

1. Overview

A. Description

Provide a brief description of the new concentration (including the specific focus of the new concentration, relationship to other concentrations in this degree program, etc).

Emerging emphasis on drone technology and drone operations in both military and civilian sectors signals a new era within the aeronautical community focused on autonomous vehicles and systems. Though current aerospace engineering graduates are well-versed in the fundamentals of aircraft aerodynamics, structures, performance, propulsion, dynamics, controls and design, in general they have not had opportunities to study application of these fundamentals to autonomous aircraft systems. It is proposed to create a new concentration within the aerospace engineering major in "Autonomous Aircraft Systems" that will provide graduates with knowledge and skills specific to unmanned aerial vehicles and systems and thus prepare them to enter the growing unmanned aerial systems workforce. The proposed concentration curriculum is structured so that students will have general exposure to engineering of autonomous aircraft plus depth in one area important to this field. The depth areas, or "tracks", are 1) guidance, navigation and control (GNC) and 2) communications. Both tracks are intended for aerospace engineering students. All paths through this concentration satisfy ABET accreditation criteria for aerospace engineering.

B. Demand

Explain the unit's need for the new concentration (e.g., market demand, research base, direction of the discipline, and interdisciplinary considerations). How will the new concentration complement the existing degree program?

Near and long-term workforce growth in the aerospace field will be driven in part by an anticipated boom in autonomous aircraft use. The Association of Unmanned Vehicle Systems estimates a total employment impact within the state of Arizona of over 3300 jobs by 2020 with a total economic impact of over \$320M. No autonomous-vehicle, engineering-based degree programs exist within the state; in fact, few, if any, such programs exist in the entire nation. Based on these projections and on student interest in autonomous aircraft, it is projected that approximately 20% of aerospace engineering majors will select the AVS concentration.

2. Support and Impact

A. Faculty governance

Provide a supporting letter from the chair of the academic unit verifying that the proposed concentration has received faculty approval through appropriate governance procedures in the unit and that the unit has the resources to support the concentration as presented in the proposal, without impacting core course resources.

B. Other related programs

Identify other related ASU programs and outline how the new concentration will complement these existing ASU programs. (If applicable, statements of support from potentially-affected academic unit administrators need to be included with this proposal submission.)

Electrical Engineering. Since EE students will be allowed to take MAE 478 and MAE 479, it will allow EE students to broaden application of their earlier course work.

C. Letter(s) of support

Provide a supporting letter from each college/school dean from which individual courses, or the entire concentration, are taken.

3. Academic Curriculum and Requirements

A. Knowledge, competencies, and skills

List the knowledge, competencies, and skills (learning outcomes) students should have when they complete this proposed concentration. Examples of program learning outcomes can be found at (<http://www.asu.edu/oue/assessment.html>).

- Graduates will demonstrate performance analysis and design of autonomous aircraft platforms.
- Graduates will understand ethical, societal and legal issues associated with the operation of autonomous aircraft.
- Graduates will demonstrate advanced proficiency in either of two tracks as they relate to engineering of autonomous aircraft:
 - Guidance, navigation and control (GNC), or
 - Communications systems

B. Admissions criteria

List the admissions criteria for the proposed concentration. If they are identical to the admission criteria for the existing major and degree program under which this concentration will be established, please note that here.

Same as existing major and degree program.

C. Curricular structure

Provide the curricular structure for this concentration. Be specific in listing required courses and specify the total minimum number of hours required for the concentration.

Required Core Courses for the Degree/Major

Prefix	Number	Title	Is this a new Course?	Credit Hours
MAE	212	Engineering Mechanics	No	4
MAE	215	Introduction to Programming in MATLAB	No	1
MAE	213	Solid Mechanics	No	3
MAE	240	Thermofluids I	No	4
EEE	202	Circuits I	No	4
MAE	214	Computer-Aided Engineering I	No	1
MAE	384	Advanced Mathematical Methods for Engineers	No	3
MAE	360	Aerodynamics	No	4
MAE	301	Applied Experimental Statistics	No	3
MAE	318	System Dynamics and Control	No	5
MAE	325	Aerospace Structures and Materials	No	4
MAE	313	Aircraft Dynamics and Control	No	3
MAE	362	High-Speed Aerodynamics	No	4
MAE	462	Space-Vehicle Dynamics and Control	No	3
MAE	463	Aircraft Propulsion	No	3
MAE	400	Engineering Profession	No	3
<i>Section sub-total:</i>				52

Required Concentration Courses

Prefix	Number	Title	Is this a new Course?	Credit Hours
MAE	478	Fundamentals of Autonomous Aircraft Systems	Yes	3
MAE	479	Design of Autonomous Aircraft Systems	Yes	3

PHI	306	Applied Ethics OR		
POS	300	Contemporary Global Controversies OR		
POS	325	Public Policy Development OR	No	3
POS	370	Law and Society		

Section sub-total: 9

Elective Concentration Courses

Prefix	Number	Title	Is this a new Course?	Credit Hours
*Communications track (select three)				
EEE	203	Signals and Systems I	No	3
EEE	304	Signals and Systems II	No	4
EEE	350	Random Signal Analysis	No	3
EEE	455	Communications Systems	No	4
EEE	459	Communication Networks	No	3
*Guidance, Navigation and Control track (select three)				
EEE	480	Feedback Systems	No	4
EEE	481	Computer-Controlled Systems	No	4
MAE	417	Control Systems Design	No	3
MAE	506 [†]	Advanced System Modeling, Dynamics, and Control	No	3
[†] Eligible students will be allowed to take MAE 506, a graduate-level course, for credit towards the GNC track.			<i>Section sub-total:</i>	9-11

Other Concentration Requirements

E.g. – Capstone experience, internship, clinical requirements, field studies, foreign language skills as applicable Credit Hours

Section sub-total:

Total minimum credit hours required for concentration 18-20

D. Minimum residency requirement

How many hours of the concentration must be ASU credit?

All of the courses directly related to this concentration must be taken at ASU.

E. Provide a brief course description for each new course.

MAE 478: First of a two-semester capstone sequence. Introduction to autonomous aircraft performance and operations. Aircraft performance prediction. Ground control and support. Sensors. Communications and telemetry. Aerospace ethics and law. Design methods.

MAE 479: Continuation of MAE 478. Interdisciplinary capstone design project for aerospace and electrical engineering students.

Note: All new required courses should be submitted in Curriculum Changemaker and ready for Provost’s Office approval

before this concentration is put on Curriculum and Academic Programs Committee (CAPC) agenda.

4. Administration and Resources

A. How will the proposed concentration be administered (including admissions, student advisement, retention, etc.)?

Admissions through ASU Admissions.

Changes of majors will be handled through the SEMTE Advising office.

Student advisement is done upon entry to the program, followed by the next consecutive semester and in the term 5 of the major map for students who are passing courses with C grades or better. Off-track or probationary students are required to see an advisor as well.

Retention programming is handled primarily through the Fulton Schools Dean’s office, but also through the SEMTE Advising office.

B. What are enrollment projections for the next three years?

	1st Year	2nd Year (Yr. 1 continuing + new entering)	3rd Year (Yr. 1 & 2 continuing + new entering)
Number of Students (Headcount)	32-40	56-70	74-92

C. Resources

What are the resource implications for the proposed concentration, including any projected budget needs? Will new books, library holdings, equipment, laboratory space and/or personnel be required now or in the future? If multiple units/programs will collaborate in offering this concentration please discuss the resource contribution of each participating program. Letters of support must be included from all academic units that will commit resources to this concentration.

None needed.

D. Primary Faculty

List the primary faculty participants regarding this proposed concentration. For interdisciplinary concentrations, please include the relevant names of faculty members from across the University.

Name	Title	Area(s) of Specialization as they relate to proposed concentration
Valana Wells	Associate Professor	Aerodynamics
Timothy Takahashi	Professor of Practice	Aircraft Design
Veronica Santos	Assistant Professor	Robotics & Control
Iman Alizadeh	Lecturer	Aerospace Vehicle Control & Design

Spring Berman	Assistant Professor	Autonomous Vehicle Control
Matthew Peet	Assistant Professor	Aerospace Vehicle Control

5. Additional Materials**A. Major Map**

Attach a copy of the “proposed” major map for this degree program and each concentration(s) to be offered. Instructions on how to create a “proposed major map” in [BAMM](#) can be found in the [Build a Major Map Training Guide](#).

B. Appendix




Complete and attach the Appendix document.



C. Attach other information that will be useful to the review committees and the Office of the Provost.








**2014 - 2015 Major Map
Aerospace Engineering (Autonomous Vehicle Systems concentration), BSE
(Proposed)**



Term 1	0 - 16 Credit Hours	Critical course signified by	Hours	Minimum Grade	Notes
		CHM 114: General Chemistry for Engineers (SQ) OR CHM 116: General Chemistry II (SQ)	4	C	<ul style="list-style-type: none"> An SAT, ACT, Accuplacer, or TOEFL score determines placement into first-year composition courses. ASU Math Placement Exam score determines placement in Mathematics course. ASU 101 or College specific equivalent First Year Seminar required of all freshman students. ASU 101-MAE and FSE 100 required for freshmen and should be completed first semester. Non-freshmen see Advisor for petitioning replacement electives. If ENG 105 taken, a 3 hr applicable elective must also be taken prior to graduation. See Advisor.
		ENG 101 or ENG 102: First-Year Composition OR ENG 105: Advanced First-Year Composition OR ENG 107 or ENG 108: First-Year Composition	3	C	
		MAT 265: Calculus for Engineers I (MA)	3	C	
		ASU 101-MAE: The ASU Experience	1		
		FSE 100: Introduction to Engineering	2	C	
		Humanities, Fine Arts and Design (HU) AND Cultural Diversity in the U.S. (C) OR Humanities, Fine Arts and Design (HU) AND Global Awareness (G) OR Humanities, Fine Arts and Design (HU) AND Historical Awareness (H)	3		
		Minimum 2.00 GPA ASU Cumulative.			
		Term hours subtotal:	16		
Term 2	17 - 31 Credit Hours	Critical course signified by	Hours	Minimum Grade	Notes
		ENG 101 or ENG 102: First-Year Composition OR ENG 105: Advanced First-Year Composition OR ENG 107 or ENG 108: First-Year Composition	3	C	
		MAT 242: Elementary Linear Algebra	2	C	
		MAT 266: Calculus for Engineers II (MA)	3	C	
		PHY 121: University Physics I: Mechanics (SQ)	3	C	
		PHY 122: University Physics Laboratory I (SQ)	1	C	
		Social and Behavioral Sciences (SB) AND Cultural Diversity in the U.S. (C) OR Social and Behavioral Sciences (SB) AND Global Awareness (G) OR Social and Behavioral Sciences (SB) AND Historical Awareness (H) OR Historical Awareness (H)	3		
		Minimum 2.00 GPA ASU Cumulative.			
		Complete ENG 101 OR ENG 105 OR ENG 107 course(s).			
		Term hours subtotal:	15		
Term 3	32 - 46 Credit Hours	Critical course signified by	Hours	Minimum Grade	Notes
		MAE 212: Engineering Mechanics	4	C	
		MAT 275: Modern Differential Equations (MA)	3	C	
		PHY 131: University Physics II: Electricity and Magnetism (SQ)	3	C	
		PHY 132: University Physics Laboratory II (SQ)	1	C	
		MAE 215: Introduction to Programming in MATLAB	1	C	
		MAT 267: Calculus for Engineers III (MA)	3	C	
		Complete MAT 265 AND MAT 266 AND PHY 121 AND MAE 212 AND MAT 275 AND PHY 131 AND CHM 114 OR CHM 116 AND PHY 122 AND PHY 132 AND MAT 242 course(s).			
		Minimum 2.00 GPA ASU Cumulative.			
		Term hours subtotal:	15		

Term 4 47 - 61 Credit Hours Critical course signified by 	Hours	Minimum Grade	Notes
 MAE 213: Solid Mechanics	3	C	
 MAE 240: Thermofluids I	4	C	
EEE 202: Circuits I	4	C	
MAE 214: Computer-Aided Engineering I	1	C	
MAE 384: Advanced Mathematical Methods for Engineers (CS)	3	C	
Term hours subtotal:	15		

Term 5 62 - 77 Credit Hours Necessary course signified by 	Hours	Minimum Grade	Notes
 MAE 360: Aerodynamics (L)	4	C	<ul style="list-style-type: none"> Both MAE 362 and MAE 360 must be taken to secure Literacy and Critical Inquiry (L) General Studies credit.
MAE 301: Applied Experimental Statistics	3	C	
MAE 318: System Dynamics and Control	5	C	
MAE 325: Aerospace Structures and Materials	4	C	
Term hours subtotal:	16		

Term 6 78 - 93 Credit Hours Necessary course signified by 	Hours	Minimum Grade	Notes
 MAE 313: Aircraft Dynamics and Control	3	C	<ul style="list-style-type: none"> Both MAE 362 and MAE 360 must be taken to secure Literacy and Critical Inquiry (L) General Studies credit.
MAE 362: High-Speed Aerodynamics (L)	4	C	
MAE 462: Space Vehicle Dynamics and Control	3	C	
Humanities, Fine Arts and Design (HU) AND Cultural Diversity in the U.S. (C) OR Humanities, Fine Arts and Design (HU) AND Global Awareness (G) OR Humanities, Fine Arts and Design (HU) AND Historical Awareness (H)	3		
Upper Division Track Focus Elective Course	3	C	
Term hours subtotal:	16		

Term 7 94 - 108 Credit Hours Necessary course signified by 	Hours	Minimum Grade	Notes
 MAE 463: Aircraft Propulsion	3	C	
 MAE 478: Fundamentals of Autonomous Aircraft Systems	3	C	
MAE 400: Engineering Profession (I)	3	C	
Upper Division Track Focus Elective Course	3	C	
Social and Behavioral Sciences (SB) AND Cultural Diversity in the U.S. (C) OR Social and Behavioral Sciences (SB) AND Global Awareness (G) OR Social and Behavioral Sciences (SB) AND Historical Awareness (H)	3		
Term hours subtotal:	15		

Term 8 109 - 120 Credit Hours Necessary course signified by 	Hours	Minimum Grade	Notes
 MAE 479: Design of Autonomous Aircraft Systems	3	C	
Upper Division Track Focus Elective Course	3	C	
POS 325 OR POS 300 OR POS 370 OR PHI 306	3		
Elective	3		
Term hours subtotal:	12		

• For a list of Upper Division Technical Elective & Elective course options, please visit: http://engineering.asu.edu/semte/aerospace_b.html.

Communications track	Guidance, Navigation, and Controls track
EEE 203: Signals and Systems I	MAE 417: Control System Design
EEE 304: Signals and Systems II	EEE 480: Feedback Systems
EEE 350: Random Signal Analysis	EEE 481: Computer-Controlled Systems
EEE 455: Communication Systems	

EEE 459: Communication Networks

MAE 506: Advanced System Modeling,
Dynamics, and Control

Total Hours: 120

Upper Division Hours: 45
minimum

Major GPA: 2.00 minimum

Cumulative GPA: 2.00 minimum

Total hrs at ASU: 30 minimum

Hrs Resident Credit for

Academic Recognition: 56

minimum

Total Community College Hrs: 64

maximum

**General University Requirements
Legend**

General Studies Core Requirements:

- Literacy and Critical Inquiry (L)
- Mathematical Studies (MA)
- Computer/Statistics/Quantitative Applications (CS)
- Humanities, Fine Arts and Design (HU)
- Social and Behavioral Sciences (SB)
- Natural Science - Quantitative (SQ)
- Natural Science - General (SG)

General Studies Awareness
Requirements:

- Cultural Diversity in the U.S. (C)
- Global Awareness (G)
- Historical Awareness (H)
First-Year Composition

General Studies designations listed on the major map are current for the 2014 - 2015 academic year.

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APPENDIX
OPERATIONAL INFORMATION FOR UNDERGRADUATE CONCENTRATIONS

(This information is used to populate the Degree Search/catalog website.
Please consider the student audience in creating your text.)

1. Proposed Concentration Name: Autonomous Vehicle Systems

2. Program Description (150 words maximum)

Emerging emphasis on drone technology and drone operations in both military and civilian sectors signals a new era within the aeronautical community focused on autonomous vehicles and systems. Though current aerospace engineering graduates are well-versed in the fundamentals of aircraft analysis and design, in general, they have not had opportunities to study the application of the fundamentals of autonomous aircraft systems. The autonomous vehicle concentration will provide graduates with knowledge and skills generally required for aerospace engineering, plus those specific to unmanned aerial vehicles and systems. The concentration curriculum is structured so that students will have general exposure to engineering of autonomous aircraft plus depth courses in one area important to this field. The depth areas, or "tracks", are guidance, navigation and control and communications. Both tracks are intended for aerospace engineering students. All paths through this concentration satisfy ABET-accreditation criteria for aerospace engineering.

3. Contact and Support Information

Building Name, code and room number: (<i>Search ASU map</i>)	ECG 202
Program office telephone number: (<i>i.e. 480/965-2100</i>)	480/965-2335
Program Email Address:	semte@asu.edu
Program Website Address:	http://engineering.asu.edu

4. Delivery/Campus Information Delivery: On-campus only (ground courses and/or iCourses)

Note: Once students elect a campus or On-line option, students will not be able to move back and forth between the on-campus and the ASU Online options. Approval from the Office of the Provost and Philip Regier (Executive Vice Provost and Dean) is required to offer programs through ASU Online.

5. Campus/Locations: indicate all locations where this program will be offered.

Downtown Phoenix Polytechnic Tempe West Other:

6. Additional Program Description Information

- A. Additional program fee required for this program? No
B. Does this program have a second language requirement? No

7. Career Opportunities & Concentrations

Provide a brief description of career opportunities available for this degree program. If program will have concentrations, provide a brief description for each concentration. (150 words maximum)
Students who earn a degree in this concentration will be prepared for a career in the aerospace industry, focusing on unmanned vehicles.

8. Additional Admission Requirements

If applicable list any admission requirements (freshman and/or transfer) that are higher than and/or in addition to the university minimum undergraduate admission requirements.)
none

9. Keywords

List all keywords used to search for this program. Keywords should be specific to the proposed program. Autonomous Vehicle Systems, Aerospace Engineering, Robotics, Drones, Unmanned Aerial Vehicles

10. Advising Committee Code UGESXX

List the existing advising committee code to be associated with this degree.

Note: If a new advising committee needs to be created, please complete the following form:

[Proposal to create an undergraduate advising committee](#)

11. First Required Math Course

List the first math course required in the major map. MAT 265 Calculus for Engineers I

12. Western Undergraduate Exchange (WUE) Eligible:

Has a request been submitted to the Provost by the Dean to consider this degree program as eligible for WUE? No

Note: No action will be taken during the implementation process with regards to WUE until approval is received from the Provost.

13. Area(s) of Interest

A. Select **one (1)** primary Area of Interest from the list below that applies to this program.

- | | |
|--|---|
| <input type="checkbox"/> <u>Architecture, Construction & Design</u> | <input checked="" type="checkbox"/> <u>Engineering & Technology</u> |
| <input type="checkbox"/> <u>Artistic Expression & Performance</u> | <input type="checkbox"/> <u>Environmental Issues & Physical Science</u> |
| <input type="checkbox"/> <u>Biological Sciences, Health & Wellness</u> | <input type="checkbox"/> <u>Interdisciplinary Studies</u> |
| <input type="checkbox"/> <u>Business, Management & Economics</u> | <input type="checkbox"/> <u>Languages & Cultures</u> |
| <input type="checkbox"/> <u>Communication & Media</u> | <input type="checkbox"/> <u>Law & Justice</u> |
| <input type="checkbox"/> <u>Computing & Mathematics</u> | <input type="checkbox"/> <u>Social Science, Policies & Issues</u> |
| <input type="checkbox"/> <u>Education & Teaching</u> | |

B. Select **any** additional Areas of Interest that apply to this program from the list below.

- | | |
|--|---|
| <input type="checkbox"/> <u>Architecture, Construction & Design</u> | <input type="checkbox"/> <u>Engineering & Technology</u> |
| <input type="checkbox"/> <u>Artistic Expression & Performance</u> | <input type="checkbox"/> <u>Environmental Issues & Physical Science</u> |
| <input type="checkbox"/> <u>Biological Sciences, Health & Wellness</u> | <input type="checkbox"/> <u>Interdisciplinary Studies</u> |
| <input type="checkbox"/> <u>Business, Management & Economics</u> | <input type="checkbox"/> <u>Languages & Cultures</u> |
| <input type="checkbox"/> <u>Communication & Media</u> | <input type="checkbox"/> <u>Law & Justice</u> |
| <input type="checkbox"/> <u>Computing & Mathematics</u> | <input type="checkbox"/> <u>Social Science, Policies & Issues</u> |
| <input type="checkbox"/> <u>Education & Teaching</u> | |

The following fields are to be completed by the Office of the Executive Vice President and Provost of the University.

CIP Code: _____

Plan Code: _____

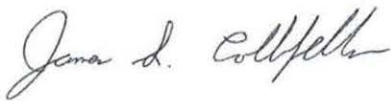
September 10, 2013

To Whom It May Concern:

The proposed concentration in Autonomous Vehicle Systems under the Aerospace Engineering BSE has been reviewed and has received approval through appropriate governance procedures in the Ira A. Fulton Schools of Engineering. I support implementation of this concentration effective spring 2014.

If you have any questions regarding this matter, please feel free to contact Jeremy Helm (Jeremy.Helm@asu.edu) in my office.

Sincerely,



James S. Collofello
Associate Dean of Academic and Student Affairs
Ira A. Fulton Schools of Engineering

cc: Jeremy Helm, Director, Academic Administration & Student Success

Valana Wells

From: Kyle Squires
Sent: Thursday, September 05, 2013 19:30
To: Mia Kroeger
Cc: Valana Wells; Maggie Olson
Subject: degree concentration

Mia,

The aerospace engineering program proposes to establish a concentration in "Autonomous Vehicle Systems". The proposal has been reviewed by the Undergraduate Affairs Committee and approved by the aerospace engineering faculty. The new concentration will require development and offering of two new courses in aerospace engineering. The program has the resources to support these additions without detriment to the core course offerings.

Please let me know if you have any questions or need any additional information. Thanks,

-- Kyle

Kyle D. Squires
Professor and Director
School for Engineering of Matter, Transport and Energy
Building ECG, Room 303
Arizona State University
Tempe, AZ 85287-6106
[phone] 480.965.3291 | [fax] 480.727.9321
engineering.asu.edu/semte

From: Jeremy Helm
Sent: Wednesday, September 25, 2013 6:39 AM
To: Frederick Corey
Cc: Julie Ramsden; James Collofello; Valana Wells; Kyle Squires; Mia Kroeger
Subject: RE: Autonomous Vehicle Systems Concentration Proposal

Hi Fred,

Thank you for the feedback. Please find attached a revised proposal and major map.

For #2, here is the note from CTI:

From: Scott Danielson
Sent: Monday, March 04, 2013 3:00 PM
To: James Collofello
Subject: RE: Autonomous Vehicle Concentration

Jim,

The College of Technology and Innovation supports the development of a Fulton Schools of Engineering concentration in autonomous vehicle systems as outlined in the attachment.

Scott

Scott Danielson, Ph.D., P.E.
Associate Dean for Academic Programs
College of Technology and Innovation
Arizona State University
480-727-1185

Best,
Jeremy

Jeremy Helm
Director, Academic Administration & Student Success
Ira A. Fulton Schools of Engineering
Arizona State University
Tempe, AZ 85287-8109
(480) 965-8931 voice
(480) 965-8095 fax