

ESE BS CONCENTRATION IN EXPLORATION SYSTEMS DESIGN

1. PURPOSE AND NATURE OF PROGRAM

The Exploration System Design concentration is designed to offer students a fundamental grounding in geology, physics and astrophysics, while providing the tools to enable them to design and build hardware and software to achieve specified goals.

At the heart of the program is a sound grounding in the fundamentals of Physics, Mathematics and Chemistry. Upon that foundation we explicitly tackle issues concerning hardware design, instrument assembly and ultimately how you knit these components together when conceiving the requirements needed for a mission or project destined for space or another planet.

As part of this degree each student will have the opportunity to learn about how projects and missions are designed and planned, starting with the scientific drivers and from there defining engineering specifications. Students will be trained in design, assembly and testing of hardware, as well as critical assessment of systems once constructed.

There is opportunity for individual specialization, with additional electives in programming, practical electronics, robotics, numerical analysis methods, the astronomical sciences and scientific data reduction.

Each student will be expected to complete a senior project that takes a desired scientific measurement and realizes the technological solution to achieve the observation.

Emphasis will be placed on identifying challenging issues in project planning and solving the problem with the best and most cost effective approach. The students will emerge from this program ready to tackle real-world technical problems and to materially contribute to the next generation of terrestrial and space-based explorers.

2. NEED AND DEMAND FOR THE PROGRAM

The undergraduate degree in Earth and Space Exploration with an Systems Design concentration will enable ASU to prepare students to provide key roles in space research and technology development, environmental and geologic engineering, earth resource exploration, and water and environment use policy. The School will leverage its significant strengths in knowledge, discoveries, and transdisciplinary resources in planetary science, geological science, and aerospace engineering to address critical shortfalls in the national and regional training of the next generation of geoscientists and aerospace engineers. Arizona has an expanding space industry with major new investments, and is prepared to engage new technologies to monitor and understand environmental issues in Arizona, the southwest, and throughout the world. SESE will actively engage the broader community in its research, teaching and outreach projects, stressing the School's role in integrating engineering, science, and technology to address the major environmental and resource issues that the U.S. and the world face. The state,

region, and nation will benefit from the development of an undergraduate major in Earth and Space Exploration that prepares well-educated, global citizens who have the tools, knowledge and understanding to address key problems of a global nature, whether they are working in the private or the public sector.

Anticipated student enrollment for this program

In estimating undergraduate enrollment, one measure of potential demand is the number of majors and students taking classes in ASU's Mechanical and Aerospace department, which currently has over 1,000 students, ~300 of whom are in aerospace engineering. The Earth and Space Exploration degree is aimed at providing students with strong quantitative backgrounds the opportunity to expand their interests into scientific problem solving, experimental design, and exploration methodologies. It is anticipated that 10-15% of the students currently in aerospace engineering (~8-12 students per year) will select the Earth and Space Exploration degree. The students will be in addition to the ~10 students per year who select this degree in place of the existing Geological Sciences degree. As the learning community and the Senior Exploration Project develop, we anticipate that the enrollment in the School and the Earth and Space Exploration degree will increase ~20% per year over the first five years.

Based on our plan for growth of SESE and the Earth and Space Exploration degree program, enrollment is projected to be the following over the first five years:

5-Year Projected Annual Enrollment	
	# Student Majors
Year 1	20
Year 2	45
Year 3	75
Year 4	105
Year 5	115

Local, regional, and national need for this program

Arizona currently has no undergraduate program that will directly train the next generation of scientists and engineers to work together to confront global challenges, nor any institution that serves to combine science and engineering curricula into a single program. By exposing students to teaching and research that stresses the connections and collaborations between scientists and engineers, the Earth and Space Exploration degree will develop a new class of these scientists and engineers that are cognizant of differing approaches, methodologies, and languages. This cross-pollination of ideas and methods will create a diverse undergraduate population with a broad range of skills and training. As the students come together into the Senior Exploration Project they will have the training and mutual interests necessary to design, develop, and complete a very complex science and engineering task. The students will be exceptionally prepared to enter a workplace in which these interdisciplinary approaches to problem solving are becoming increasingly necessary and increasingly demanding. It is expected that students trained in ASU's Earth and Space Exploration program will set a new standard for undergraduate education in the science and engineering fields.

3. LEARNING OUTCOMES AND ASSESSMENT

- A. **List the knowledge, competencies, and skills** students should have when they graduate from the proposed degree program. (You can find examples of program Learning Outcomes at (<http://www.asu.edu/oue/assessment.html>))

Competencies

- Reduce complex problems to their most important attributes; and design and carry out experiments, models, or observations that address these attributes.
- Capacity for critical thinking regarding scientific and engineering problems and findings
- Ability to work collegially, fairly, and effectively in groups on relevant projects.
- Ability to use technology effectively in learning and research.
- Capacity for informal and formal communication of science concepts through various media (writing, graphics, oral presentations).

Knowledge Outcomes

- Physical and chemical nature of materials that make up the universe, galaxies, stars, and planets.
- Relationship of scientific requirements to engineering specifications.
- Effective interactions of technologies.
- Principles of engineering design for exploration and of exploration as a discipline.
- Principles of instrumentation design and assembly.
- Principles of electronic circuits.
- Supporting concepts of biology, chemistry, geoscience, physics, and mathematics.

Skills Outcomes

- Connect scientific drivers and/or data with engineering applications.
- Assess the best path to a goal from a set of options, including cost, risk, and schedule.
- Integrate science and engineering in a capstone project.
- Preparation to progress to professional positions or to graduate studies.

- B. **Describe the plan and methods to assess** whether students have achieved the knowledge, competencies and skills identified in the Learning Outcomes. (You can find examples of assessment methods at (<http://www.asu.edu/oue/assessment.html>))

Student *Formative* Assessment Metric

- Quality of sample of work completed in milestone course SES 310 Concepts of E&M Engineering Design.

Student *Summative* Assessment Metric

- Quality of work and effectiveness of integration of science and technology in the completed Senior Exploration Project (SES 410/411).

Program Assessment Metrics

- Track career trajectories of graduates for 10 years.
- Annually review quality and effectiveness of capstone course(s) in integrating overall features of the degree program.

4. REQUIREMENTS FOR THE MAJOR (NO CONCENTRATION OPTION)

A. SPECIFIC LIST OF COURSES REQUIRED

	Concentration in:
	Exploration Systems Design
COMMON INTRO:	SES 100 SES 101/102/103/104 Credits = 11
OUTSIDE SCIENCE:	PHY 121/122/131/132 MAT 265/266/275 CHM 114 Gen Chem for Engineers (4) Credits = 21
DISCIPLINE CORE:	SES 210 Engg Sys & Exp Design SES 310 Concepts of E & M Engg Design SES 330 Practical Electronics & Inst. Assem. (4) SES 405 Exploration Systems Engineering Credits = 13
ELECTIVES:	For 12 credits, mix and match from (suggested): MAT 267 Calculus for Engineers III SES 394 Numerical Methods SES 490 Robotics for ESE SES/AST 498/598 Ast. Inst. & Data Analysis GLG 321 Mineralogy GLG 424 Petrology CEE 440 Engineering Hydrology GLG 404 Fundamentals of Planetary Geology AST 321 Intro to Planetary & Stellar Astro. AST 322 Intro to Galactic & Extragal. Astro. SES 311 Essentials of Astrobiology Credits = 12
COMMON CAPSTONE:	SES 410/411 Credits = 6

Total Credits = 63 in major.

B. MAJOR MAP

See Attached for revised BS in ESE concentration in Exploration Systems

Design Major Map – end of this proposal.

Note that other AST/GLG/SES upper division electives may be substituted with advisor approval. This class list uses existing classes from SESE, and other academic units. There are **two** new classes specified as part of this new degree, and the syllabi are detailed below.

5. REQUIRED NEW COURSES

SES 330 – Practical Electronics and Instrumentation (4 credits, including lab)

SES 405 – Exploration Systems Engineering

6. PRIMARY FACULTY PARTICIPANTS

All SESE Faculty in core classes and general electives, plus following specifics:

Faculty-to-Class Assignments for Classes Unique to this Concentration

SES 210	Engineering Systems and Exploration Design	Hodges
SES 310	Concepts of Electrical and Mechanical Eng. Design	Groppi, Yu
SES 330	Practical Electronics & Instrumentation Assembly	Groppi, Behar
SES 405	Exploration System Engineering Christensen, Scowen	Robinson,
SES 410/411 appropriate	Senior Exploration Project I & II	Any faculty as

7. MINIMUM RESIDENCY REQUIREMENT

30 units.



Critical Requirements: Students who follow the 2010-2011 catalog year and are entering ASU as either a first-time freshman or transfer from any Arizona public university or Arizona community college must complete critical requirements.

Major Map: Earth & Space Exploration, Conc. in Exploration Systems Design - Bachelor of Science (B.S.)

School or College, Campus

Catalog Year: 2010-2011

Course Subject and Title	Critical Course	Hrs.	Completed ATP: ___ Yes ___ No			Completed AGEC: ___ Yes ___ No	
			Upper Division	Transfer Course/Grade	Minimum Grade if Required	Additional Critical Requirements and/or Notes	
TERM ONE: 0-16 CREDIT HOURS							
SES 100 Intro. To Exploration	<input checked="" type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>	C		
SES 101 Earth, Solar System, Universe	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>	C		
SES 103 Earth, Solar System, Universe Lab	<input type="checkbox"/>	1	<input type="checkbox"/>	<input type="checkbox"/>	C		
MAT 265 Calculus I	<input checked="" type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
Social & Behavioral Science (SB)	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
ENG 101 or 102: First-Year Composition or ENG 105: Advanced First-Year Composition or ENG 107 or 108: English for Foreign Students	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
Academic Success Class or First Year Seminar	<input type="checkbox"/>	1	<input type="checkbox"/>	<input type="checkbox"/>			
TERM TWO: 17-30 CREDIT HOURS							
SES102 Earth, Solar System, Universe	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>	C		
SES104 Earth, Solar System, Universe Lab	<input type="checkbox"/>	1	<input type="checkbox"/>	<input type="checkbox"/>	C		
MAT 266 Calculus II	<input checked="" type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
CHM 114 Gen. Chem. For Engineering	<input checked="" type="checkbox"/>	4	<input type="checkbox"/>	<input type="checkbox"/>			
ENG 101 or 102: First-Year Composition or ENG 105: Advanced First-Year Composition or ENG 107 or 108: English for Foreign Students	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
TERM THREE: 31-46 CREDIT HOURS							
MAT 275 Differential Equations	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
PHY121 Physics I	<input checked="" type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
PHY122 Physics I Lab	<input checked="" type="checkbox"/>	1	<input type="checkbox"/>	<input type="checkbox"/>			
SES210 Engineering Systems	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>	C		
Humanities, Fine Arts & Design (HU) and Cultural Diversity in the US ©	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
General Elective	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
TERM FOUR: 47-61 CREDIT HOURS							
PHY131 Physics II	<input checked="" type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
PHY132 Physics II Lab	<input checked="" type="checkbox"/>	1	<input type="checkbox"/>	<input type="checkbox"/>			
SES310 Concept of Elec./Mech. Engr.	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>	<input type="checkbox"/>			
CLAS Science and Society	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
SES/GLG/AST Upper Div Elective	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>	<input type="checkbox"/>			
Literacy and Critical Inquiry (L)	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
TERM FIVE: 62-75 CREDIT HOURS							
SES330 Practical Electronics & Instrumentation	<input type="checkbox"/>	4	<input checked="" type="checkbox"/>	<input type="checkbox"/>	C		
SES/GLG/AST Upper Div Elective	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>	<input type="checkbox"/>			
Humanities, Fine Arts & Design (HU) and Cultural	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
University General Studies	<input type="checkbox"/>	2	<input type="checkbox"/>	<input type="checkbox"/>			
University General Studies	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
TERM SIX: 76-90 CREDIT HOURS							
SES405 Exploration Systems Engineering	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>	<input type="checkbox"/>	C		
CLAS UD science and Society	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>	<input type="checkbox"/>			
Upper Division Literacy and Critical Inquiry (L)	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>	<input type="checkbox"/>			
Computer/Statistics/Quantitative applications (CS)	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
General Elective	<input type="checkbox"/>	3	<input type="checkbox"/>	<input type="checkbox"/>			
	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			
	<input type="checkbox"/>		<input type="checkbox"/>	<input type="checkbox"/>			

TERM SEVEN: 91-105 CREDIT HOURS					
SES410 Senior Exploration Project I	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>		C
SES/GLG/AST Upper Div Elective	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>		C
SES/GLG/AST Upper Div Elective	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>		
Humanities, Fine Arts & Design (HU) or Social Behavioral Science (SB)	<input type="checkbox"/>	3	<input type="checkbox"/>		
General Elective	<input type="checkbox"/>	3	<input type="checkbox"/>		
	<input type="checkbox"/>		<input type="checkbox"/>		
	<input type="checkbox"/>		<input type="checkbox"/>		
TERM EIGHT: 106-120 CREDIT HOURS					
SES411 Senior Exploration Project II	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>		C
Upper division Humanities, Fine Arts & Design (HU) or Social Behavioral Science (SB)	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>		
General Elective U Div	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>		
General Elective U Div	<input type="checkbox"/>	3	<input checked="" type="checkbox"/>		
	<input type="checkbox"/>		<input type="checkbox"/>		
	<input type="checkbox"/>		<input type="checkbox"/>		
	<input type="checkbox"/>		<input type="checkbox"/>		

120

Graduation Requirements Summary:

Total Hours (120 minimum)	Total Hrs at ASU (30 hour minimum)	Hrs Resident Credit required for Academic Recognition (56)	Major GPA (2.000 minimum)	Total UD Hrs (45 minimum)	Total Community College Hrs. (64 maximum)
120	30				

General University Requirements: Legend

- < General Studies Core Requirements:
 - o Literacy and Critical Inquiry (L)
 - o Mathematical Studies (MA)
 - o Computer/Statistics/Quantitative applications (CS)
 - o Humanities, Fine Arts, and Design (HU)
 - o Social and Behavioral Sciences (SB)
 - o Natural Science-Quantitative (SQ)
 - o Natural Science-General (SG)
- < General Studies Awareness Requirements
 - o Cultural Diversity in the US (C)
 - o Global Awareness (G)
 - o Historical Awareness (H)
- < First Year Composition

Additional Notes:

- There is room in this map to add a concurrent degree, minor, or certificate

----- Forwarded Message

From: Paul Johnson <PAUL.C.JOHNSON@asu.edu>

Date: Thu, 8 Oct 2009 08:40:12 -0700

To: Thomas Sharp <tom.sharp@asu.edu>

Cc: Kyle Squires <squires@asu.edu>, Stephen Phillips <Stephen.Phillips@asu.edu>, James Collofello <JAMES.COLLOFELLO@asu.edu>, Deirdre Meldrum <Deirdre.Meldrum@asu.edu>, Albert Filardo <Albert.Filardo@asu.edu>

Subject: RE: Request for impact statements on our new modified BS concentration in Exploration Systems Design

Dear Tom -

We have reviewed the proposal for the new modified BS concentration in Exploration Systems Design. First, based on discussions with our leadership team, we don't anticipate any negative impact on existing engineering programs as it is targeted to science students that would benefit from having some hands-on/practical engineering and technology experiences. Second, there are potential benefits for Engineering students if in the future there is sufficient course capacity and acceptance by Engineering of some of the proposed courses for credit as technical electives in our degree programs. We hope that we will have the opportunity in the future to continue to discuss these courses (and others) and how they might help us to continue to evolve towards more shared astronautics educational experiences for both SESE and Engineering students.

Thanks!

PCJ

From: Thomas Sharp

Sent: Wednesday, October 07, 2009 2:33 PM

To: Stephen Phillips; Thomas Sharp

Cc: Paul Johnson

Subject: Re: Request for impact statements on our new modified BS concentration in Exploration Systems Design

Steve

This is fine, thanks.

Paul

Would you be willing to provide an impact statement regarding the new concentration. Remember that this concentration is intended to provide science students with some engineering coursework and hands-on experience so that they will be able to work in an environment that employs engineering and new technology to solving scientific problems. I have attached the proposal for that concentration.

Sincerely

Tom