter V. O'Neil, 7th Edition.

Required work

Three in-class exams and one comprehensive final exam will be given. They will emphasize the material presented in class but will also cover the reading assignments.

Homework will be assigned for every topic covered. The homework will not be graded, but solutions will be provided and students are expected to check their exercises and come to office hours with any difficulties encountered.

Late work:

Make up exams are not given. If an exam is missed due to an excused absence (see paragraph below), a make up exam will be given the same day of the final exam. Exams that are missed illegitimately result in a score of 0 in the final grade. Missing more than one exam results in an F grade for the entire course.

Excused Absences:

Legitimate conflicts and excuses require <u>written documentation</u> and are limited to death or near death instances in the immediate family, a student's illness that requires immediate doctor's care (with the corresponding doctor's note), a University sponsored event (not club sports) and regularly scheduled religious obligations. <u>The documentation must be presented on the day the student returns to the university</u>. Excuses that will NOT be considered include personal travel arrangements, non-University sponsored events, a conflicting appointment, or an illness that does not prevent you from coming to the exam.

Attendance and punctuality:

Although not mandatory, I strongly urge you to attend all classes. On the other hand, you will be responsible for any announcements, information, problems or course changes that are made in all lectures. Students are expected to arrive on time to the lectures. Repeated lateness will not be tolerated.

If a class is not attended, it is the student's responsibility to find out what was covered in class and to secure notes from another student. During office hours, and after the student has read and worked on the notes on his own, only <u>specific questions</u> regarding the material missed will be answered.

Grading system

The final grade will be obtained as follows:

- 70% three in-class exams
- 30% final exam

Evaluation:

- In-class: 75 minute exams consisting of some problems related to the material covered in class.
- Final exam: The final exam is cumulative. It will cover the entire semester's material, will be an up to 3 hour exam, and will be similar in form to the in-class exams.
- A positive evolution in grades might have a positive impact in the overall grade.
- Active participation during the lectures by asking interesting questions will have a positive impact on the final grade, bringing up borderline grades.
- You are going to be evaluated not only on your knowledge of facts beyond the surface level, but also on your creative and critical thinking, your ability to draw conclusions and make connections, and to communicate information in a reasoning and organized way.

Remark: <u>No complaints</u> about the grade of an exam will be accepted two weeks after the results have been announced to the class.

Important Dates:

- **September:**
  o 1 Th: First day of classes.
  o 14 Wed: Last day to DROP a class without a grade of "W" and/or add a class. Last day to choose audit (AU), or Pass/No Pass (P/NP) Options.
  o 26 Mon: First in-class exam.
- **October:**
  o 12 Wed: Holiday (University closed).
  o 14 Fri: Last day to submit transfer application for Spring semester.
  o 24 Mon: second in-class exam.
  o 28 Fri: Last day to drop a class and receive a "W".
- **November:**
  o 1 Tue: Holiday (University closed).
  o 3 Th: Registration for Spring semester begins.

- **December:**
    o   6 Tue: Holiday (University closed)
    o   8 Th: Holiday (University closed)
    o   14 Wed: Final day of classes.
    o   21 Wed: Final Exam (15:30-18:30)

For other important dates, visit
http://www.slu.edu/madrid/academics/registrar/academic-calendar/fall-2016

Course outline

Chapter 6. Vectors and Vector Spaces
    6.4 The Vector Space R^n
    6.5 Linear independence, Spanning sets, and Dimensions in R^n

Chapter 7. Matrices and Systems of Linear Equations
    7.1 Matrices
    7.2 Elementary Row Operations and Elementary matrices
    7.3 Row Echelon Form of a Matrix
    7.4 The Row and Column Spaces of a Matrix and rank of a matrix
    7.5 Solution of Homogeneous Systems of Linear Equations
    7.6 The solution space of $AX=0$
    7.7 Nonhomogeneous System of Linear Equations
    7.8 Matrix Inverses

Chapter 9. Eigenvalues, Diagonalization, and Special Matrices
    9.1. Eigenvalues and Eigenvectors
    9.2 Diagonalization of Matrices
    9.3 Orthogonal and Symmetric Matrices
    9.4 Quadratic Forms
    9.5 Unitary, Hermitian, and Skew-Hermitian Matrices

Chapter 10. Systems of Linear Differential equations
    10.1 Theory of Systems of Linear First Order Differential Equations
    10.2 Solution of $X' = AX$ when A is a constant
    10.3 Solution of $X' = AX + G$

Chapter 12. Vector Differential Calculus
    12.1 Vector Functions of One variable

    12.2 Velocity, Acceleration, Curvature and Torsion
    12.3 Vector Fields and Streamlines
    12.4 The Gradient Field and Directional Derivatives
    12.5 Divergence and Curl

Chapter 13. Vector Integral Calculus
    13.1 Line Integrals
    13.2 Green's Theorem
    13.3 Independence of Path and Potential Theory in the Plane
    13.4 Surfaces in 3-Space and Surface Integrals
    13.5 Applications of Surface Integrals
    13.6 Preparation for the Integral Theorems of Gauss and Stokes
    13.7 The Divergence Theorem of Gauss
    13.8 The Integral Theorem of Stokes

Chapter 14. Fourier Series
14.1 Why Fourier Series?
14.2 The Fourier Series of a Function
14.3 Convergence of Fourier Series
14.4 Fourier Cosine and Sine Series
14.6 The Phase Angle Form of a Fourier Series
14.7 Complex Fourier Series and the Frequency Spectrum

Additional Material: The Application of Fourier Series in Forced Oscillations (Extension of Section 2.7)

Chapter 15. The Fourier Integrals and Fourier Transforms
15.1 The Fourier Integral
15.2 Fourier Cosine and Sine Integrals
15.3 The Complex Fourier Integral and the Fourier Transform
15.4 Additional properties and Applications of the Fourier Transform
Additional material: Introduction to some Partial Differential Equations (The Wave Equation, The Heat Equation, and the Potential Equation)

Things that you should do in order to get a good grade in this class:

- Don't miss classes, but if you ever have to miss one, ask one of your classmates (not me) for the notes as soon as possible and go over them before the next lecture.

- Do ALL the solved exercises recommended from the textbook. I can't emphasize this enough. All math classes require a lot of practice and this is not an exception.

- Work every week, and if possible, every day. If you don't have an assignment or exercises to practice (that would be very rarely), review your class notes and go over the problems we have solved in class on your own one more time.

- Feel free to pass by my office to ask me if something is not clear from the lecture before the next lecture, you will probably have trouble understanding this otherwise.

- Form study groups and make sure that all members participate and learn from each other. Experience shows that math is more effectively learned when you work in groups.

- Write your homework and exams neatly and in an organized way. Remember that you are going to be evaluated **not only** on your knowledge of facts beyond the surface level, **but also** on your creative and critical thinking, your ability to draw conclusions and make connections, and to communicate information in a reasoning and organized way.

Things that you shouldn't do in this class:

- Missing classes…have I made it clear?

- Be late to the lectures, it is very disruptive to the other students and very disrespectful. Also, you miss the most important part of the lecture, where I say what we are going to do and sometimes do a short review of what we did in the previous class.

- Use your phone during the lectures, whether it is for texting or using internet or, obviously, talking, it is extremely disrespectful. I will not allow it and you will be invited to leave the room.

- Work on something else during classes. Again, you will be invited to leave the room.

- Get up and walk out of the class. It is very disruptive. If you are planning to get out to take care of some urgent issue, let me know in advance.

- Think that by just coming to class, you have all the work done. If you don't practice, you will not learn the material.

- Try to study everything two days before the test. It is impossible to really understand this topic by rushing over the material in a few hours.

- Skip homework.

- Copy the homework from someone else. It is completely useless. The only purpose of the homework is to help you learn.

- Use graphic calculators or any other type of electronic device during tests or exams. It will be considered a violation of the Academic Honesty Code.

Academic Honesty Policy Statement:

Academic integrity is honest, truthful and responsible conduct in all academic endeavors. The mission of Saint Louis University is "the pursuit of truth for the greater glory of God and for the service of humanity." Accordingly, all acts of falsehood demean and compromise the corporate endeavors of teaching, research, health care and community service via which SLU embodies its mission. The University strives to prepare students for lives of personal and professional integrity, and therefore regards all breaches of academic integrity as matters of serious concern.

The governing University-level Academic Integrity Policy can be accessed on the Provost's Office website at: http://www.slu.edu/Documents/provost/academic_affairs/University-wide%20Academic%20Integrity%20Policy%20FINAL%20%206-26-15.pdf. Additionally, SLU-Madrid has posted its academic integrity policy online: http://www.slu.edu/madrid/academics. As a member of the University community, you are expected to know and abide by these policies, which detail definitions of violations, processes for reporting violations, sanctions and appeals. The professor will review these policies during the first weeks of the term: please direct questions about any facet of academic integrity to your professor, the chair of the department of your academic program or the Academic Dean of the Madrid Campus.

Only **non-graphic** scientific calculators may be used in tests or in the final examination. Other calculators and devices will be taken from students during the exam and students may have to start the exam again. Not following this regulation will be considered a violation of the academic honesty code.

Accommodation Statement

In recognition that people learn in a variety of ways and that learning is influenced by multiple factors (e.g., prior experience, study skills, learning disability), resources to support student success are available on campus. Students who think they might benefit from these resources can find out more about:

- Course-level support (e.g., faculty member, departmental resources, etc.) by asking your course instructor.
- University-level support (e.g., tutoring/writing services, Disability Services) by visiting the Academic Dean's Office (San Ignacio Hall) or by going to http://www.slu.edu/madrid/learning-resources.

Students with a documented disability who wish to request academic accommodations must contact Disability Services to discuss accommodation requests and eligibility requirements. Once successfully registered, the student also must notify the course instructor that they wish to access accommodations in the course. Please contact Disability Services at disabilityservices- madrid@slu.edu or +915 54 58 58, ext. 230 for an appointment. Confidentiality will be observed in all inquiries. Once approved, information about the student's eligibility for academic accommodations will be shared with course instructors via email from Disability Services. For more information about academic accommodations, see "Student Resources" on the SLU-Madrid webpage.

Note: Students who do not have a documented disability but who think they may have one are encouraged to contact to Disability Services.

Student Outcome Assessment:

In order to maintain quality academic offerings and to conform to accreditation requirements, SLU- Madrid regularly assesses its teaching, services and programs for evidence of student learning. For this purpose, SLU-Madrid keeps representative examples of student work from all courses and programs on file, including assignments, papers, exams, portfolios and results from student surveys, focus groups and reflective exercises. Copies of your work for this course may be kept on file for institutional research, assessment and accreditation purposes. If you prefer SLU-Madrid not to retain your work for this purpose, you must communicate this decision in writing to your professor.

Title IX

Saint Louis University and its faculty are committed to supporting our students and seeking an environment that is free of bias, discrimination, and harassment. If you have encountered any form of sexual misconduct (e.g. sexual assault, sexual harassment, stalking, domestic or dating violence), we encourage you to report this to the University. If you speak with a faculty member about an incident of misconduct, that faculty member must notify SLU's Title IX deputy coordinator, Marta Maruri, whose office is located on the ground floor of Padre Rubio Hall, Avenida del Valle, 28 (mmaruri@slu.edu; 915-54-5858, ext. 213) and share the basic fact of your experience with her. The Title IX deputy coordinator will then be available to assist you in understanding all of your options and in connecting you with all possible resources on and off campus.

If you wish to speak with a confidential source, you may contact the counselors at the SLU-Madrid's Counseling Services on the third floor of San Ignacio Hall (counselingcenter-madrid@slu.edu; 915- 54-5858, ext. 230) or Sinews Multipletherapy Institute, the off-campus provider of counseling services for SLU-Madrid (www.sinews.es; 917-00-1979). To view SLU-Madrid's sexual misconduct policy and for resources, please visit the following web address: http://www.slu.edu/Documents/Madrid/campus-life/SLUMadridSexualMisconductPolicy.pdf.