

SYSTEMS ENGINEERING

THE SYSTEMS ENGINEERING MAJOR AT A GLANCE: Systems Engineering is an interdisciplinary major administered by the Departments of Aeronautical Engineering, Astronautical Engineering, Behavioral Sciences and Leadership, Computer Science, Electrical Engineering, and Engineering Mechanics with participation by the Department of Management.

Systems Engineering is a broad discipline that addresses the engineering of large, complex systems and the integration of the many subsystems that comprise the larger system. All of these various components must function together in an effective and efficient manner in order to carry out the mission. The systems engineer designs, integrates, and helps to ensure smooth functioning of complex systems typical in today's high-tech Air Force. The systems engineer is a "big picture" engineer, always keeping an eye on the design of the overall system to ensure that it will meet the needs of all the system's stakeholders, including operators, maintainers and commanders, and even our ultimate customer -- the American public!

The systems engineer must consider elements of system development, verification, manufacturing, deployment, training, operations, support, and disposal. The entire life cycle of the system is considered in a holistic fashion early in the system's development cycle. To accomplish this difficult job, the SE must have broad interdisciplinary knowledge across many areas of study.

USAF's system engineering program emphasizes a systems-of-systems approach that integrates a rigorous engineering curriculum augmented with studies in human systems, operations research analysis, program management, and the core curriculum. Cadets will learn that the systems engineering process is an interdisciplinary engineering process that evolves, verifies, and documents an integrated, life-cycle-balanced set of system solutions that satisfy customer needs. Cadets will specialize in one of nine defined option areas which include: Aeronautical Systems, Communication Systems, Computer Systems, Control Systems, Electronic Systems Design, Human Systems, Information Systems, Mechanical Systems, and Space Systems.

Cadets who successfully complete the Systems Engineering major are awarded a Bachelor of Science in Systems Engineering degree.

Systems Engineering *Program Operational Goals*

Two to three years after graduation, our graduates are expected to be officers who:

- Possess breadth of integrated, fundamental knowledge in the basic sciences, engineering, humanities, and social sciences; and depth of knowledge in the selected option sequence,
- Can communicate effectively,
- Can work effectively with others,
- Are independent thinkers and learners,
- Can apply their knowledge and skills to solve Air Force engineering problems, both well- and ill-defined, and

- Know and practice their ethical and professional responsibilities as embodied in the United States Air Force core values.

Systems Engineering *Program Curricular Outcomes*

Each Systems Engineering graduate shall demonstrate satisfactory:

- Application of the fundamental concepts of systems engineering to solve engineering problems,
- Breadth of knowledge and analysis skills in systems engineering, engineering design, test, human systems, information systems, operations research, management, and other related disciplines; depth of knowledge about engineering design in the chosen area of emphasis,
- Synthesis and integration of the above knowledge to effectively identify and solve the types of complex, multidisciplinary problems encountered as Air Force systems engineers,
- Balancing cost, schedule, performance, and risk factors in decision making,
- Laboratory techniques including procedures, recording, and analysis,
- Design, fabrication, and testing techniques,
- Written and oral communication skills,
- Knowledge of ethical and professional responsibilities,
- Knowledge of the benefits and the skills needed to engage in life-long learning,
- Ability to be effective multidisciplinary team members,
- Skills to be an independent learner while knowing when to seek assistance,
- Knowledge of the role of Air Force engineering officers in our global society, and
- Knowledge of contemporary social, political, military, and engineering issues.

COURSE REQUIREMENTS: 147 semester hours

A. 91 Semester hours of Dean's academic core courses to include the following core alternates:

Required Core Alternate		Substitutes for
Ops Rsch 310	Systems Analysis	Systems Option
El Engr 231	Electrical Circuits and Systems I	El Engr 215
Math 356	Probability and Statistics for Engineers and Scientists	Math 300

B. 5 Semester hours of Director of Athletics courses.

C. 3 Semester hours of Academy Option.

D. No Foreign Language courses required.

E. 21 Semester hours of major's courses:

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| 1. Sys Engr 290 | Introduction to Systems Engineering I |
| 2. Sys Engr 301 | Introduction to Systems Engineering II |

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| 3. Ops Rsch 321 | Probabilistic Models |
| or Ops Rsch 411 | Topics in Mathematical Programming |
| 4. Comp Sci 211 | Intro to Programming for Scientists and Engineers |
| 5. Beh Sci 373 | Introduction to Human Factors |
| 6. Systems Engineering Capstone Design I (See Supplemental Information) | |
| 7. Systems Engineering Capstone Design II (See Supplemental Information) | |
| 8. Sys Engr 405 | Systems Engineering Seminar I |
| 9. Sys Engr 406 | Systems Engineering Seminar II |

F. 27 Semester hours of courses determined by the cadet's choice of systems engineering option sequence:

Aeronautical Systems Option:

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| Math 243 (or Math 253) | Calculus III (or Advanced Placed Calculus III) |
| Math 245 | Differential Equations |
| Engr Mech 320 | Dynamics |
| Aero Engr 241 | Aero-Thermodynamics |
| Aero Engr 341 | Aeronautical Fluid Dynamics |
| Aero Engr 351 | Aircraft Performance and Static Stability |
| Aero Engr 352 | Aircraft Dynamic Stability and Control |
| Aero Engr 361 | Propulsion |
| Sys Engr Option | Any 300 or 400 level Engineering, Operations Research, or Basic Science course where the prerequisites are met |

Communication Systems Option:

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| Math 243 (or Math 253) | Calculus III (or Advanced Placed Calculus III) |
| Math 245 | Differential Equations |
| El Engr 332 | Electric Circuits and Systems II |
| El Engr 333 | Continuous-Time Signals and Linear Systems |
| El Engr 434 | Discrete-Time Signals and Systems |
| El Engr 447 | Communications Systems I |
| El Engr 448 | Communications Systems II |
| Sys Engr Option I | Astro Engr 331, Engr 341, or any non-core course offered by the Electrical Engineering Department, |
| Sys Engr Option II | Any 300 or 400 level Engineering, Operations Research, or Basic Science course where the prerequisites are met |

Computer Systems Option:

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| Math 340 | Discrete Math |
| Math Option | Math 243 (or Math 253), Math 245, Philos 370, or
Comp Sci 431 (Cryptography) |
| Comp Sci 362 | Modeling and Simulation |
| Comp Sci 364 | Information Storage and Retrieval |
| Comp Sci 467 | Networks |
| El Engr 281 | Introductory Digital Systems |
| El Engr 382 | Microcomputer Programming |

El Engr 383	Microcomputer System Design I
Sys Engr Option	Any 300 or 400 level Engineering, Operations Research, or Basic Science course where the prerequisites are met

Control Systems Option:

Math 243 (or Math 253)	Calculus III (or Advanced Placed Calculus III)
Math 245	Differential Equations
Engr Mech 320	Dynamics
Engr 341	Linear Systems Analysis
Engr 342	Linear Control Systems
Astro Engr 443	Digital Control
Astro Engr 444	Modern Control
Sys Engr Option I	Any 300 or 400 level Engineering, Operations Research, or Basic Science course where the prerequisites are met
Sys Engr Option II	Any 300 or 400 level Engineering, Operations Research, or Basic Science course where the prerequisites are met

Electronic Systems Design Option:

Math 243 (or Math 253)	Calculus III (or Advanced Placed Calculus III)
Math 245	Differential Equations
El Engr 321	Electronics I
El Engr 322	Electronics II
or Comp Engr 373	Digital VLSI Circuits
El Engr 332	Electric Circuits and Systems II
El Engr 281	Introductory Digital Systems
El Engr 382	Microcomputer Programming
El Engr 383	Microcomputer Systems Design I
Sys Engr Option	Any 300 or 400 level Engineering, Operations Research, or Basic Sciences course where the prerequisites are met

Human Systems Option:

Math 245	Differential Equations
Math Option	Math 243 (or Math 253) or Math 340
Beh Sci 375	Human Factors in Systems Failure
Beh Sci 471	Engineering Psychology
Beh Sci 472	Human Computer Interaction
Beh Sci 473	Human Factors in Systems Design
Sys Engr 472	Cognitive Systems Engineering
Sys Engr Option I	Any 300 or 400 level Engineering, Operations Research, or Basic Science course where the prerequisites are met
Sys Engr Option II	Any Option I course or 300 or 400 level AIC approved course in Behavioral Sciences, Operations Research, or Management.

Information Systems Option:

Math 340	Discrete Math
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Math Option	Math 243 (or Math 253), Math 245, Philos 370, or Comp Sci 437 (Cryptography)
Comp Sci 310	Information Technology
Comp Sci 315	Web Design and Construction
Comp Sci 362	Modeling and Simulation
Comp Sci 364	Information Storage and Retrieval
Comp Sci 438	Computer Security and Information Warfare
Comp Sci 467	Networks (need to waive prereq, CS 483)
Sys Engr Option	Any 300 or 400 level Engineering, Operations Research, or Basic Science course where the prerequisites are met

Mechanical Systems Option:

Math 243 (or Math 253)	Calculus III (or Advanced Placed Calculus III)
Math 245	Differential Equations
Engr Mech 320	Dynamics
Mech Engr 312	Thermal Fluids Engineering I
Engr Mech 330	Mechanics of Deformable Bodies
Mech Engr 325	Engineering System Dynamics
Engr Mech 350	Mechanical Behavior of Materials
Sys Engr Option I	Any 300 or 400 level Engineering or Basic Science course where the prerequisites are met
Sys Engr Option II	Any 300 or 400 level Engineering, Operations Research, or Basic Science course where the prerequisites are met

Space Systems Option:

Math 243 (or Math 253)	Calculus III (or Advanced Placed Calculus III)
Math 245	Differential Equations
Engr Mech 320	Dynamics
Aero Engr 241	Aero-Thermodynamics
Astro Engr 321	Astrodynamics
Astro Engr 331	Space Systems Engineering
Astro Engr 351	Rocket Propulsion
Astro Engr 423	Space Mission Design
Sys Engr Option	Any 300 or 400 level Engineering, Operations Research, or Basic Science course where the prerequisites are met

Supplemental Information:

Cadets will be placed into one of the following two-semester capstone design options, based on interest, performance, and availability, to satisfy the Systems Engineering Capstone Design sequence requirement.

Aeronautical Engineering Capstone Design A

Aero Engr 481	Intro to Aircraft and Propulsion System Design
Aero Engr 482	Aircraft Design

Aeronautical Engineering Capstone Design B

Aero Engr 481	Intro to Aircraft and Propulsion System Design
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Aero Engr 483	Aircraft Engine Design
<i>Astronautical Engineering Capstone Design A</i>	
Astro Engr 436	Small Spacecraft Engineering I
Astro Engr 437	Small Spacecraft Engineering II
<i>Astronautical Engineering Capstone Design B</i>	
Astro Engr 452	Rocket Engineering I
Astro Engr 453	Rocket Engineering II
<i>Computer Engineering Capstone Design</i>	
Comp Engr 463	Capstone Design Project I
Comp Engr 464	Capstone Design Project II
<i>Engineering Mechanics Capstone Design</i>	
Mech Engr 491	First-Class Capstone Design Project I
Mech Engr 492	First-Class Capstone Design Project II
<i>Electrical Engineering Capstone Design</i>	
El Engr 463	Capstone Design Project I
El Engr 464	Capstone Design Project II
<i>Software Engineering Capstone Design</i>	
Comp Sci 453	Software Engineering I
Comp Sci 454	Software Engineering II

SUGGESTED COURSE SEQUENCE

	4°		3°		2°		1°		hrs	per		
Fall	Chem 141	3	2	Math Option 243/340	3	1	Comp Sci 211	3	1	Sys Engr Option	3	1
	Comp Sci 110	3	1	El Engr 231	3	1	Sys Engr Option	3	1	Sys Engr Option	3	1
	English 111	3	1	Beh Sci 110	3	1	History 202	3	1	Sys Engr 491	3	2
	Math 141	3	1	English 211	3	1	Ops Rsch 310	3	1	Sys Engr 405	0	1
	Engr 100	3	1	Physics 215	3	2	Mgt 200	2	1	Beh Sci 310	3	1
				Soc Sci 112	3	1	Econ 200	2	1	English 411	3	1
	Phy Ed	0.5	2	Phy Ed	1	2	Biology 215	3	2	Philos 310	3	1
						Phy Ed	1	2	Phy Ed	0.5	2	
	15.5 8			19 9			20 10			18.5 10		
Spring	Physics 110	3	2	Sys Engr 290	3	2	Ops Rsch 321/411	3	1	Sys Engr Option	3	1
	Chem 142	3	2	Math 245	3	1	Beh Sci 373	3	1	Sys Engr Option	3	1
	Math 142	3	1	Sys Engr Option	3	1	Sys Engr 301	3	1	Sys Engr 492	3	2
	MSS 100	3	1	Civ Engr 210	3	1	Sys Engr Option	3	1	Sys Engr 406	0	1
	Engr Mech 120	3	1	Aero Engr 315	3	1	Pol Sci 311	3	1	Academy Option	3	1
	History 101	3	1	Math 356	3	1	Law 220	3	1	Astro Engr 310	3	1
	Phy Ed	0.5	2	Phy Ed	0.5	2	Phy Ed	0.5	2	MSS 400	3	1
	18.5 10			18.5 9			18.5 8			18.5 10		

Course Unit Summary
Core (31)
Major (16)
Academy Option (1)
Phy Ed (10)

Semester Hour Summary	
Core =	91.0 Sem Hours
Major =	48.0 "
Academy Option =	3.0 "
Phy Ed =	5.0 "
Total =	147.0 "