

Cover Sheet: Request 15555

EML 4XXX – Li-ion Next Generation Batteries

Info

Process	Course New Ugrad/Pro
Status	Pending at PV - University Curriculum Committee (UCC)
Submitter	Bruce Carroll bfc@ufl.edu
Created	12/8/2020 12:42:54 PM
Updated	2/11/2021 4:16:30 PM
Description of request	New Course Request for EML4xxx Li-ion Next Generation Batteries. This is a technical elective for the BS mechanical engineering and aerospace engineering programs. Course description: Qualities and reactions that characterize Li-ion batteries and other electrochemical cells. Emphasis on mechanical properties. Li-ion and Sodium-ion batteries, fuel cells, capacitors, and hydrogen storage. Credits: 3

Actions

Step	Status	Group	User	Comment	Updated
Department	Approved	ENG - Mechanical & Aerospace Engineering	Bruce Carroll		1/12/2021
No document changes					
College	Approved	ENG - College of Engineering	Heidi Dublin	Approved by the HWCOE Curriculum Committee and Faculty Council.	2/11/2021
EML 4xxx Li-ion Next Generation Batteries Syllabus - Rev 1.pdf					1/25/2021
University Curriculum Committee	Pending	PV - University Curriculum Committee (UCC)			2/11/2021
No document changes					
Statewide Course Numbering System					
No document changes					
Office of the Registrar					
No document changes					
Student Academic Support System					
No document changes					
Catalog					
No document changes					
College Notified					
No document changes					

Course|New for request 15555

Info

Request: EML 4XXX – Li-ion Next Generation Batteries

Description of request: New Course Request for EML4xxx Li-ion Next Generation Batteries. This is a technical elective for the BS mechanical engineering and aerospace engineering programs. Course description: Qualities and reactions that characterize Li-ion batteries and other electrochemical cells. Emphasis on mechanical properties. Li-ion and Sodium-ion batteries, fuel cells, capacitors, and hydrogen storage. Credits: 3

Submitter: Bruce Carroll bfc@ufl.edu

Created: 12/8/2020 12:29:34 PM

Form version: 1

Responses

Recommended Prefix

Enter the three letter code indicating placement of course within the discipline (e.g., POS, ATR, ENC). Note that for new course proposals, the State Common Numbering System (SCNS) may assign a different prefix.

Response:
EML

Course Level

Select the one digit code preceding the course number that indicates the course level at which the course is taught (e.g., 1=freshman, 2=sophomore, etc.).

Response:
4

Course Number

Enter the three digit code indicating the specific content of the course based on the SCNS taxonomy and course equivalency profiles. For new course requests, this may be XXX until SCNS assigns an appropriate number.

Response:
xxx

Category of Instruction

Indicate whether the course is introductory, intermediate or advanced. Introductory courses are those that require no prerequisites and are general in nature. Intermediate courses require some prior preparation in a related area. Advanced courses require specific competencies or knowledge relevant to the topic prior to enrollment.

Response:
Advanced

- 1000 level = Introductory undergraduate
- 2000 level = Introductory undergraduate
- 3000 level = Intermediate undergraduate
- 4000 level = Advanced undergraduate
- 5000 level = Introductory graduate
- 6000 level = Intermediate graduate
- 7000 level = Advanced graduate
- 4000/5000= Joint undergraduate/graduate
- 4000/6000= Joint undergraduate/graduate

**Joint undergraduate/graduate courses must be approved by the UCC and the Graduate Council)*

Lab Code

Enter the lab code to indicate whether the course is lecture only (None), lab only (L), or a combined lecture and lab (C).

Response:

None

Course Title

*Enter the title of the course as it should appear in the Academic Catalog. There is a 100 character limit for course titles. *

Response:

Li-ion Next Generation Batteries

Transcript Title

Enter the title that will appear in the transcript and the schedule of courses. Note that this must be limited to 30 characters (including spaces and punctuation).

Response:

Li-ion Next Gen Batteries

Degree Type

Select the type of degree program for which this course is intended.

Response:

Baccalaureate

Delivery Method(s)

Indicate all platforms through which the course is currently planned to be delivered.

Response:

On-Campus

Co-Listing

Will this course be jointly taught to undergraduate, graduate, and/or professional students?

Response:

No

Effective Term

Select the requested term that the course will first be offered. Selecting "Earliest" will allow the course to be active in the earliest term after SCNS approval. If a specific term and year are selected, this should reflect the department's best projection. Courses cannot be implemented retroactively, and therefore the actual effective

term cannot be prior to SCNS approval, which must be obtained prior to the first day of classes for the effective term. SCNS approval typically requires 2 to 6 weeks after approval of the course at UF.

Response:
Earliest Available

Effective Year

Select the requested year that the course will first be offered. See preceding item for further information.

Response:
Earliest Available

Rotating Topic?

Select "Yes" if the course can have rotating (varying) topics. These course titles can vary by topic in the Schedule of Courses.

Response:
No

Repeatable Credit?

Select "Yes" if the course may be repeated for credit. If the course will also have rotating topics, be sure to indicate this in the question above.

Response:
No

Amount of Credit

Select the number of credits awarded to the student upon successful completion, or select "Variable" if the course will be offered with variable credit and then indicate the minimum and maximum credits per section. Note that credit hours are regulated by Rule 6A-10.033, FAC. If you select "Variable" for the amount of credit, additional fields will appear in which to indicate the minimum and maximum number of total credits.

Response:
3

S/U Only?

Select "Yes" if all students should be graded as S/U in the course. Note that each course must be entered into the UF curriculum inventory as either letter-graded or S/U. A course may not have both options. However, letter-graded courses allow students to take the course S/U with instructor permission.

Response:
No

Contact Type

Select the best option to describe course contact type. This selection determines whether base hours or headcount hours will be used to determine the total contact hours per credit hour. Note that the headcount hour options are for courses that involve contact between the student and the professor on an individual basis.

Response:
Regularly Scheduled

- Regularly Scheduled [base hr]
- Thesis/Dissertation Supervision [1.0 headcount hr]
- Directed Individual Studies [0.5 headcount hr]
- Supervision of Student Interns [0.8 headcount hr]
- Supervision of Teaching/Research [0.5 headcount hr]
- Supervision of Cooperative Education [0.8 headcount hr]

Contact the Office of Institutional Planning and Research (352-392-0456) with questions regarding contact type.

Weekly Contact Hours

Indicate the number of hours instructors will have contact with students each week on average throughout the duration of the course.

Response:
3

Course Description

Provide a brief narrative description of the course content. This description will be published in the Academic Catalog and is limited to 500 characters or less. See course description guidelines.

Response:
Qualities and reactions that characterize Li-ion batteries and other electrochemical cells.
Emphasis on mechanical properties. Li-ion and Sodium-ion batteries, fuel cells, capacitors, and hydrogen storage.

Prerequisites

Indicate all requirements that must be satisfied prior to enrollment in the course. Prerequisites will be automatically checked for each student attempting to register for the course. The prerequisite will be published in the Academic Catalog and must be formulated so that it can be enforced in the registration system. Please note that upper division courses (i.e., intermediate or advanced level of instruction) must have proper prerequisites to target the appropriate audience for the course.

Courses level 3000 and above must have a prerequisite.
Please verify that any prerequisite courses listed are active courses.

Response:
EGM3520 (C) & EMA3010

Completing Prerequisites on UCC forms:

- Use "&" and "or" to conjoin multiple requirements; do not use commas, semicolons, etc.
- Use parentheses to specify groupings in multiple requirements.
- Specifying a course prerequisite (without specifying a grade) assumes the required passing grade is D-. In order to specify a different grade, include the grade in parentheses immediately after the course number. For example, "MAC 2311(B)" indicates that students are required to obtain a grade of B in Calculus I. MAC2311 by itself would only require a grade of D-.
- Specify all majors or minors included (if all majors in a college are acceptable the college code is sufficient).
- "Permission of department" is always an option so it should not be included in any prerequisite or co-requisite.
- If the course prerequisite should list a specific major and/or minor, please provide the plan code for that major/minor (e.g., undergraduate Chemistry major = CHY_BS, undergraduate Disabilities in Society minor = DIS_UMN)

Example: A grade of C in HSC 3502, passing grades in HSC 3057 or HSC 4558, and undergraduate PBH student

should be written as follows: HSC 3502(C) & (HSC 3057 or HSC 4558) & UGPBH

Co-requisites

Indicate all requirements that must be taken concurrently with the course. Co-requisites are not checked by the registration system. If there are none please enter N/A.

Response:
None

Rationale and Placement in Curriculum

Explain the rationale for offering the course and its place in the curriculum.

Response:
This course is a technical elective suitable for undergraduate students in mechanical engineering, aerospace engineering, and related fields. Students would typically take this course during their last two semesters of the BS degree program.

Course Objectives

Describe the core knowledge and skills that student should derive from the course. The objectives should be both observable and measurable.

Response:
Upon completion of this course, students will demonstrate:

- an understanding of the operation and application of Li-ion batteries used as energy sources for electronic devices and electric vehicles.
- an ability to analyze and characterize electrochemical cells with focus on the mechanical properties of components, such as the anodes, cathodes, and electrolytes.
- an ability to apply concepts from engineering mechanics and materials science to develop design criteria for next generation Li-ion batteries.

The objectives will be achieved through:

- In class lectures and examples
- Student completion of homework
- Student completion of Hour Exams and Final Exam

Course Textbook(s) and/or Other Assigned Reading

Enter the title, author(s) and publication date of textbooks and/or readings that will be assigned. Please provide specific examples to evaluate the course and identify required textbooks.

Response:
High Energy Density Lithium Batteries: Materials, Engineering, Applications, K.E. Aifantis, S.A. Hackney, and R.V. Kumar, Wiley-VCH, Weinheim (2010) ISBN-13: 978-3527324071

Weekly Schedule of Topics

Provide a projected weekly schedule of topics. This should have sufficient detail to evaluate how the course would meet current curricular needs and the extent to which it overlaps with existing courses at UF.

Response:
Week 1: Introduction to electrochemical cells
Week 2: Quantities characterizing batteries, Experimental techniques for measurements of

chemo-mechanical coupling in batteries, hw1 due
 Week 3: Computational methods in battery modeling, elasticity theory, hw 2 due
 Week 4: Experimental demonstrations, stress-assisted diffusion in energy storage systems, hw 3 due
 Week 5: Mechanics of composite materials in fuel cell systems, hw 4 due
 Week 6: Review, Exam 1
 Week 7: Damage mechanisms in batteries, electro-chemo-mechanical behavior of cathode particle, hw 5 due
 Week 8: Kinematics of solid electrolyte interface and dendrite formation in Li-ion batteries, fatigue of electrode materials, hw 6 due
 Week 9: Stress evolution of Li-ion during lithiation, hydrogen embrittlement in hydrogen storage materials, hw 7 due
 Week 10: Review, Exam 2
 Week 11: Experimental demonstrations, fluid and thermal mechanics and gradient theories
 Week 12: Thermo-mechanical modeling of solid oxide fuel cell materials, hw 8 due
 Week 13: Numerical modeling of failure in energy storage systems, hw 9 due
 Week 14: Size effects in batteries and nanomechanics, hw 10 due
 Week 15: Fluid mechanics of liquid metal batteries, hw 11 due
 Final Exam

Grading Scheme

List the types of assessments, assignments and other activities that will be used to determine the course grade, and the percentage contribution from each. This list should have sufficient detail to evaluate the course rigor and grade integrity. Include details about the grading rubric and percentage breakdowns for determining grades. If participation and/or attendance are part of the students grade, please provide a rubric or details regarding how those items will be assessed.

Response:

Homework will be assigned weekly. There will be two in-class hour exams during the semester and a cumulative final exam.

Assignment	Percentage of Final Grade
Homework	20%
Exam 1	

25%	
Exam 2	

25%	
Final Exam	30%

Grading Policy

Percent	Grade	Grade Points
93.4 - 100	A	4.00
90.0 - 93.3	A-	3.67
86.7 - 89.9	B+	3.33
83.4 - 86.6	B	3.00
80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9		

E	0.00
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Instructor(s)

Enter the name of the planned instructor or instructors, or "to be determined" if instructors are not yet identified.

Response:

Katerina E. Aifantis

Attendance & Make-up

Please confirm that you have read and understand the University of Florida Attendance policy.

A required statement related to class attendance, make-up exams and other work will be included in the syllabus and adhered to in the course. Courses may not have any policies which conflict with the University of Florida policy. The following statement may be used directly in the syllabus.

• Requirements for class attendance and make-up exams, assignments, and other work in this course are consistent with university policies that can be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx>.

Response:

Yes

Accommodations

Please confirm that you have read and understand the University of Florida Accommodations policy.

A statement related to accommodations for students with disabilities will be included in the syllabus and adhered to in the course. The following statement may be used directly in the syllabus:

• Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, www.dso.ufl.edu/drc/) by providing appropriate documentation. Once registered, students will receive an accommodation letter which must be presented to the instructor when requesting accommodation. Students with disabilities should follow this procedure as early as possible in the semester.

Response:

Yes

UF Grading Policies for assigning Grade Points

Please confirm that you have read and understand the University of Florida Grading policies.

Information on current UF grading policies for assigning grade points is required to be included in the course syllabus. The following link may be used directly in the syllabus:

• <https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Response:

Yes

Course Evaluation Policy

Course Evaluation Policy

Please confirm that you have read and understand the University of Florida Course Evaluation Policy.

A statement related to course evaluations will be included in the syllabus. The following statement may be used directly in the syllabus:

• Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/public-results/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

Response:

Yes

Exx 4xxx Li-ion Next Generation Batteries

Class Periods: MWF 8th Period

Class Location: MAE-A 303

Instructor:

Katerina E. Aifantis

kaifantis@ufl.edu

352-392-6227

Office Hours: 11:45 am to 12:35 pm, MAE-B 226

Teaching Assistants:

TA to be determined

Course Description

Qualities and reactions that characterize Li-ion batteries and other electrochemical cells. Emphasis on mechanical properties. Li-ion and Sodium-ion batteries, fuel cells, capacitors, and hydrogen storage.

Credits: 3

Course Pre-Requisites / Co-Requisites

Pre-Requisites: EGM3520, EMA3010

Co-Requisites: None

Course Objectives

Upon completion of this course, students will demonstrate:

- an understanding of the operation and application of Li-ion batteries used as energy sources for electronic devices and electric vehicles.
- an ability to analyze and characterize electrochemical cells with focus on the mechanical properties of components, such as the anodes, cathodes, and electrolytes.
- an ability to apply concepts from engineering mechanics and materials science to develop design criteria for next generation Li-ion batteries.

The objectives will be achieved through:

- In class lectures and examples
- Student completion of homework
- Student completion of Hour Exams and Final Exam

Materials and Supply Fees: None

Required Textbooks and Software

High Energy Density Lithium Batteries: Materials, Engineering, Applications, K.E. Aifantis, S.A. Hackney, and R.V. Kumar, Wiley-VCH, Weinheim (2010) ISBN-13: 978-3527324071

Course Schedule

Week 1: Introduction to electrochemical cells

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- Week 6: Review, **Exam 1**
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- Week 15: Fluid mechanics of liquid metal batteries, hw 11 due
- Final Exam**

Evaluation of Grades

Homework will be assigned weekly. There will be two in-class hour exams during the semester and a cumulative final exam.

Assignment	Percentage of Final Grade
Homework	20%
Exam 1	25%
Exam 2	25%
Final Exam	30%

Grading Policy

Percent	Grade	Grade Points
93.4 - 100	A	4.00
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80.0 - 83.3	B-	2.67
76.7 - 79.9	C+	2.33
73.4 - 76.6	C	2.00
70.0 - 73.3	C-	1.67
66.7 - 69.9	D+	1.33
63.4 - 66.6	D	1.00
60.0 - 63.3	D-	0.67
0 - 59.9	E	0.00

More information on UF grading policy may be found at:

<https://catalog.ufl.edu/ugrad/current/regulations/info/grades.aspx>

Students Requiring Accommodations

Students with disabilities who experience learning barriers and would like to request academic accommodations should connect with the disability Resource Center by visiting

<https://disability.ufl.edu/students/get-started/>. It is important for students to share their accommodation letter with their instructor and discuss their access needs, as early as possible in the semester.

Course Evaluation

Students are expected to provide professional and respectful feedback on the quality of instruction in this course by completing course evaluations online via GatorEvals. Guidance on how to give feedback in a professional and respectful manner is available at <https://gatorevals.aa.ufl.edu/students/>. Students will be notified when the evaluation period opens, and can complete evaluations through the email they receive from GatorEvals, in their Canvas course menu under GatorEvals, or via <https://ufl.bluera.com/ufl/>. Summaries of course evaluation results are available to students at <https://gatorevals.aa.ufl.edu/public-results/>.

University Honesty Policy

UF students are bound by The Honor Pledge which states, “We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: “On my honor, I have neither given nor received unauthorized aid in doing this assignment.” The Honor Code (<https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code/>) specifies a number of behaviors that are in violation of this code and the possible sanctions. Furthermore, you are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor or TAs in this class.

Commitment to a Safe and Inclusive Learning Environment

The Herbert Wertheim College of Engineering values broad diversity within our community and is committed to individual and group empowerment, inclusion, and the elimination of discrimination. It is expected that every person in this class will treat one another with dignity and respect regardless of gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture.

If you feel like your performance in class is being impacted by discrimination or harassment of any kind, please contact your instructor or any of the following:

- Your academic advisor or Graduate Program Coordinator
- Robin Bielling, Director of Human Resources, 352-392-0903, rbielling@eng.ufl.edu
- Curtis Taylor, Associate Dean of Student Affairs, 352-392-2177, taylor@eng.ufl.edu
- Toshikazu Nishida, Associate Dean of Academic Affairs, 352-392-0943, nishida@eng.ufl.edu

Software Use

All faculty, staff, and students of the University are required and expected to obey the laws and legal agreements governing software use. Failure to do so can lead to monetary damages and/or criminal penalties for the individual violator. Because such violations are also against University policies and rules, disciplinary action will be taken as appropriate. We, the members of the University of Florida community, pledge to uphold ourselves and our peers to the highest standards of honesty and integrity.

Student Privacy

There are federal laws protecting your privacy with regards to grades earned in courses and on individual assignments. For more information, please see: <https://registrar.ufl.edu/ferpa.html>

Campus Resources:

Health and Wellness

U Matter, We Care:

Your well-being is important to the University of Florida. The U Matter, We Care initiative is committed to creating a culture of care on our campus by encouraging members of our community to look out for one another and to reach out for help if a member of our community is in need. If you or a friend is in distress, please contact umatter@ufl.edu so that the U Matter, We Care Team can reach out to the student in distress. A nighttime and weekend crisis counselor is available by phone at 352-392-1575. The U Matter, We Care Team can help connect students to the many other helping resources available including, but not limited to, Victim Advocates, Housing staff, and the Counseling and Wellness Center. Please remember that asking for help is a sign of strength. In case of emergency, call 9-1-1.

Counseling and Wellness Center: <http://www.counseling.ufl.edu/cwc>, and 392-1575; and the University Police Department: 392-1111 or 9-1-1 for emergencies.

Sexual Discrimination, Harassment, Assault, or Violence

If you or a friend has been subjected to sexual discrimination, sexual harassment, sexual assault, or violence contact the **Office of Title IX Compliance**, located at Yon Hall Room 427, 1908 Stadium Road, (352) 273-1094, title-ix@ufl.edu

Sexual Assault Recovery Services (SARS)

Student Health Care Center, 392-1161.

University Police Department at 392-1111 (or 9-1-1 for emergencies), or <http://www.police.ufl.edu/>.

Academic Resources

E-learning technical support, 352-392-4357 (select option 2) or e-mail to Learning-support@ufl.edu. <https://lss.at.ufl.edu/help.shtml>.

Career Resource Center, Reitz Union, 392-1601. Career assistance and counseling. <https://www.crc.ufl.edu/>.

Library Support, <http://cms.uflib.ufl.edu/ask>. Various ways to receive assistance with respect to using the libraries or finding resources.

Teaching Center, Broward Hall, 392-2010 or 392-6420. General study skills and tutoring. <https://teachingcenter.ufl.edu/>.

Writing Studio, 302 Tigert Hall, 846-1138. Help brainstorming, formatting, and writing papers. <https://writing.ufl.edu/writing-studio/>.

Student Complaints Campus: <https://care.dso.ufl.edu>.

On-Line Students Complaints: <http://www.distance.ufl.edu/student-complaint-process>.