DO NOT TYPE IN THIS BOX
Bulletin # : 3
Academic Year : 2020-2021

FLORIDA INTERNATIONAL UNIVERSITY
UNIVERSITY CURRICULUM COMMITTEE
Proposal for a New Course

1. **School/College** Engineering and Computing

   Div./Dept. in Which Taught School of Computing and Information Sciences

2. COT (Alpha Prefix) 3 (1st Digit) XXX (Last 3 Digits) ____ ("C"-lec-lab "L"-Lab) 3 (Cr. Hrs.) **CIP Code** *(Leave this blank):* ____

previously submitted in bulletin 2 2020-2021

3. **Grading Method (select one):** ■ Graded ☐ Pass/Fail

4a. **Course Title** Applied Linear Structures for Computing

b. **Abbreviated course Title** *(for computer class schedules, transcripts)* Appl Lnr Strc for Comp

LIMITED TO 25 Characters *(including spaces)*

5. **Statewide Course Numbering Subject Matter Area** COT (Computing Theory)

6. **Catalog Description/Major Topics** *(not to exceed 200 characters including spaces)*

   College of Medicine and College of Law: Attach description not exceeding 1,000 characters including spaces.

   This course is designed to prepare computer science/IT students with the applied knowledge of linear structures necessary for computing, data analytics, and machine learning.

7. **Attach detailed syllabus course outline and course justification on separate page(s).**
8. **Prerequisite(s):** MAC-XXXX and COP-XXXX (passed at least one college level math course and one b
9. **Corequisite(s):** COT3100 (Discrete Structures)
10. **Objective(s) of Course:**

    Learning fundamental computational concepts to deal with linear structures in computer science domains, e.g., data analytics, distributed computing, machine learning, and artificial intelligence.

11. **Does this course duplicate/overlap other courses at FIU?** ☐ No ■ Yes

    If yes, please explain: 20% of this course reviews concepts covered in MAS3105 and EEL3120(approv

12. **What other closely related department(s) have been consulted about this course?**

    Department of Mathematics and Statistics, Department of Electrical and Computer Engineering

13. **Is this course used for the assessment of a program or a certificate (if yes, then send a notification to assessment@fiu.edu)?** No Yes

PROPOSAL REQUESTED BY:

	(Type name)	(Signature)	
Faculty Contact	Mohammadhadi Amini	Mohammad hadi Amini	10 / 22 / 2020
	moamini@fiu.edu (Email address)	305-348-9936 (Phone number)	
Chairperson (Dept./Div.)	Jason Liu	[signature]	10 / 22 / 2020
Chairperson (Curr. Comm.)	Wei-Chiang Lin	Wei-Chiang L.	10 / 27 / 2020
College/School Dean	John Volakis	[signature]	____ / ____ / 2020

Submit one original form. Attach one copy of the course justification and course syllabus, course description, objectives, major topics and textbooks.

Applied Linear Structures for Computing - Course Justification

Several computer sciences (CS) and information technology (IT) applications, such as data analytics, machine learning, distributed computing, and artificial intelligence use fundamental notions of linear structures to facilitate the process of storing and analyzing large-scale datasets. Specifically, representing data as matrices and vectors facilitates the mathematical representation of real-world problems, and translating them into understandable equations for machines. One of the most recent instances is quantum computing.

Due to the increasing interest in data analytics, machine learning, distributed computing, and emerging computing tools that leverage notions from linear structures, it is imperative to provide computer science students with a practical understanding of linear structures, with an emphasis on the computing tools that they will frequently need during their study and future careers. In order to address these emerging needs in computing, this course proposes to address this need by providing a brief introduction to necessary concepts from linear structures/algebra during the first three weeks of the class, and then focus on the selected computing applications of these concepts that will be useful from CS and IT students. Based on the textbook entitled "Introduction to Applied Linear Algebra" and the emerging applications of linear structures in data analytics, machine learning, distributed computing, and artificial intelligence, this course provides brief introduction to basic linear structure definitions, and their corresponding operations and characteristics which is tailored towards computer science applications. The main objective of this course is to prepare CS and IT student, with little or no prior exposure to linear algebra, for deploying algorithms and methods that are highly relying on linear structures. While there are other courses, such as **MAS3105** (undergraduate level linear algebra), that mainly cover the theoretical aspects of the linear structures with an emphasis on the fundamental theorems and proofs; and **EEL3120** (introduction to linear algebra for engineers) that focuses on the materials related to linear algebra concepts as the MAS3105, as well as the applications of linear algebra in engineering, including the "*abstract concepts from linear algebra, emphasizing topics useful in engineering*" and the "*use of linear algebra to analyze resistive and dynamic electric circuits*". Computer science students need a tailored course that prepare them for dealing with the future courses such as data science courses, machine learning, and theory of computation at the School of Computing and Information Sciences. The proposed course will briefly provide an introduction to basic linear structure definitions and then focusing on computing application with the computer science perspective, from characterizing the raw data using matrices, to using linear algebra tools for data analytics, to using linear structures for distribution computing.

This undergraduate-level course will thoroughly equip students with the tools and ideas required to understand a large variety of data fitting, computing, and learning algorithms and techniques that are crucial for the development of next-generation of computing and information systems, such as quantum computing. There are many industrial, and academic positions available in high-tech companies, national labs, and universities requiring people with CS-related degrees who have solid understanding of the foundations of the AI, ML and data analytics methods. This course acts as the first step for the students who plan to understand the foundation of such methods and paves the path towards advanced senior-level and graduate-level courses. Currently, Brown University (The Matrix in Computer Science), University of Colorado Boulder (Linear Algebra with Computer Science Applications), University of Florida (Linear Algebra for Data Science), and University of Oxford (Linear Algebra for Computer Science Students) offer similar courses within the department of computer science specifically for CS/IT students.

School of Computing and Information Sciences

Course Title: Applied Linear Structures for Computing **Date:** 10/08/2020

Course Number: COT-3***

Number of Credits: 3

Subject Area: Foundations	**Subject Area Coordinator:** Xudong He **email:** hex@cs.fiu.edu
Catalog Description: This course is designed to prepare computer science/IT students with the applied knowledge of linear structures for computing and data analytics.	
Textbooks: Boyd, Stephen, and Lieven Vandenberghe. Introduction to applied linear algebra: vectors, matrices, and least squares. Cambridge university press, 2018. ISBN: I978-1-316-51896-0	
References (for further reading): [1] Heller, Don. "A survey of parallel algorithms in numerical linear algebra." *Siam Review* 20.4 (1978): 740-777. [2] Xiao, Han. "Towards parallel and distributed computing in large-scale data mining: A survey." *Technical University of Munich, Tech. Rep* (2010). [3] Davis, Ernest. *Linear algebra and probability for computer science applications*. CRC Press, 2012.	
Prerequisites Courses: MAC-XXXX and COP-XXXX (passed at least one college level math course and one basic college level programming course)	
Corequisite Courses: COT 3100 or MAD 2104	

School of Computing and Information Sciences
COT 3***
Applied Linear Structures

Type: Elective for CS and IT Majors.

Prerequisites Topics:

1. Solve basic algebraic equations
2. Systems of linear equations
3. Functions
4. Radical Expressions and Equations

Applied linear structures course requires that students must have completed some introductory math (any MAC-XXXX) and some introductory programming experience (any COP-XXXX) as prerequisite/corequisite. Additionally, the students need university level discrete structures knowledge by previously/simultaneously taking COT3100.

Course Outcomes:

1. Be familiar with basic definitions of vectors, matrices, linear functions, norm, and linear structures
2. Master the computing applications of linear structures, including those in data analytics
3. Be exposed to computing tools (e.g., clustering, regression, and least squares) using applied linear structure tools
4. Be familiar with application of linear structures in distributed computing and distributed optimization.
5. Be exposed to future application of linear structures in computing, including distributed machine learning and quantum computing

School of Computing and Information Sciences
COT 3***
Applied Linear Structures
Relationship between Course Outcomes and Program Outcomes

BS in CS: Program Outcomes	Course Outcomes
a) Demonstrate proficiency in the foundation areas of Computer Science including mathematics, discrete structures, logic and the theory of algorithms	1, 2, 3, 4, 5
b) Demonstrate proficiency in various areas of Computer Science including data structures and algorithms, concepts of programming languages and computer systems.	
c) Demonstrate proficiency in problem solving and application of software engineering techniques	
d) Demonstrate mastery of at least one modern programming language and proficiency in at least one other.	
e) Demonstrate understanding of the social and ethical concerns of the practicing computer scientist.	
f) Demonstrate the ability to work cooperatively in teams.	
g) Demonstrate effective communication skills.	

Assessment Plan for the Course & how Data in the Course are used to assess Program Outcomes

Student and Instructor Course Outcome Surveys are administered at the conclusion of each offering, and are evaluated as described in the School's Assessment Plan: http://www.cis.fiu.edu/programs/undergrad/cs/assessment/

School of Computing and Information Sciences
COT 3***
Applied Linear Structures

Outline

Topic	Number of Lecture Hours (Total: 37.5 hours = 15 weeks * 2 lectures/week * 1.25 hrs/lecture)	Outcome
1. <u>Introduction to Applied Linear Structures</u> 1.1. Vector Operation, inner product, and addition 1.2. Linear functions and their application in computing 1.3. Norm, Distance, and Matrix Algebra	8.75	1, 2, 5
2. <u>Clustering, and Least Squares for Data Analytics</u> 3.1. Data Clustering Objectives 3.2. k-means Algorithm 3.3. Least squares data fitting 3.4. Least squares classification 3.5. Linear Regression Using Least Squares 3.6. Iteratively Reweighted Least Squares	10	2, 3,5
3. <u>Computing and Data Analytics Applications of Linear Structures</u> 3.1. Data analytics using matrix decomposition 3.2. Eigenvalue decomposition for distributed computing 3.3. Linear Computing Algorithms, e.g., Simplex algorithm 3.4. Future Linear Computing Applications, e.g., quantum computing	8.75	2, 3, 5
4. <u>Distributed Linear Computing</u> 4.1. Linear dependence 4.2. Distributed Linear optimization 4.3. Distributed Processing	10	4,5

Learning Outcomes: (Familiarity → Usage → Assessment)

<u>Introduction to Applied Linear Structures</u>

School of Computing and Information Sciences
COT 3***
Applied Linear Structures

1. Explain with examples the basic terminology of vectors, norm, distance, and linearity. [Familiarity]
2. Perform the operations associated with vectors and linear functions. [Usage]
3. Relate practical examples to the appropriate vector, linear function, or norm/distance, and interpret the associated operations and terminology in context. [Assessment]
4. Describe how constructs of these concepts can be used in computer science applications. [Assessment]
5. Describe how matrices and matrix algebra can be used to model real-life situations or applications, including those arising in computing contexts such as clustering and distributed algorithms. [Usage]

<u>Clustering and Least Squares for Data Analytics</u>

1. Identify the definitions of clustering techniques, and least squares. [Familiarity]
2. Outline the preliminaries needed to understand these techniques. [Familiarity]
3. Apply each of the clustering and least squares methods to practical applications, e.g., data analytics for a small dataset. [Usage]
4. Explain various instances of least squares for data analytics, including linear regression using least squares and least squares classification [Familiarity]
5. Apply Iteratively Reweighted Least Squares in presence of outlier data [Usage]
6. Explain the k-means algorithms and provide computer science applications that benefit of this method. [Assessment]

<u>Computing and Data Analytics Applications of Linear Structures</u>

1. Identify the fundamental definitions for various matrix decomposition techniques. [Familiarity]
2. Apply decomposition techniques to solve linear computing problems. [Usage]
3. Solve a group of computer science-related problems using matrix factorization, especially data analytics problems. [Usage]
4. Describe how a computing problem can be represented in terms of matrices, and how matrices can be used and implemented to analyze a real-world dataset. [Assessment]

<u>Distributed Linear Computing</u>

1. Describe how to use linear equations to formulate a decision-making problem [Usage]
2. Model a variety of real-world problems in computer science, e.g., data fitting, using appropriate forms of linear systems. [Usage]
3. Show how concepts from linear systems can be leveraged for distributed computing. [Usage]
4. Apply linear programming to a hands-on example. [Usage]

School of Computing and Information Sciences
COT 3***
Applied Linear Structures

Oral and Written Communication

No significant coverage

Written Reports		Oral Presentations	
Number Required	Approx. Number of pages	Number Required	Approx. Time for each
0	0	0	0

Social and Ethical Implications of Computing Topics

No significant coverage

Topic	Class time	student performance measures

School of Computing and Information Sciences
COT 3***
Applied Linear Structures

Approximate number of credit hours devoted to fundamental CS topics

Fundamental CS Area	Core Hours	Advanced Hours
Algorithms:	0.6	
Software Design:		
Computer Organization and Architecture:		
Data Structures:	0.4	
Concepts of Programming Languages		

Theoretical Contents

Topic	Class time
Algorithms and Complexity (AL)	22.5 hours
Parallel and Distributed Computing (PD)	15 hours

Problem Analysis Experiences

Solution Design Experiences

School of Computing and Information Sciences
COT 3***
Applied Linear Structures

The Coverage of Knowledge Units within Computer Science Body of Knowledge[1]

Knowledge Unit	Topic	Type	Lecture Hours
AL1. Introduction to Applied Linear Structures	1	Tier 1	8.75
AL3. Clustering and Least Squares for Data Analytics	2	Tier 1	10
PD4. Computing and Data Analytics Applications of Linear Structures	3	Tier 1	8.75
PD5. Distributed Linear Computing	4	Tier 1	10

[1]See Appendix A in Computer Science Curricula 2013. Final Report of the IEEE and ACM Joint Task Force on Computing Curricula, available at: http://www.acm.org/education/CS2013-final-report.pdf

Gmail

Hadi Amini <h.amini67@gmail.com>

Request for feedback on new Computer Science Course

Laura De Carli <decarlil@fiu.edu> Mon, Sep 21, 2020 at 10:19 AM
To: Hadi Amini <amini@cs.fiu.edu>
Cc: John Zweibel <zweibelj@fiu.edu>, Prabakar <prabakar@cis.fiu.edu>, Trevor Cickovski <tcickovs@fiu.edu>, Mohammadhadi Amini <moamini@fiu.edu>

Dear Dr. Amini,

Based on the information that you provided, we approve the proposed course with the modification that you suggest
All the best,

Laura De Carli
Professor
Florida International University
Mathematics and Statistics
Miami (FL) 33199
web: faculty.fiu.edu/~decarlil

On Fri, Sep 18, 2020 at 8:20 AM Hadi Amini <amini@cs.fiu.edu> wrote:

> Dear Dr. De Carli,
>
> Thanks again for your feedback. Please find the detailed answers to your inquiries below. Please let me know if you have any further inputs:
> 1- You acknowledge that your proposed course description has a lot in common with your MAS 3105. It has also a lot in common with EEL3120 - in fact, we estimate that your proposed course has over 40% overlap with both MAS3105 and EEL3120. These two courses are not focused on the application of linear algebra to computer sciences, but we are not sure what percentage of your course is.
>
> >> Thanks for the feedback. As the main definitions of vectors, matrices, and some of the operations that are needed for data analytics, distributed computing, and machine learning are from linear algebra, they are common with both MAS3105 and EEL3120 courses. I have reached out to ECE department regarding EEL 3120. According to the syllabus (attached) "EEL 3120 is an introductory course on linear systems deals with the use of linear algebra to analyze resistive and dynamic electric circuits."
> Hence, as you properly mentioned, our focus and EEL3120's focus are completely on different applications. Indeed, the fundamental definitions are shared between all three courses, with the MAS3105 dives deeper into theories, EEL3120 applies it to circuits and engineering applications, and the proposed courses applies these concepts to computer science applications. The proposed course also has some programming and hands-on experience to expose students to concepts that they need for data science, distributed computing, and machine learning courses.
>
> In order to understand better what you are proposing, we would like to see a complete syllabus, with a specific text (Boyd and Vandenberghe ?), and an exact list of the sections of your chosen text that they wish to cover in the course. The list of topics that you have already provided is not in 1 to 1 correspondence with section titles in the table of contents of the book that you mention. Since the textbook Boyd and Vandenberghe are available online, providing a list of sections to be covered would then allow us to be able to see exactly what you propose to do in the course.
>
> >> Thanks for your feedback. I tried to provide as much detail as possible in the syllabus. Please find the link to open access book here: http://vmls-book.stanford.edu/vmls.pdf
> Here are some components of the book that will be covered in the course. I would like to mention that we are not going to entirely cover all chapters of the book, specifically the part corresponding to fundamental definitions will be covered briefly, just to make sure students are familiar with the main definitions in linear algebra/systems. The main focus of the course is on the Computer science and IT applications of linear algebra. Here are the sections of the book that cover the applications: section 4(Clustering); section 12 (least squares), section 13(LS data fitting), 14 (LS classification), 16/17 (constrained LS & applications).

For the distributed linear optimization I will use my notes on linear programming that is mainly based on the pioneer George Dantzig, as well as distributed linear programming with Philip Wolfe.
When it comes to matrix multiplication, inverse, decompositions, and eigenvalue calculations, we will provide brief definitions and move forward to applied programming using large scale matrices. This helps students to see how these strong tools are applicable in data analytics.

Also, in your proposal, you did not specify which MAC class is a prerequisite for the proposed course, but we think that the mathematical prerequisite should be **(MAC 2311 or MAC 2281)** with a corequisite **(MAD 2104 or COT 3100)**. We don't think that it's realistic to expect students with MAC 1147 or even MAC 1105 mathematical training, to handle this subject. In principle it is possible, but for example, we do not see how students without some exposure to differential calculus can be expected to appreciate the topic 1.2, linear functions, and Taylor approximation.

>>Thanks for pointing out this important point. I agree and added **(MAD 2104 or COT 3100)** as the pre or co-requisites of this course. This helps us to ensure that students can handle definitions regarding functions. Students who are in COT3100 class can handle these concepts conveniently and we believe they will be able to learn the basic definitions covered in the propsoed course. In order to tackle the issue about the Taylor series, as it is not affecting other applications that this course covers, I removed Taylor approximation from the syllabus to address this concern.

Please let me know if you and your colleagues have any further input/feedback.

Thanks,
Hadi

www.hadiamini.com
www.solidlab.network

[Quoted text hidden]

Gmail

Hadi Amini <h.amini67@gmail.com>

SCIS-ECE discussion of pending course proposals

5 messages

Ariana Taglioretti <ataglior@fiu.edu> Wed, Oct 14, 2020 at 6:26 PM
To: Jason Liu <liux@fiu.edu>, Jean Andrian <andrianj@fiu.edu>, Mark Finlayson <markaf@fiu.edu>, Elias Alwan <ealwan@fiu.edu>, Mohammadhadi Amini <moamini@fiu.edu>

zoom

Good afternoon,

Dr. Jason Liu is inviting you to a scheduled Zoom meeting.

Re: SCIS-ECE discussion of pending course proposals

Join Zoom Meeting

Meeting URL: https://fiu.zoom.us/my/jasonxliu

Thank you!

Best,
Ariana

invite.ics
3K

Hadi Amini <amini@cs.fiu.edu> Mon, Oct 19, 2020 at 8:52 AM
To: Jean Andrian <andrianj@fiu.edu>, Elias Alwan <ealwan@fiu.edu>
Cc: Jason Liu <liux@fiu.edu>, Mark Finlayson <markaf@fiu.edu>, Ariana Taglioretti <ataglior@fiu.edu>

Dear All,

I hope you are doing well.
Attached, please find the most recent version of the SCIS new course proposal with the following documents:
#1- Revised course proposal form;
#2- Revised Syllabus of a proposed course;
#3-Revised Justification of the course;
#4- Approval from the Math and Stats department;
#5- ECE EEI3120 Course Syllabus
#6- Table of comparison among the existing and proposed course, as well as revisions made to items #1-#3

Looking forward to our meeting on Tue Oct 20, 2020 4pm – 5pm (EDT).

Thanks,
Hadi

M. Hadi Amini, Ph.D., D.Eng.
Assistant Professor, School of Computing and Information Sciences, Florida International University
Director, solid lab
www.hadiamini.com
www.solidlab.network

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SCIS Revised Course Proposal-Appl Linear Strc for Computing.zip
2394K

Hadi Amini <amini@cs.fiu.edu> Wed, Oct 21, 2020 at 9:45 AM
To: Jean Andrian <andrianj@fiu.edu>
Cc: Jason Liu <liux@fiu.edu>, Mark Finlayson <markaf@fiu.edu>, Ariana Taglioretti <ataglior@fiu.edu>, Elias Alwan <ealwan@fiu.edu>, Masoud Sadjadi <sadjadi@cs.fiu.edu>

Dear Jean,

It was great meeting you and other colleagues from the ECE Department, and hearing your feedback on the SCIS curse proposal on "Applied Linear Structures for Computing". I have made the requested changes and attached the updated course proposal for your review. Please let me know if you have any further comments. Otherwise, I wonder if you could approve that we have addressed the ECE Department's comments.

Thanks,
Hadi

M. Hadi Amini, Ph.D., D.Eng.
Assistant Professor, School of Computing and Information Sciences, Florida International University
Director, solid lab
www.hadiamini.com
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Revised Course Proposal-Appl Linear Strc for Comp.zip
521K

Jean Andrian <andrianj@fiu.edu> Wed, Oct 21, 2020 at 9:51 AM
To: Hadi Amini <amini@cs.fiu.edu>
Cc: Jason Liu <liux@fiu.edu>, Mark Finlayson <markaf@fiu.edu>, Ariana Taglioretti <ataglior@fiu.edu>, Elias Alwan <ealwan@fiu.edu>, sadjadiATcs <sadjadi@cs.fiu.edu>

Dear Hadi,

I went through the documents, I have no further comments and I approve the changes you made to address the ECE department concerns.

Best

Jean Andrian

ECE Interim Chair

Sent from Mail for Windows 10

[Quoted text hidden]

Hadi Amini <amini@cs.fiu.edu> Wed, Oct 21, 2020 at 9:53 AM
To: Jean Andrian <andrianj@fiu.edu>
Cc: Jason Liu <liux@fiu.edu>, Mark Finlayson <markaf@fiu.edu>, Ariana Taglioretti <ataglior@fiu.edu>, Elias Alwan <ealwan@fiu.edu>, sadjadiATcs <sadjadi@cs.fiu.edu>

Dear Jean,

Thanks for your prompt response.

Sincerely,
Hadi

M. Hadi Amini, Ph.D., D.Eng.
Assistant Professor, School of Computing and Information Sciences, Florida International University
Director, solid lab
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