Brothers, Sheila

From: Cramer, Aaron
Sent: Thursday, March 07, 2019 11:25 AM
To: Bird-Pollan, Jennifer; Brothers, Sheila; Ett-Mims, Joanie
Cc: Smith, Suzanne
Subject: NEW UC: Aerospace Engineering
Attachments: 20190303 AeroEngr UG Certificate - SC Revisions.pdf

Proposed New Undergraduate Certificate: Aerospace Engineering

This is a recommendation that the University Senate approve the establishment of a new Undergraduate Certificate: Aerospace Engineering, in the College of Engineering.

Rationale: Aerospace engineering careers are typically developed in graduate school or through career experience. The proposed undergraduate certificate program introduces students to the multidisciplinary aspects of aerospace engineering while preparing them for graduate education and careers. Technical electives and mathematical coursework are paired with an aerospace engineering educational experience to provide context. Aerospace is a growth sector in Kentucky's economy requiring engineering expertise and workforce. An initial 15 students growing to 35 students are expected.

Aaron

Aaron M. Cramer
Associate Professor, Electrical and Computer Engineering
Director of Graduate Studies, Electrical Engineering
Chair, Senate Academic Programs Committee
University of Kentucky
859-257-9113
aaron.cramer@uky.edu

An Undergraduate Certificate is an integrated group of courses (as defined here 12 or more credits) that are 1) cross-disciplinary, but with a thematic consistency, and 2) form a distinctive complement to a student's major and degree program, or 3) leads to the acquisition of a defined set of skills or expertise that will enhance the success of the student upon graduation. Undergraduate Certificates meet a clearly defined educational need of a constituency group, such as continuing education or accreditation for a particular profession; provide a basic competency in an emerging area within a discipline or across disciplines; or respond to a specific state mandate.

After the proposal receives college approval, please submit this form electronically to the Undergraduate Council. Once approved at the academic council level, the academic council will send your proposal to the Senate Council office for additional review via a committee and then to the Senate for approval. Once approved by the Senate, the Senate Council office will send the proposal to the appropriate entities for it to be included in the Bulletin. The contact person listed on the form will be informed when the proposal has been sent to committee and other times, subsequent to academic council review.

Please click here for more information about undergraduate certificates.

1. GENERAL INFORMATION				
1a	Date of contact with Institutional Effectiveness (IE)[1]:	9/18/18		
	☒ Appended to the end of this form is a PDF of the reply from Institutional Effectiveness.			
1b	Home college: College of Engineering			
1c	Home educational unit (department, school, college[2]): *College of Engineering*			
1d	Proposed certificate name: *Aerospace Engineering*			
1e	CIP Code[3]: *14.0201*			
1f	Requested effective date:	☒ Fall semester following approval.	OR	☐ Specific Date[4]: *Fall 20*
1g	Contact person name: *Suzanne Weaver Smith*	Email: *suzanne.smith@uky.edu*		Phone: *8593234545*
2. OVERVIEW				
2a	Provide a brief description of the proposed new undergraduate certificate. *(300 word limit)*			
	Aerospace Engineering careers are typically developed in graduate school or career experience. Therefore the UK undergraduate Aerospace Engineering certificate introduces UK students to the multidisciplinary aspects of aerospace engineering while preparing UK students for graduate education and careers. A strong foundation in			

[1] You can reach Institutional Effectiveness by phone or email (257-2873 or OSPIE@l.uky.edu).
[2] Only cross-disciplinary certificates may be homed at the college level.
[3] In consultation with the Undergraduate Council Chair and Registrar, identify the appropriate CIP code(s) *prior* to college-level approval.
[4] Certificates are typically made effective for the semester following approval. No program will be made effective unless all approvals, up through and including University Senate approval, are received.

	mathematics is essential in aerospace, so technical elective coursework is paired with cross-disciplinary Mathematics options. This will advance the mathematical maturity of aerospace certificate students, positively impact student performance in engineering courses, and prepare students for aerospace graduate degree programs and career opportunities. *An educational experience provides context. All Aerospace Engineering certificate students must complete EGR 390 Experiential Learning in Engineering or Computer Science – Aerospace Experince (0 credits). This documents and synthesizes their learning from at least one of the following educational experiences relevant for aerospace engineering: Aerospace-related capstone design project or design/build/fly competition, aerospace-related internship or co-op term, faculty-mentored aerospace-related research or independent study, EGR 490 Engineering Leadership or Engineering Scholars Program, AF ROTC or aerospace-related military experience, or approved equivalent aerospace-related educational experience (course must be completed with a C or better). In addition, students complete with a C or better the 12-hours of coursework for at least one of the aerospace specialties lists below.* *Interested students will complete the application at the latest during their Junior year (having completed between 24 to 80 hours with a 2.5 GPA) indicating their intent and plan to complete the requirements for Aerospace Certificate. Annual activities and events will be held for recruiting, to add educational value (e.g., seminars), to encourage student multidisciplinary interactions, and in order to honor completion achievement, with more activities added if industry or individual gift support becomes available.*
2b	This proposed undergraduate certificate (check all that apply):
	☒ Is cross-disciplinary[5].
	☐ Is certified by a professional or accredited organization/governmental agency.
	☒ Clearly leads to advanced specialization in a field.
2c	**Affiliation.** Is the undergraduate certificate affiliated with a degree program? Yes ☐ No ☒
	If "yes," include a brief statement of how it will complement the program. If it is not affiliated with a degree program, incorporate a statement as to how it will provide an opportunity for a student to gain knowledge or skills not already available at UK. *(300 word limit)*
	The College of Engineering does not offer a specific degree program in aerospace engineering. Therefore, prospective students who are interested in aerospace engineering have the difficult decision of choosing a different university (with an aerospace engineering major), or navigating a degree program from among more than three different departments within the College of Engineering-- Mechanical Engineering (ME); Electrical and Computer Engineering (ECE); and Chemical and Materials Engineering (CME). Each of the programs offer courses that relate in some way to aerospace systems and aerospace engineering topics; however, for most students initially learning about the field, recognizing how aerospace engineering fits within each of these different degree programs is daunting. The proposed Aerospace Engineering Certificate aims to address this. *The Aerospace Engineering undergraduate certificate is offered in the College of Engineering in partnership with the Mathematics Department. A strong foundation in mathematics is essential in aerospace, so engineering technical elective coursework is paired with cross-disciplinary mathematics options. This will advance the mathematical maturity of aerospace certificate students, positively impact student performance in engineering courses, and prepare students for graduate degree programs. In addition to completing 12 hours of coursework, students will complete an educational experience through an aerospace-related capstone design project or design/build/fly competition, aerospace-related internship or co-op term, faculty-mentored aerospace-related research or independent study, EGR 490 Engineering Leadership or Engineering Scholars Program, AF ROTC or aerospace-related military experience, or approved equivalent aerospace-related educational experience. The experience will be documented by student completion of EGR 390 Experiential Learning in Engineering or*

[5] An undergraduate certificate must be cross-disciplinary and students must take courses in at least two disciplines, with a minimum of three credits to be completed in a second discipline.

	Computer Science – Aerospace Experience (0 credits). Annual events are planned to encourage student multidisciplinary interaction and for honoring achievement.
2d	**Duplication.** Are there similar regional or national offerings? Yes ☐ No ☒
	If "Yes," explain how the proposed certificate will or will not compete with similar regional or national offerings.
2d	**Rationale and Demand.** Explain the need for the new undergraduate certificate (e.g. market demand and cross-disciplinary considerations). *(300 word limit)*
	No Kentucky academic institutions currently offer an undergraduate degree program in Aerospace Engineering, so Kentucky students pursue undergraduate aerospace degree programs in other states via the Academic Common Market agreements or attend UK Engineering and try to tailor their degree. Therefore, offering an Aerospace Certificate will guide UK student preparation and recognize their accomplishments toward their aerospace career aspirations. Further, transcript notation of successful completion will attract additional Kentucky student enrollment at UK. *Aerospace is a growth sector in Kentucky's economy requiring engineering expertise and workforce. Kentucky is the only state with three logistics hubs: UPS, DHL and Amazon, and Kentucky's aviation infrastructure has 60 airports including international airports in large urban centers and small airports in rural communities. Kentucky is second in the nation with nearly $11B in aerospace exports, including manufacturing of jet engines and landing gear systems, among more than 600 aerospace-affiliated companies.*
2e	**Target audience.** Check the box(es) that apply to the target student population.
	☒ Currently enrolled undergraduate students.
	☐ Post-baccalaureate students.
2f	Describe the demographics of the intended audience. *(150 word limit)*
	The Aerospace Certificate is aimed at upperclassmen, guiding their choice of technical electives and increasing their mathematical maturity as preparation for graduate study or aerospace career opportunities.
2g	**Projected enrollment.** What are the enrollment projections for the first three years?

		Year 1	*Year 2* *(Yr. 1 continuing + new entering)*	*Year 3* *(Yrs. 1 and 2 continuing + new entering)*
	Number of Students	*15*	*25*	*35*

2h	**Distance learning (DL).** Initially, will any portion of the undergraduate certificate be offered via DL?			Yes ☒	No ☐
	If "Yes," please indicate below the percentage of the certificate that will be offered via DL.				
	1% - 24% ☒	25% - 49% ☐	50% - 74% ☐	75 - 99% ☐	100% ☐
	If "Yes," describe the DL course(s) in detail, including the number of required DL courses. *(200 word limit)*				
	One of the option courses in the Structures Specialization, ME 513 Vibrations, is offered via distance learning for students on the Lexington campus. An option course in Computational Fluid Dynamics (CFD) under the				

	Aerodynamics Specialization is currently offered at the Paducah campus, but may be developed as a future distance offering for Lexington campus students, if the need justifies. The Systems Engineering class, ME 516, has been offered face-to-face on both the Lexington and Paducah campuses in the past. A distance offering version has been approved, so in the future that may be offered via distance to students at the other campus.

3. ADMINISTRATION AND RESOURCES

3a	**Administration.** Describe how the proposed undergraduate certificate will be administered, including admissions, student advising, retention, etc. *(150 word limit)*
	The Director of the Aerospace Engineering Certificate is responsible for overseeing the administration of the certificate with assistance of faculty designated from ME (2; largest expected numbers of students), ECE (1) and CME (1) to serve as the Faculty of Record, along with a designated student advisor. Duties include reviewing student applications, evaluating requests for exceptions, transfer credits or substitutions, certifying successful completion of requirements, and notifying the College of Engineering records office when requirements are completed. Faculty designated from ME, ECE and CME will also provide general information and advising about the certificate to their interested students. The Director, Faculty of Record, or advisor will reach out to students semi-annually to evaluate their progress towards completing the Certificate.
3b	**Faculty of Record.** The Faculty of Record consists of the undergraduate certificate director and other faculty who will be responsible for planning and participating in the certificate program. Describe the process for identifying the certificate director. Regarding membership, include the aspects below. *(150 word limit)* • Selection criteria; • Whether the member is voting or non-voting; • Term of service; and • Method for adding/removing members.
	Faculty memebers from each of ME (2), ECE (1) and CME (1) will serve as Faculty of Record (FoR). Nominated department representatives will be approved by the FoR and the Director will be selected by mutual consent of the entire group. The department chair will nominate the representative(s) for his/her department with the approval of the departmental faculty. Typical terms will be two years; reappointment is allowed and members can be reappointed until they no longer wish (or are no longer able) to serve. During the term, should unavailability or other need arise, with the approval of the departmental faculty, the department chair can be asked for or can initiate nomination of another member. Selection crieteria is based onfamiliarity with the certificate program and willingness to perform the required duties. Originating members: S. Smith &Martin (ME), W. Smith & JE Lumpp (ECE), Beck (CME).
3c	**Advisory board.** Will the undergraduate certificate have an advisory board[6]? Yes ☐ No ☒
	If "Yes," please describe the standards by which the faculty of record will add or remove members of the advisory board. *(150 word limit)*
	If "Yes," please list below the number of each type of individual (as applicable) who will be involved in the advisory board.
	Faculty within the college who are within the home educational unit.
	Faculty within the college who are outside the home educational unit.

[6] An advisory board includes both faculty and non-faculty who advise the faculty of record on matters related to the program, e.g. national trends and industry expectations of graduates.

		Faculty outside the college who are within the University.
		Faculty outside the college and outside the University who are within the United States.
		Faculty outside the college and outside the University who are outside the United States.
		Students who are currently in the program.
		Students who recently graduated from the program.
		Members of industry.
		Community volunteers.
		Other. Please explain:
		Total Number of Advisory Board Members

3d	**Course utilization.** Will this undergraduate certificate utilize courses from other academic units?	Yes ☒	No ☐
	If "Yes," two pieces of supporting documentation are required. ☒ Check to confirm that appended to the end of this form is a letter of support from the other units' chair/director[7] from which individual courses will be used. The letter must include demonstration of true collaboration between multiple units[8] and impact on the course's use on the home educational unit. ☒ Check to confirm that appended to the end of this form is verification that the chair/director of the other unit has consent from the faculty members of the unit. This typically takes the form of meeting minutes.		
3e	**Financial Resources.** What are the (non-course) resource implications for the proposed undergraduate certificate, including any projected budget needs? *(300 word limit)*		
	No non-course resource needs or financial support are required. As industry or individual gift support is available in the future, annual events will be added to encourage enrollment or provide additional multi-disciplinary student interactions and career opportunities exposure.		
3f	**Other Resources.** Will the proposed undergraduate certificate utilize resources (e.g. departmentally controlled equipment or lab space) from additional units/ programs?	Yes ☐	No ☒
	If "Yes," identify the other resources that will be shared. (*150 word limit*)		
	If "Yes," two pieces of supporting documentation are required. ☐ Check to confirm that appended to the end of this form is a letter of support from the appropriate chair/director[9] of the unit whose "other resources" will be used. ☐ Check to confirm that appended to the end of this form is verification that the chair/director of the other unit has consent from the faculty members of the unit. This typically takes the form of meeting minutes.		

4. IMPACT			
4a	**Other related programs.** Are there any related UK programs and certificates?	Yes ☐	No ☒
	If "Yes," describe how the new certificate will complement these existing UK offerings. *(250 word limit)*		

[7] A dean may submit a letter only when there is no educational unit below the college level, i.e. there is no department/school.
[8] Show evidence of detailed collaborative consultation with such units early in the process.
[9] A dean may submit a letter only when there is no educational unit below the college level, i.e. there are no departments/schools.

	If "Yes," two pieces of supporting documentation are required. ☐ Check to confirm that appended to the end of this form is a letter of support from the appropriate chair/director of the unit whose "other resources" will be used. ☐ Check to confirm that appended to the end of this form is verification that the chair/director has input from the faculty members of the unit. This typically takes the form of meeting minutes.

5. ADMISSIONS CRITERIA AND CURRICULUM STRUCTURE

5a	**Admissions criteria.** List the admissions criteria for the proposed undergraduate certificate. *(150 word limit)*
	For admission to the aerospace certificate program, students must submit an application, be in good academic standing, and have completed at least 24 hours and no more than 80 hours of coursework with a minimum GPA of 2.5.

5b **Core Courses.** List the required courses below.

Prefix & Number	Course Title	Credit Hrs	Course Status[10]
	see attached course lists for aerospace specializations		Select one....
			Select one....
			Select one....
			Select one....
			Select one....

5c **Elective courses.** List the electives below.

Prefix & Number	Course Title	Credit Hrs	Course Status[11]
			Select one....
			Select one....
			Select one....
			Select one....
			Select one....
			Select one....
	Total Credit Hours:		

5d	Are there any other requirements for the undergraduate certificate? If "Yes," note below. *(150 word limit)*	Yes ☒	No ☐
	In addition to completing at least 12 hours of coursework with grades of C or better, students will complete EGR 390 Experiential Learning in Engineering or Computer Science – Aerospace Experience (0 credits to document completion of an educational experience through an aerospace-related capstone design project or design/build/fly		

[10] Use the drop-down list to indicate if the course is a new course ("new"), an existing course that will change ("change"), or if the course is an existing course that will not change ("no change").
[11] Use the drop-down list to indicate if the course is a new course ("new"), an existing course that will change ("change"), or if the course is an existing course that will not change ("no change").

	competition, aerospace-related internship or co-op term, faculty-mentored aerospace-related research or independent study, EGR 490 Engineering Leadership or Engineering Scholars Program, AF ROTC or aerospace-related military experience, or approved equivalent.
5e	Is there any other narrative about the undergraduate certificate that should be included in the Bulletin? If "Yes," please note below. *(300 word limit)* — Yes ☒ No ☐
	Aerospace Engineering careers are multidisciplinary, mathematical, and typically developed in graduate school or through career experience. Therefore the UK undergraduate Aerospace Engineering certificate introduces UK students to multidisciplinary context of aerospace engineering through experiential education while preparing them for graduate education and careers through certificate coursework. A strong foundation in mathematics is also essential, so technical elective coursework is paired with cross-disciplinary Mathematics options. This will advance the mathematical maturity of aerospace certificate students, positively impact student performance in engineering courses, and prepare students for aerospace graduate degree programs and career opportunities.
6. ASSESSMENT	
6a	**Student learning outcomes.** Please provide the student learning outcomes for this undergraduate certificate. List the knowledge, competencies, and skills (learning outcomes) students will be able to do upon completion. (Use action verbs, not simply "understand.") *(250 word limit)*
	The aerospace discipline integrates many diverse specializations, and the UK Aerospace Certificate establishes a framework of aerospace specializations with mathematical underpinnings as an asset for students pursuing opportunities in graduate education or aerospace career tracks. To put the coursework into practice OR context, the certificate also requires completion of at least one of the following educational experiences relevant for aerospace engineering (all courses must be completed with C or better): Aerospace-related capstone design project or design/build/fly competition, aerospace-related internship or co-op term, faculty-mentored aerospace-related research or independent study, EGR 490 Engineering Leadership or Engineering Scholars Program, AF ROTC or aerospace-related military experience, or approved equivalent aerospace-related educational experience. The Aerospace Educational Experience will be documented by student enrollment in and completion of EGR 390 Experiential Learning in Engineering or Computer Science – Aerospace Experience (0 credits). *Upon completion, Aerospace Certificate students will be able to 1) demonstrate depth of mastery of mathematical, computational, theoretical, and experimental skills under their chosen specialization, 2) succinctly and clearly communicate the interdisciplinary nature, mathematical framework, and broader context of the aerospace discipline, including connections to their EGR 390 experience, and 3) provide feedback upon completion and during their first step afterwards.*
6b	**Student learning outcome (SLO) assessment.** How and when will student learning outcomes be assessed? Please map proposed measures to the SLOs they are intended to assess. Do not use grades or indirect measures (e.g. focus groups, surveys) as the sole method. Measures likely include artifacts such as course-embedded assessment (e.g., portfolios, research papers or oral presentations); and test items (embedded test questions, licensure/certification testing, nationally or state-normed exams). *(300 word limit)*
	Student learning outcomes assessment will be summative and formative, comprised of three aspects: 1) grades in completed coursework required for the certificate specializations, 2) student responses to a written essay assignment in EGR 390 about interdisciplinary aspects in aerospace, mathematical bases of aerospace subjects, their aerospace experience, and the broader context of the aerospace sector in defense, exploration, and our daily lives, and 3) student responses to a self-assessment survey in EGR 390 of aerospace skills confidence: a) understanding of aerospace in public policy: understanding of multidisciplinary interactions in aerospace;

	understanding of the role of the student's primary discipline (major and/or minor) in aerospace; understanding of aerospace organizations. Assessment assignments will be piloted before certificate implementation.
6c	**Certificate outcome assessment[12].** Describe program evaluation procedures for the proposed undergraduate certificate. Include how the faculty of record will determine whether the program is a success or a failure. List the benchmarks, the assessment tools, and the plan of action if the program does not meet its objectives. *(250 word limit)*
	Assessment of the certificate's effectiveness includes participant input, graduate placement, and initial success in graduate education or aerospace employment. Discussions at the annual gathering(s) of participating students will be planned and conducted by the Director, with as-needed help from the Faculty of Record, to include opportunities forstudent input to program assessment. Aerospace certificate students will be asked about the certificate program strengths, weaknesses, and suggestions for improvement, along with their next step in graduate education or employment. Toward the end of the 5th year of being offered, the Faculty of Record, under the leadership of the Director, will prepare a report summarizing the certificate status, operations, and certificate recipients during that period. The report will also include an enrollment report, expectaions for future enrollments, and a recomendation for renewal of the certificate curriculum (or not). The report will be provided to the Dean and to the Associate Provost for Undergraduate Education.
7. OTHER INFORMATION	
7a	Is there any other information about the undergraduate certificate to add? (*150 word limit)*
	The College of Engineering Aerospace Certificate was established in 2007. Over 30 students completed the 18-hour original aerospace-minor format. The proposal retains valued aspects of the original (experiential education, technical elective focus), while adjusting to the new format. A successful pilot in Spring 2018 identified and resolved issues.
8. APPROVALS/REVIEWS	
Information below does not supersede the requirement for individual letters of support from educational unit administrators and verification of faculty support (typically takes the form of meeting minutes).	

	Reviewing Group Name	**Date Approved**	**Contact Person Name/Phone/Email**
8a	(Within College) *In addition to the information below, attach documentation of department and college approval. This typically takes the form of meeting minutes but may also be an email from the unit head reporting department- and college-level votes.*		
			/ /
			/ /
			/ /
			/ /
8b	(Collaborating and/or Affected Units)		
			/ /
			/ /
			/ /

[12] This is a plan of how the certificate will be assessed, which is different from assessing student learning outcomes.

			/ /
			/ /
			/ /
			/ /
			/ /
			/ /

8c	(Senate Academic Council)	**Date Approved**	**Contact Person Name**
	Health Care Colleges Council (if applicable)		
	Undergraduate Council		

Brandenburg, Barbara

From: Pearson, RaeAnne
Sent: Tuesday, September 18, 2018 9:31 AM
To: Brandenburg, Barbara
Subject: Substantive Change Decision- Aerospace Engineering, UG

Dear BJ,

Thank you for submitting an NOI regarding the proposed program**, Aerospace Engineering, Undergraduate Certificate (14.0201).**

My email will serve 2 purposes: 1.) Next steps for SACSCOC, and 2.) Verification and notification that you have contacted OSPIE—a Senate requirement for proposal approval.

1. **Next steps for SACSCOC:** None required
2. **Verification that OSPIE has reviewed the proposal:** Based on the proposed documentation presented and the Substantive Change Checklist, the proposed program does not constitute a substantive change as defined by the SACSCOC, the university's regional accreditor. Therefore, no additional information is required by the Office of Strategic Planning & Institutional Effectiveness at this time. The proposed program may move forward in accordance with college and university-level approval processes.

Should you have questions or concerns about UK's substantive change policy and its procedures, please do not hesitate to contact me.

RaeAnne Pearson, Ph.D.
Planning and Accreditation Coordinator
University of Kentucky
Office of Planning and Institutional Effectiveness
Patterson Office Tower #555
Lexington, KY 40506
859-218-4009

University of Kentucky
College of Engineering
Office of the Dean

351 Ralph G. Anderson Bldg.
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September 17, 2018

To Whom It May Concern:

The College of Engineering faculty reviewed the new Undergraduate Certificate for Aerospace Engineering via email. There were no concerns or objections raised. The College of Engineering approved the new Undergraduate Certificate for Aerospace Engineering on September 12, 2018.

Sincerely,

Kimberly W Anderson

Kimberly Anderson, Ph.D.
Associate Dean for Administration and Academic Affairs

University of Kentucky
College of Engineering
Department of Mechanical Engineering

November 6, 2017

Dr. Suzanne Weaver Smith
Undergraduate Certificate in Aerospace Engineering
151 RG Anderson Bldg
Lexington, KY 40506-0503

Dear Dr. Smith,
The Mechanical Engineering (ME) Department enthusiastically supports offering an Undergraduate Aerospace Engineering Certificate in partnership with Mathematics, Electrical and Computer Engineering and Materials Engineering. The requirement for experiential education through an aerospace-related capstone design project or design/build/fly competition, aerospace-related internship or co-op term, faculty-mentored aerospace-related research or independent study, EGR 490 Engineering Leadership, or AF ROTC will bring together certificate students from the various disciplines. Currently, approximately 150-200 UK students are preparing themselves for aerospace careers and participating in experiences such as these. Validating their efforts through the aerospace certificate is welcome.

Fifteen 500-level courses comprise the list of technical electives that ME students can choose among to satisfy the requirements for four aerospace specializations typical of ME careers in the aerospace industry or graduate study in aerospace. ME students will be able to specialize in one or more of the following: 1) Structures, Instrumentation and Testing, 2) Mechanical Systems Engineering, 3) Aerodynamics, or 4) Propulsion and Control.

A strong foundation in mathematics is essential for any specialization in aerospace, so it is appropriate and welcome for the certificate to partner technical elective coursework with Mathematics options to advance the mathematical maturity of aerospace certificate students. This will positively impact student performance in the technical elective courses, as well as in graduate classes that follow for certificate students in UK's University Scholars Program or for those in graduate programs at other universities.

The Department of Mechanical Engineering initiated and has managed a college-offered aerospace certificate for more than 10 years. ME first approved development of an Aerospace Certificate at the Nov 1, 2004 department retreat, and noted further approval in faculty meeting minutes of Dec 13, 2006. Since the first two were awarded in May 2009, more than 30 ME students have completed course requirements for the 18-hour College of Engineering Undergraduate Certificate in Aerospace Engineering. Adjusting and submitting requirements for a UK Undergraduate Aerospace Certificate was affirmed with discussion at the Sept 6 2017 faculty meeting.

Sincerely,

Michael W. Renfro, Ph.D.
Professor and Chair Mechanical Engineering Department

Smith, Suzanne

From: Johnson, Michael
Sent: Friday, December 01, 2017 3:18 PM
To: Smith, Suzanne
Subject: FYI - aerospace certificate tracks approved by ECE faculty

Hi Suzanne,

Just wanted to let you know the aerospace certificate tracks were approved unanimously by ECE faculty in our meeting today, with no changes or objections.

Mike

==========

Dr. Michael T. Johnson
Professor and Chair, Electrical and Computer Engineering
FPAT 453, (859) 257-0717
University of Kentucky
http://johnson.engineering.uky.edu/

Department of Chemical and Materials Engineering

177 Anderson Hall
Lexington, KY 40506-0046
(859) 257-5507
douglass.kalika@uky.edu

February 15, 2019

Professor Suzanne Smith
Department of Mechanical Engineering
University of Kentucky

Dear Prof. Smith,

Per our recent communication, the faculty of the Department of Chemical and Materials Engineering have agreed to the proposed (modified) course grouping for chemical engineering undergraduates seeking to earn the undergraduate certificate in Aerospace Engineering.

Specially, the course grouping for Aerospace Chemical Systems Engineering will be as follows:

- EGR 390 Experiential Learning in Engineering or CS – Aerospace Experience (0 hrs)
- MA 322 Matrix Algebra and Its Applications (or approved MA 4XX course)
- ME 516 Systems Engineering

And two of the following:

- CME 404G Polymeric Materials
- CME 554 Chemical and Physical Processing of Polymer Systems
- CME 556 Introduction to Composite Materials

The CME faculty were consulted via e-mail regarding this change (week of February 11), and have approved the revised course grouping.

Sincerely,

Doug Kalika

Douglass Kalika, Professor and Chair
Chemical and Materials Engineering

University of Kentucky
College of Arts and Sciences
Department of Mathematics

4 November 2017

Suzanne Smith
Department of Mechanical Engineering
College of Engineering

Dear Professor Smith:

The Department of Mathematics is pleased to support the College of Engineering's proposed undergraduate certificate in Aerospace Engineering. Differential equation solutions, matrix computations, vector calculus, and other mathematical topics included in the 4xxG courses are important foundational ideas and concepts for graduate study, research and development in aerospace. Engineering undergraduates already complete the first course in differential equations (MA214), and many add the first course in matrix computations (MA 322). Listing the 4xxG classes along with the first courses will encourage undergraduates to increase their mathematical skills as they complete the aerospace certificate credential. The classes are regularly offered, so no additional teaching load is required. However, with the slightly increased enrollments that would result from encouraging more undergraduate engineering students to take the 4xxG classes, additional stability in their offerings for graduate students may also result.

As noted, many undergraduate engineering majors complete MA 214 and MA 322 as part of their program and we offer a large number of seats in each of these courses. The 4xxG courses are generally run below full capacity and thus, there are seats that go unused in many of these courses. We agree that these courses will be valuable to some students in your program and are pleased that you are willing to direct your students towards these courses.

Sincerely,

Russell Brown
Professor and Chair

Course Descriptions

Engineering Courses
[EGR 390 is required for every Aerospace Engineering Certificate]
EGR 390 EXPERIENTIAL LEARNING IN ENGINEERING OR COMPUTER SCIENCE. (0-3)
Project or activity led by an engineering faculty member, designed to provide students the opportunity to apply engineering principles in the context of real-world and multi-disciplinary community-based problems. May be repeated to a maximum of three credits. Prereq: Engineering standing.

Mathematics Courses
MA 322 MATRIX ALGEBRA AND ITS APPLICATIONS. (3)
Algebra of matrices, elementary theory of vector spaces and inner product spaces, the solution of simultaneous linear equations using Gaussian elimination and triangular factorization. Orthogonal projections, pseudo inverse and singular value decomposition, least squares approximation. Determinants, eigenvalues and eigenvectors, diagonalization. Prereq: MA 114.

MA 415G COMBINATORICS AND GRAPH THEORY. (3)
A basic course in the theory of counting and graph theory. Topics in enumerative combinatorics may include: generating functions, compositions, partitions, Fibonacci numbers, permutations, cycle structure of permutations, permutations statistics, Stirling numbers of the first and second kind, Bell numbers, inclusion-exclusion. Topics in graph theory may include: Eulerian and Hamiltonian cycles, matrix tree theorem, planar graphs and the 4-color theorem, chromatic polynomial, Hall's marriage theorem, stable marriage theorem, Ramsey theory, electrical networks. Prereq: MA 213 or MA 322. (Same as CS 415G.)

MA 416G INTRODUCTION TO OPTIMIZATION. (3)
The course is an introduction to modern operations research and includes discussion of modeling, linear programming, dynamic programming, integer programming, scheduling and inventory problems, and network algorithms. Prereq: MA 213 or equivalent. (Same as CS 416G.)

MA 417G DECISION MAKING UNDER UNCERTAINTY. (3)
A continuation of MA 416 with topics selected from stochastic models, decision making under uncertainty, inventory models with random demand, waiting time models and decision problems. Prereq: CS/MA 416G and MA/STA 320, or consent of instructor. (Same as STA 417G.)

MA 432G METHODS OF APPLIED MATHEMATICS I. (3)
Partial differentiation, Jacobians, implicit function theorem, uniform convergence of series, line and surface integrals. Green's and Stokes' theorems. Prereq: MA 213 or equivalent.

MA 433G INTRODUCTION TO COMPLEX VARIABLES. (3)
Elementary complex variable theory with applications. Complex field, analytic functions, Cauchy theorem, power series, residue theory. Prereq: MA 213 or consent of the instructor.

MA 471G ADVANCED CALCULUS I. (3)
A careful and vigorous investigation of the calculus of functions of a single variable. Topics will include elementary topological properties of the real line, convergence limits, continuity, differentiation and integration. Prereq: MA 213 and MA 322; or consent of the instructor.

MA 472G ADVANCED CALCULUS II. (3)
A continuation of MA 471G to functions of several variables. A careful and rigorous investigation of the extensions of the concepts of the one variable calculus to n-dimensions. Prereq: MA 471G or consent of instructor.

MA 481G DIFFERENTIAL EQUATIONS. (3)
The fundamental goal is to cover those mathematical theories essential to the study of quantum mechanics (physics and mathematics students) and the qualitative and quantitative study of partial differential equations, especially the partial differential equations of mathematical physics (engineering graduate students). The course encompasses the following topics: uniform convergence, Picard's existence proof, Power series techniques, regular singular point theory, Bessel's equation, Legendre, Hermite and Chebychev polynomials, Orthogonal Functions, completeness, convergence in the mean, Sturm-Liouville theory, eigenvalues, eigenfunction expansions, Sturm comparison and oscillation theorems. Separation of variable techniques for the heat, wave, and Laplace's equation. Prereq: One of MA 432G, MA 471G or equivalent, or consent of instructor.

MA 483G INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS. (3)
MA 483G is essentially an introductory course in partial differential equations designed to prepare undergraduate mathematics majors for serious work in partial differential equations and to provide Ph.D. candidates in engineering and science with an introduction to partial differential equations which will serve as a foundation for their advanced numerical and qualitative work (e.g., in computational fluid dynamics.) The course encompasses the following topics: first order linear equations, characteristics, Laplace's equation, wave equation and heat equation, boundary value problems, Fourier series, Green's identities and Green's functions, general eigenvalue problems. Prereq: One of MA 432G, MA 471G, MA 481G, or equivalent, or consent of instructor.

Mechanical Engineering Courses
ME 506 MECHANICS OF COMPOSITE MATERIALS. (3)
A study of the structural advantages of composite materials over conventional materials, considering high strength-to-weight and stiffness-to-weight ratios. Fiber reinforced, laminated and particulate materials are analyzed. Response of composite structures to static and dynamic loads, thermal and environmental effects, and failure criteria are studied. Prereq: EM 302, engineering standing or consent of instructor. (Same as EM/MSE 506.)

ME 510 VIBRO-ACOUSTIC DESIGN IN MECHANICAL SYSTEMS. (3)
Application of basic acoustics and vibrations to engineering problems in vibro-acoustic design. The objective is to acquaint the student with the tools used in industry for noise and vibration control and to make the student aware of the major applications of such tools in the automotive, aerospace, and consumer product industries. Prereq: ME 310, ME 340. This course is open only to graduate students or undergraduates with engineering standing.

ME 513 MECHANICAL VIBRATIONS. (3)
The analysis of vibrational motion of structural and mechanical systems. Single-degree-of-freedom systems; free vibrations; nonperiodic excitation; harmonic excitation. Modal analysis of multiple-degree-of-freedom systems. Vibration of continuous bodies, including strings and bars (axial, torsional and flexural modes). Energy methods. Prereq: EM 313 and EM 302, engineering standing or consent of instructor. (Same as MFS 513.)

ME 516 SYSTEMS ENGINEERING. (3)
Systems Engineering is a discipline necessary for cost-effective development of complex multi-disciplinary systems. Optimal design of modern systems for defense, transportation, telecommunications and energy, among other industries, requires a different perspective than the design of subsystems operating within them. This course presents principles and the practice of Systems Engineering, along with its origins in the aerospace and software industries, historical perspective and case studies of current interest. Topics include system life-cycle, requirements definition, modeling, personality, trade studies, design optimization (with minimal information), risk management, proposal writing and others. Guest lecturers and case studies provide a realistic setting for understanding the application of course materials. Prereq: Engineering Standing.

ME 530 GAS DYNAMICS. (3)
Consideration of the mass, energy and force balances applied to compressible fluids. Isentropic flow, diabatic flow, flow with friction, wave phenomena and one-dimensional gas dynamics. Applications to duct flows and to jet and rocket propulsion engines. Prereq: ME 321, ME 330 and Engineering standing.

ME 531 FLUID DYNAMICS I. (3)
Stress at a point (introduced as a tensor of rank two). Equation of conservation of mass, rate of strain tensor, derivation of Navier-Stokes equation, source-sink flows, motion due to a doublet, vortex flow, two- and three-dimensional irrotational flow due to a moving cylinder with circulation, two-dimensional airfoils. Prereq: ME 330, MA 432G and Engineering standing.

ME 532 ADVANCED STRENGTH OF MATERIALS. (3)
Unsymmetrical bending of beams, thin plates, stress analysis of thick-walled cylinders, and rotating discs. Theory of elastic energy, curved beams, stress concentration, and fatigue. Prereq: EM 302 and engineering standing.

ME 548 AERODYNAMICS OF TURBOMACHINERY. (3)
Aerodynamic analysis and design of turbomachines (pumps, compressors and turbines). Blade element performance (deflection and losses), and models for performance prediction are present. Special topics - rotating stall and surge, and aeromechanical considerations. Prereq: ME 321 and ME 330. This course is open only to graduate students or undergraduates with engineering standing.

ME 556 INTRODUCTION TO COMPOSITE MATERIALS. (3)
Modern composite materials and their applications. Basic concepts and definitions. Fundamental properties of fibers and polymer resins. Manufacturing methods. Analysis and design of laminated and chopped fiber reinforced composites. Micro- and macro-mechanical analysis of elastic constants. Failure theory of composite materials. Computational design of composites. Prereq: Engineering Standing, and EM 302 or with instructor permission. (Same as CME/MFS/MSE 556.)

ME 563 BASIC COMBUSTION PHENOMENA. (3)
Simultaneous application of fluid mechanics, heat and mass transfer, chemical kinetics and thermodynamics to combustion. Topics covered include chemical kinetics, chain and thermal explosions, detonation and deflagration, flammability limits, stirred reactors. Flame stabilization in high and low velocity streams, laminar and turbulent diffusion flames, droplet burning, and metal combustion. Prereq: ME 321, ME 330, ME 325 and engineering standing; or graduate standing.

ME 565 SCALE MODELING IN ENGINEERING. (3)
A study of concepts of scale modeling in engineering applications. The course will include dimensionless numbers, scaling laws, and their application in engineering design and research. Prereq: ME 310, ME 321, ME 325. This course is open only to graduate students or undergraduates with engineering standing.

ME 599 TOPICS IN MECHANICAL ENGINEERING (Subtitle required). (3)
[Topic with approval of Certificate Director]
A detailed investigation of a topic of current significance in mechanical engineering such as: computer-aided manufacturing, special topicsin robotics, and current topics in heat transfer. May be repeated under different subtitles to a maximum of nine credits. A particular topicmay be offered at most twice under the ME 599 number. Prereq: Variable; given when topic is identified. This course is open only tograduate students or undergraduates with engineering standing.

Electrical Engineering Courses
EE503 POWER ELECTRONICS. (3)
Study of solid-state power electronic devices and their applications. Examination of control philosophies, steady-state models, and numerical simulation of characterizing differential equations. Current topics of interest from the literature. Prereq: EE 415G and EE 461 or consent of instructor.

EE 511 INTRODUCTION TO COMMUNICATION SYSTEMS. (3)
An introduction to the basic signal processing operations in communications systems. Topics include frequency and time domain signal and system representation, random signals, modulation, sampling, pulse modulation, information theory. Prereq: EE 421G, MA 320, and engineering standing.

EE 512 DIGITAL COMMUNICATION SYSTEMS. (3)
A treatment of the basic signaling concepts involved in the communication of digital information. Topics include transmission requirements and distortion of digital signals; discrete amplitude, frequency, and phase modulation; error control coding. Prereq: EE 421G, EE 422G, engineering standing or consent of instructor.

EE 522 ANTENNA DESIGN. (3)
Principles of radiation, potential solution to Maxwell’s equations for current in empty space, electrically small antennas, antenna arrays, wire antenna principles, introduction to numerical methods, aperture antennas, frequency scaling antennas, receiving properties of antennas, antenna measurement techniques. Prereq: EE 468G and engineering standing.

EE 523 MICROWAVE CIRCUIT DESIGN. (3)
Physical and mathematical descriptions of wave propagation in guided structures; microstrip lines; microwave integrated circuits; passive components; two-terminal devices; four-terminal devices; S-parameter concept; equivalent circuit concept; solid state microwave amplifiers and oscillators. Prereq: EE 468G and engineering standing.

EE 525 NUMERICAL METHODS AND ELECTROMAGNETICS. (3)
This course covers the basics of numerical methods and programming with applications in electromagnetics. Examples range from statics to radiation/scattering problems involving numerical solutions to integro-differential and finite difference equations. Prereq: EE 468G and engineering standing, or consent of instructor.

EE 527 ELECTROMAGNETIC COMPATIBILITY. (3)
Design of electronic systems to minimize 1) emission of electromagnetic signals that cause interference in other electronic systems, 2) the susceptibility of that system to electromagnetic signal from other electronic systems, and 3) the susceptibility of that system to its own, internally generated signals. A set of brief laboratory experiments demonstrate the design principles and provide familiarity with modern test equipment. Prereq: EE 468G and engineering standing.

EE 543 SOLAR CELL DEVICES AND SYSTEMS FOR ELECTRICAL ENERGY GENERATION. (3)
Physics of photovoltaic (PV) devices, emerging technologies, design of PV cells and systems, electronic components for signal conditioning, integration, installation, performance evaluation and economic issues related to PV systems. Prereq: EE 211 or EE 305 and Engineering Standing, or consent of instructor. (Same as BAE 543/EGR 543.)

EE576 CYBERSECURITY. (3)
This course focuses on technologies in protecting infrastructure, networks, programs and data from unintended or unauthorized access, change or destruction. It provides a survey of latest developments in cyber-security through study of theoretical foundation and hands on practical implementation. Topics include basic security technology, cryptography, security management, risk assessment, operations and physical security, software and network security, as well as ethical and legal issues. Prereq: CS 270 and EE 380 or consent of instructor.

EE 580 EMBEDDED SYSTEM DESIGN. (3)
Embedded System Design covers the design and implementation of hardware and software for embedded computer systems. Topics include architectural support for embedded systems, power management, analog and digital I/O, real-time processing design constraints and the design of embedded systems using a real-time operating systems. Prereq: EE/CPE 287, EE/CPE 380, and engineering standing or consent of instructor. (Same as CPE 580.)

EE 582 HARDWARE DESCRIPTION LANGUAGES AND PROGRAMMABLE LOGIC. (3)
A study of hardware description languages including netlists, VHDL and Verilog; their use in digital design methodologies including modeling techniques, design verification, simulation, synthesis, and implementation in programmable and fabricated logic media. Programmable logic topics include CPLD and FPGA architectures, programming technologies and techniques. Prereq: EE/CS 380 and engineering standing.

EE 584 INTRODUCTION OF VLSI DESIGN AND TESTING. (3)
Introduction to the design and layout of Very Large Scale Integrated (VLSI) Circuits for complex digital systems; fundamentals of the VLSI fabrication process; and introduction to VLSI testing and structured design for testability techniques. Prereq: Engineering standing or consent of instructor. (Same as CPE 584.)

EE 585 FAULT TOLERANT COMPUTING. (3)
Students in this course study the theory and practice of fault-tolerant and dependable computing systems. The course will introduce sources of faults, error and failures in computer controlled systems and approaches to design masking and recovery techniques at the hardware, software, and systems level. Prereq: EE/CPE 380 and engineering standing or consent of the instructor. (Same as CPE 585.)

EE 586 COMMUNICATION AND SWITCHING NETWORKS. (3)
Fundamentals of modern communication networking and telecommunications, data transmission, multiplexing, circuit switching networks, network topology routing and control, computer communication, packet switching networks, congestion control, frame relay, ATM switching networks, traffic and congestion control. Prereq: EE/CPE 282 and engineering standing. (Same as CPE 586.)

EE 587 ADVANCED EMBEDDED SYSTEMS. (3)
An advanced course in the design of embedded systems using state-of-the art microcontroller hardware and software development tools. Topics include architecture support for real-time operating systems, language support for embedded and real-time processing, embedded and wireless networking. Prereq: EE/CPE 580 and engineering standing or consent of instructor. (Same as CPE/CS 587.)

EE 588 REAL-TIME COMPUTER SYSTEMS. (3)
This course covers features typically found in real-time and embedded systems. Topics include real-time operating systems, scheduling synchronization, and architectural features of single and multiple processor real-time and embedded systems. Prereq: EE/CPE 580 and engineering standing or consent of instructor. (Same as CPE 588.)

EE 599 TOPICS IN ELECTRICAL ENGINEERING (Subtitle required). (2-3)
[Topic with approval of Certificate Director]
A detailed investigation of a topic of current significance in electrical engineering such as biomedical instrumentation, digital filter design, active networks, advanced electrical devices, digital communications, display of electronics. May be repeated to a maximum of six credits,but only three credits can be earned under the same title. A particular topic may be offered at most twice under the EE 599 number. Prereq: Equivalent of two 400-level courses in electrical engineering, consent of instructor and engineering standing.

Chemical Engineering Courses
CME 404G POLYMERIC MATERIALS. (3)
Synthesis, structure, and processing of polymers, useful geometric forms, mechanical and thermal properties, crystallinity, polymer blends, evaluation of polymers for specific applications (aerospace, automotive, biomedical), laboratory activities for each of the above. Prereq: Engineering standing. CHE 230 or CHE 236. MSE 301 or consent of instructor. (Same as MSE 404G.)

CME 554 CHEMICAL AND PHYSICAL PROCESSING OF POLYMER SYSTEMS. (3)
Theory and practice as related to the chemical and physical processing of polymer systems. Polymer rheology, heat transfer in polymer flows, polymer engineering properties. Polymer processing operations and materials selection; flow instabilities. Prereq: CME 330, CME 425 or ME 325; or consent of instructor. This course is open only to graduate students or undergraduates with engineering standing. (Same as ME/MFS/MSE 554.)

CME 556 INTRODUCTION TO COMPOSITE MATERIALS. (3)
Modern composite materials and their applications. Basic concepts and definitions. Fundamental properties of fibers and polymer resins. Manufacturing methods. Analysis and design of laminated and chopped fiber reinforced composites. Micro- and macro-mechanical analysis of elastic constants.

Failure theory of composite materials. Computational design of composites. Prereq: Engineering Standing, and EM 302 or with instructor permission. (Same as ME/MFS/MSE 556.)

Materials Science and Engineering Courses

MSE 506 MECHANICS OF COMPOSITE MATERIALS. (3)
A study of structural advantages of composite materials over conventional materials, considering high strength-to-weight and stiffness-to-weight ratios. Fiber reinforced, laminated and particulate materials are analyzed. Response of composite structures to static and dynamic loads, thermal and environmental effects, and failure criteria are studied. Prereq: EM 302, engineering standing or consent of instructor. (Same as EM/ME 506.)

MSE 554 CHEMICAL AND PHYSICAL PROCESSING OF POLYMER SYSTEMS. (3)
Theory and practice as related to the chemical and physical processing of polymer systems. Polymer rheology, heat transfer in polymer flows, polymer engineering properties. Polymer processing operations and materials selection; flow instabilities. Prereq: CME 330, CME 425 or ME 325; or consent of instructor. This course is open only to graduate students or undergraduates with engineering standing. (Same as CME/ME/MFS 554.)

MSE 556 INTRODUCTION TO COMPOSITE MATERIALS. (3)
Modern composite materials and their applications. Basic concepts and definitions. Fundamental properties of fibers and polymer resins. Manufacturing methods. Analysis and design of laminated and chopped fiber reinforced composites. Micro- and macro-mechanical analysis of elastic constants. Failure theory of composite materials. Computational design of composites. Prereq: Engineering Standing, and EM 302 or with instructor permission. (Same as CME/ME/MFS 556.)

MSE 569 ELECTRONIC PACKAGING SYSTEMS AND MANUFACTURING PROCESSES. (3)
Study of packaging systems which interconnect, support, power, cool, protect, and maintain electronic components. The course will address systems at the chip, board, and product levels. Topics include design, properties, materials, manufacture, and performance of various packaging systems. Laboratory will provide familiarity with design software and production equipment and processes. Prereq: EE 211 or EE 305, EE 360 or MSE 402G, or consent of instructor. (Same as EE 569.)

COURSE LISTS FOR THE NEW-FORMAT UNDERGRADUATE

AEROSPACE ENGINEERING CERTIFICATE

OPTION IN THE COLLEGE OF ENGINEERING

Note: GPA > 2.5 required for acceptance.

In addition to successfully completing with a C or better the 12-hours of coursework for **at least one** of the aerospace specialties areas lists below, students must also successfully complete **at least one** of the following educational experiences relevant for aerospace engineering (all courses must be completed with C or better): Aerospace-related capstone design project or design/build/fly competition, aerospace-related internship or co-op term, faculty-mentored aerospace-related research or independent study, EGR 490 Engineering Leadership or Engineering Scholars Program, AF ROTC or aerospace-related military experience, or approved equivalent aerospace-related educational experience. **Your Aerospace Educational Experience is documented by your registration in EGR 390 Experiential Learning in Engineering or Computer Science – Aerospace Experience (0 credits).**

SPECIALTY AREA(S) TO BE COMPLETED (see areas below):		TERM ENROLLING IN EGR 390 (Fall/Spring and year):	

SPECIALTY AREAS COURSE CHECKLISTS (also con't on pages 2-3)

§ Cross-disciplinary course

COURSE#	REQUIRED COURSES (credit hours)	Grade
	Structures, Instrumentation and Testing (min 12 hours)	
	• EGR 390 Experiential Learning in Engineering or CS – Aerospace Experience (0 hrs)	[ ]
	• MA 4xxG§ **or** MA 322 Matrix Algebra and Its Applications§	[ ]
	• ME 506 Mechanics of Composite Materials **or** ME 556 Intro to Composite Materials	[ ]
	• ME 513 Mechanical Vibrations **or** ME 510 Vibro-Acoustic Design in Mechanical Sys	[ ]
	And one of the following:	
	• ME 532 Advanced Strength of Materials	[ ]
	• ME 565 Scale Modeling in Engineering	[ ]
	• ME 599 – with Certificate Director approval	[ ]

	Aerodynamics (min 12 hours)	
	• EGR 390 Experiential Learning in Engineering or CS – Aerospace Experience (0 hrs)	[ ]
	• MA 4xxG§ **or** MA 322 Matrix Algebra and Its Applications§	[ ]
	• ME 530 Gas Dynamics	[ ]
	• ME 531 Fluid Dynamics	[ ]
	And one of the following:	
	• ME 548 Aerodynamics of Turbomachinery	[ ]
	• ME 565 Scale Modeling in Engineering	[ ]
	• ME 599 – with Certificate Director approval	[ ]

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SPECIALTY AREAS COURSE CHECKLISTS (also con't on page 3)

§ Cross-disciplinary course

COURSE#	REQUIRED COURSES (credit hours)	Grade

Mechanical Systems Engineering (min 12 hours)	
• EGR 390 Experiential Learning in Engineering or CS – Aerospace Experience (0 hrs)	[ ]
• MA 4xxG§ **or** MA 322 Matrix Algebra and Its Applications§	[ ]
• ME 516 Systems Engineering	[ ]
And two of the following:	
• ME 513 Mechanical Vibrations or ME 510 Vibro-Acoustic Design in Mechanical Sys	[ ]
• ME 506 Mechanics of Composite Materials or ME 556 Intro to Composite Materials	[ ]
• ME 530 Gas Dynamics or ME 531 Fluid Dynamics	[ ]
• ME 599 – with Director approval or ME 565 Scale Modeling in Engineering	[ ]

Embedded Systems (min 12 hours)	
• EGR 390 Experiential Learning in Engineering or CS – Aerospace Experience (0 hrs)	[ ]
• MA 4xxG§ **or** MA 322 Matrix Algebra and Its Applications§	[ ]
• EE 580 Embedded Systems Design	[ ]
And two of the following:	
• EE 582 Hardware Description Languages and Programmable Logic	[ ]
• EE 584 Introduction of VSLI Design and Testing	[ ]
• EE 585 Fault Tolerant Systems	[ ]
• EE 587 Advanced Embedded Systems	[ ]
• EE 588 Real-Time Computer Systems	[ ]

Communications (min 12 hours)	
• EGR 390 Experiential Learning in Engineering or CS – Aerospace Experience (0 hrs)	[ ]
• MA 4xxG§ **or** MA 322 Matrix Algebra and Its Applications§	[ ]
• EE 511 Introduction to Communication Systems	[ ]
And two of the following:	
• EE 512 Digital Communication Systems	[ ]
• EE 522 Antenna Design	[ ]
• EE 523 Microwave Circuit Design	[ ]
• EE 586 Communication and Switching Networks	[ ]

Power and Performance (min 12 hours)	
• EGR 390 Experiential Learning in Engineering or CS – Aerospace Experience (0 hrs)	[ ]
• MA 4xxG§ **or** MA 322 Matrix Algebra and Its Applications§	[ ]
And three of the following:	
• EE 503 Power Electronics	[ ]
• EE 527 Electromagnetic Compatibility	[ ]
• EE 543 Solar Cell Devices and Systems for Electrical Energy Generation	[ ]
• EE 585 Fault Tolerant Computing	[ ]
• EE 576 Cybersecurity	[ ]
• EE 599 – with Certificate Director approval	[ ]

SPECIALTY AREAS COURSE CHECKLISTS (con't)

§ Cross-disciplinary course

COURSE#	REQUIRED COURSES (credit hours)	Grade

Electromagnetics (min 12 hours)	
• EGR 390 Experiential Learning in Engineering or CS – Aerospace Experience (0 hrs)	[ ]
• MA 4xxG§ **or** MA 322 Matrix Algebra and Its Applications§	[ ]
And three of the following:	
• EE 522 Antenna Design	[ ]
• EE 523 Microwave Circuit Design	[ ]
• EE 525 Numerical Methods and Electromagnetics	[ ]
• EE 527 Electromagnetic Compatibility	[ ]

Aerospace Chemical Systems Engineering (min 12 hours)	
• EGR 390 Experiential Learning in Engineering or CS – Aerospace Experience (0 hrs)	[ ]
• MA 4xxG§ **or** MA 322 Matrix Algebra and Its Applications§	[ ]
• ME 516 Systems Engineering	[ ]
And two of the following:	
• CME 404G Polymeric Materials	[ ]
• CME 554 Chemical and Physical Processing of Polymer Systems	[ ]
• CME 556 Introduction to Composite Materials	[ ]

Aerospace Materials Systems Engineering (min 12 hours)	
• EGR 390 Experiential Learning in Engineering or CS – Aerospace Experience (0 hrs)	[ ]
• MA 322 Matrix Algebra and Its Applications§	[ ]
• ME 516 Systems Engineering	[ ]
And two of the following:	
• MSE 506 Mechanics of Composite Materials or MSE 556 Intro to Composite Materials	[ ]
• MSE 554 Chemical and Physical Processing of Polymer Systems	[ ]
• MSE 569 Electronic Packaging Systems and Manufacturing Processes	[ ]

Note: For completion, Certificate GPA must be > 3.0, with no grade less than C.