

# B.S. in Aerospace Engineering

The Bachelor of Science in Aerospace Engineering program exists in partial fulfillment of the University's purpose "to provide a comprehensive education to prepare graduates for productive careers and responsible citizenship with special emphasis on the needs of aviation, aerospace engineering, and related fields." The program's focus is primarily on the engineering of mission-oriented vehicles for atmospheric and space flight.

Within a few years of graduation, the alumni of the BSAE program are expected to have successful engineering careers as productive members or leaders within teams or organizations or as independent innovators, to have applied creative thinking and practical problem-solving skills to the solution of problems or to the development of processes or products for the aerospace industry, or to be engaged in advanced studies.

Furthermore, these alumni are expected to be responsible and ethical members of society and the engineering profession, and to pursue personal development through continuing education and active participation in professional organizations.

In order to achieve these objectives, the following student outcomes have been adopted:

1. *An ability to identify, formulate and solve complex engineering problems by applying principles of engineering, science, and mathematics*
2. *An ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors*
3. *An ability to communicate effectively with a range of audiences*
4. *An ability to recognize ethical and professional responsibilities in engineering situations and make informed judgements, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.*
5. *An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives*
6. *An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgement to draw conclusions.*
7. *An ability to acquire and apply new knowledge as needed, using appropriate learning strategies*

To enter this program, students should have demonstrated competence in mathematics, physics, and chemistry in high school.

The Aerospace Engineering program is accredited by the Engineering Accreditation Commission of ABET, <http://www.abet.org>.

## Degree Requirements

The Bachelor of Science in Aerospace Engineering program requires successful completion of a minimum of 129 credit hours. The program may be completed in eight semesters, assuming appropriate background and full-time enrollment. A CGPA of 2.0 or higher with a grade of "C" or better within three attempts, including audits and withdrawals in all courses, is required for degree completion.

## Remaining on Track for AE

Aerospace Engineering students must maintain a CGPA of 2.50 or higher, and achieve a GPA of 2.50 or higher in those courses prescribed by the College of Engineering, Engineering Fundamentals Program, First-Year for Aerospace, and achieve a GPA of 2.50 or higher in CHM, EGR, MA

and PS courses prescribed in First-Year for Aerospace prior to and upon completing AE 201 to continue in the program.

### Students will:

- Have an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics.
- Have an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors.
- Have an ability to communicate effectively with a range of audiences.
- Have an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts.
- Have an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.
- Have an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.
- Have an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## General Education Requirements

For a full description of Embry-Riddle General Education guidelines, please see the General Education section of this catalog. These minimum requirements are applicable to all degree programs.

|   |  |   |
|---|--|---|
| Communication Theory & Skills (COM 122, COM 219, COM 221) | 9  |   |
| Lower-Level Humanities (HU 14x) *                         | 3  |   |
| Lower-Level Social Sciences *                             | 3  |   |
| Lower or Upper-Level Humanities or Social Sciences *      | 3  |   |
| Upper-Level Humanities or Social Sciences *               | 3  |   |
| Computer Science (EGR 115)                                | 3  |   |
| Mathematics (MA 241 & MA 242)                             | 8  |   |
| Physical and Life Sciences - (PS 150, PS 160 & PS 253)    | 7  |   |
| <b>Total Credits</b>                                      | <b>39</b>  |   |
| UNIV 101  | College Success  | 1 |
| <b>Mathematics</b>  |  |   |
| MA 243  | Calculus and Analytical Geometry III   | 4 |
| MA 345  | Differential Equations and Matrix Methods                                    | 4 |
| <b>AOC Specific Math</b>                                  |  |   |
| MA 441  | Mathematical Methods for Engineering and Physics I (Aero, Jet Prop AOC Only) |   |
| MA 432  | Linear Algebra (Astro, Rocket Prop AOC Only)                                 |   |
| <b>Physical Science</b>                                   |  |   |
| CHM 110   | General Chemistry I  | 3 |
| CHM 110L  | General Chemistry I Laboratory   | 1 |
| PS 250  | Physics for Engineers III  | 3 |
| <b>Engineering Core</b>                                   |  |   |
| AE 201  | Aerospace Flight Vehicles  | 3 |
| AE 313  | Space Mechanics  | 3 |
| AE 314  | Experimental Aerodynamics  | 1 |
| AE 315  | Experimental Aerodynamics Laboratory   | 1 |
| AE 316  | Aerospace Engineering Materials  | 3 |
| AE 318  | Aerospace Structures I   | 3 |
| AE 416  | Aerospace Structures and Instrumentation                                     | 1 |
| AE 417  | Aerospace Structures and Instrumentation Laboratory                          | 1 |
| AE 442  | Experimental Dynamics and Control  | 1 |

|   |  |           |
|---|--|-----------|
| AE 443  | Experimental Dynamics and Control Laboratory   | 1         |
| <b>AE AOC Specific Engineering Core</b>               |  | <b>9</b>  |
| AE 307, AE 308 & AE 418 (Aero, Jet Prop AOC Only)     |  |           |
| AE 319, AE 323 & AE 429 (Astro, Rocket Prop AOC Only) |  |           |
| EGR 101   | Introduction to Engineering                    | 2         |
| EGR 120   | Graphical Communications                       | 3         |
| ES 201  | Statics  | 3         |
| ES 202  | Solid Mechanics                                | 3         |
| ES 204  | Dynamics                                       | 3         |
| ES 305  | Thermodynamics                                 | 3         |
| EE 327  | Electrical Engineering Fundamentals            | 3         |
| EE 328  | Electrical Engineering Fundamentals Laboratory | 1         |
| <b>Total Credits</b>                                  |  | <b>67</b> |

**Choose one of the following Four Options 17****Aeronautics Option**

|        |                                |  |
|--------|--------------------------------|--|
| AE 403 | Jet Propulsion                 |  |
| AE 413 | Airplane Stability and Control |  |
| AE 420 | Aircraft Preliminary Design    |  |
| AE 421 | Aircraft Detail Design         |  |
| AE 432 | Flight Dynamics and Control    |  |

**Astronautics Option**

|        |                               |  |
|--------|-------------------------------|--|
| AE 414 | Space Propulsion              |  |
| AE 426 | Spacecraft Attitude Dynamics  |  |
| AE 427 | Spacecraft Preliminary Design |  |
| AE 434 | Spacecraft Control            |  |
| AE 445 | Spacecraft Detail Design      |  |

**Jet Propulsion Option**

|        |                                   |  |
|--------|-----------------------------------|--|
| AE 403 | Jet Propulsion                    |  |
| AE 413 | Airplane Stability and Control    |  |
| AE 432 | Flight Dynamics and Control       |  |
| AE 435 | Jet Propulsion Preliminary Design |  |
| AE 440 | Jet Propulsion Detail Design      |  |

**Rocket Propulsion Option \*\*\***

|        |                                      |  |
|--------|--------------------------------------|--|
| AE 414 | Space Propulsion                     |  |
| AE 426 | Spacecraft Attitude Dynamics         |  |
| AE 434 | Spacecraft Control                   |  |
| AE 441 | Rocket Propulsion Preliminary Design |  |
| AE 451 | Rocket Propulsion Detail Design      |  |

**Technical Electives (See Approved List) \*\* 6**

\*\*One of the Technical Electives must be an AE course

**Total Credits 129****Aeronautics Plan of Study**

Students should be aware that most courses in each academic year have prerequisites and/or corequisites (check the Undergraduate Courses section before registering for classes to ensure required sequencing). See the AE flowchart(s) from the department for the recommended plan of study.

NOTE: Students in the Aerospace Engineering program desiring to complete a minor must complete at least six credit hours of coursework applied to the minor that are not specifically required in the student's degree program.

**Year One**

|                         |   |             |
|-------------------------|---|-------------|
|                         | See the College of Engineering, Engineering Fundamentals Program for course selection | 33          |
| <b>Credits Subtotal</b> |   | <b>33.0</b> |
| <b>Credits Total:</b>   |   | <b>33.0</b> |

**Aeronautics Option****Year Two**

|                         |  |                |
|-------------------------|--|----------------|
|                         |  | <b>Credits</b> |
| AE 201                  | Aerospace Flight Vehicles                          | 3              |
| COM 221                 | Technical Report Writing                           | 3              |
| ES 201                  | Statics  | 3              |
| ES 202                  | Solid Mechanics                                    | 3              |
| ES 204                  | Dynamics   | 3              |
| ES 305                  | Thermodynamics                                     | 3              |
| MA 243                  | Calculus and Analytical Geometry III               | 4              |
| MA 441                  | Mathematical Methods for Engineering and Physics I | 3              |
| PS 160                  | Physics for Engineers II                           | 3              |
| PS 250                  | Physics for Engineers III                          | 3              |
| PS 253                  | Physics Laboratory for Engineers                   | 1              |
| <b>Credits Subtotal</b> |  | <b>32.0</b>    |

**Year Three**

|                         |  |             |
|-------------------------|--|-------------|
| AE 307                  | Incompressible Aerodynamics                    | 3           |
| AE 308                  | Compressible Aerodynamics                      | 3           |
| AE 313                  | Space Mechanics                                | 3           |
| AE 314                  | Experimental Aerodynamics *                    | 1           |
| AE 315                  | Experimental Aerodynamics Laboratory *         | 1           |
| AE 316                  | Aerospace Engineering Materials                | 3           |
| AE 318                  | Aerospace Structures I                         | 3           |
| AE 403                  | Jet Propulsion                                 | 3           |
| AE 413                  | Airplane Stability and Control                 | 3           |
| COM 219                 | Speech   | 3           |
| EE 327                  | Electrical Engineering Fundamentals *          | 3           |
| EE 328                  | Electrical Engineering Fundamentals Laboratory | 1           |
| MA 345                  | Differential Equations and Matrix Methods      | 4           |
| <b>Credits Subtotal</b> |  | <b>34.0</b> |

**Year Four**

|                         |   |             |
|-------------------------|---|-------------|
| AE 416                  | Aerospace Structures and Instrumentation *                  | 1           |
| AE 417                  | Aerospace Structures and Instrumentation Laboratory *       | 1           |
| AE 418                  | Aerospace Structures II                                     | 3           |
| AE 420                  | Aircraft Preliminary Design                                 | 4           |
| AE 421                  | Aircraft Detail Design                                      | 4           |
| AE 432                  | Flight Dynamics and Control                                 | 3           |
| AE 442                  | Experimental Dynamics and Control *                         | 1           |
| AE 443                  | Experimental Dynamics and Control Laboratory                | 1           |
|                         | Humanities or Social Sciences Lower or Upper-Level Elective | 3           |
|                         | Humanities or Social Sciences Upper-Level Elective          | 3           |
|                         | Approved Upper-Level Technical Electives                    | 3           |
|                         | Approved AE Upper-Level Technical Electives                 | 3           |
| <b>Credits Subtotal</b> |   | <b>30.0</b> |
| <b>Credits Total:</b>   |   | <b>129</b>  |

## Technical Electives

Two upper-level Technical Electives needs to be selected from the BSAE Approved Technical Electives list, in the areas of Engineering and Science, maintained by the AE Department. One Technical Elective must be a non-duplicating AE undergraduate or graduate course. The second Technical Elective can be any course on the BSAE Approved Technical Elective list. Proposed courses not on the list may be submitted to the AE Curriculum Committee.

\* Lecture/Lab courses must be taken at the same time.

## Astronautics Plan of Study

Students should be aware that most courses in each academic year have prerequisites and/or corequisites (check the Undergraduate Courses section before registering for classes to ensure required sequencing). See the AE flowchart(s) from the department for the recommended plan of study.

**Because of new courses being phased in, this option is recommended for new students only.**

NOTE: Students in the Aerospace Engineering program desiring to complete a minor must complete at least six credit hours of coursework applied to the minor that are not specifically required in the student's degree program.

### Year One

|   | Credits     |
|---|-------------|
| See the College of Engineering, Engineering Fundamentals Program for course selection | 33          |
| <b>Credits Subtotal</b>   | <b>33.0</b> |
| <b>Credits Total:</b>   | <b>33.0</b> |

## Astronautics Option

### Year Two

|  | Credits     |
|--|-------------|
| AE 201 Aerospace Flight Vehicles                 | 3           |
| COM 221 Technical Report Writing                 | 3           |
| ES 201 Statics                                   | 3           |
| ES 202 Solid Mechanics                           | 3           |
| ES 204 Dynamics                                  | 3           |
| ES 305 Thermodynamics                            | 3           |
| MA 243 Calculus and Analytical Geometry III      | 4           |
| MA 345 Differential Equations and Matrix Methods | 4           |
| PS 160 Physics for Engineers II                  | 3           |
| PS 250 Physics for Engineers III                 | 3           |
| PS 253 Physics Laboratory for Engineers          | 1           |
| <b>Credits Subtotal</b>                          | <b>33.0</b> |

### Year Three

|   |   |
|---|---|
| AE 313 Space Mechanics                                | 3 |
| AE 314 Experimental Aerodynamics *                    | 1 |
| AE 315 Experimental Aerodynamics Laboratory *         | 1 |
| AE 316 Aerospace Engineering Materials                | 3 |
| AE 318 Aerospace Structures I                         | 3 |
| AE 319 Aerodynamics                                   | 3 |
| AE 323 Spacecraft Systems                             | 3 |
| AE 414 Space Propulsion                               | 3 |
| AE 426 Spacecraft Attitude Dynamics                   | 3 |
| COM 219 Speech  | 3 |
| EE 327 Electrical Engineering Fundamentals *          | 3 |
| EE 328 Electrical Engineering Fundamentals Laboratory | 1 |

|   |             |
|---|-------------|
| MA 432 Linear Algebra                                       | 3           |
| <b>Credits Subtotal</b>                                     | <b>33.0</b> |
| <b>Year Four</b>  |             |
| AE 416 Aerospace Structures and Instrumentation *           | 1           |
| AE 417 Aerospace Structures and Instrumentation Laboratory  | 1           |
| AE 427 Spacecraft Preliminary Design                        | 4           |
| AE 429 Space Environmental Applications                     | 3           |
| AE 434 Spacecraft Control                                   | 3           |
| AE 445 Spacecraft Detail Design                             | 4           |
| AE 442 Experimental Dynamics and Control *                  | 1           |
| AE 443 Experimental Dynamics and Control Laboratory         | 1           |
| Humanities or Social Sciences Lower or Upper-Level Elective | 3           |
| Humanities or Social Sciences Upper-Level Elective          | 3           |
| Approved Upper-Level Technical Electives                    | 3           |
| Approved AE Upper-Level Technical Electives                 | 3           |
| <b>Credits Subtotal</b>                                     | <b>30.0</b> |
| <b>Credits Total:</b>                                       | <b>129</b>  |

## Technical Electives

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### Footnotes

\* Lecture/Lab courses must be taken at the same time.

## Jet Propulsion Plan of Study

Students should be aware that most courses in each academic year have prerequisites and/or corequisites (check the Undergraduate Courses section before registering for classes to ensure required sequencing). See the AE flowchart(s) from the department for the recommended plan of study.

NOTE: Students in the Aerospace Engineering program desiring to complete a minor must complete at least six credit hours of coursework applied to the minor that are not specifically required in the student's degree program.

### Year One

|   | Credits     |
|---|-------------|
| See the College of Engineering, Engineering Fundamentals Program for course selection | 33          |
| <b>Credits Subtotal</b>   | <b>33.0</b> |
| <b>Credits Total:</b>   | <b>33.0</b> |

## Jet Propulsion Option

### Year Two

|                                  | Credits |
|----------------------------------|---------|
| AE 201 Aerospace Flight Vehicles | 3       |
| COM 221 Technical Report Writing | 3       |
| ES 201 Statics                   | 3       |
| ES 202 Solid Mechanics           | 3       |
| ES 204 Dynamics                  | 3       |
| ES 305 Thermodynamics            | 3       |

|        |  |   |
|--------|--|---|
| MA 243 | Calculus and Analytical Geometry III               | 4 |
| MA 441 | Mathematical Methods for Engineering and Physics I | 3 |
| PS 160 | Physics for Engineers II                           | 3 |
| PS 250 | Physics for Engineers III                          | 3 |
| PS 253 | Physics Laboratory for Engineers                   | 1 |

**Credits Subtotal** **32.0**

#### Year Three

|         |  |   |
|---------|--|---|
| AE 307  | Incompressible Aerodynamics                      | 3 |
| AE 308  | Compressible Aerodynamics                        | 3 |
| AE 313  | Space Mechanics                                  | 3 |
| AE 314  | Experimental Aerodynamics *                      | 1 |
| AE 315  | Experimental Aerodynamics Laboratory *           | 1 |
| AE 316  | Aerospace Engineering Materials                  | 3 |
| AE 318  | Aerospace Structures I                           | 3 |
| AE 403  | Jet Propulsion                                   | 3 |
| AE 413  | Airplane Stability and Control                   | 3 |
| COM 219 | Speech   | 3 |
| EE 327  | Electrical Engineering Fundamentals *            | 3 |
| EE 328  | Electrical Engineering Fundamentals Laboratory * | 1 |
| MA 345  | Differential Equations and Matrix Methods        | 4 |

**Credits Subtotal** **34.0**

#### Year Four

|        |   |   |
|--------|---|---|
| AE 416 | Aerospace Structures and Instrumentation *            | 1 |
| AE 417 | Aerospace Structures and Instrumentation Laboratory * | 1 |
| AE 418 | Aerospace Structures II                               | 3 |
| AE 432 | Flight Dynamics and Control                           | 3 |
| AE 435 | Jet Propulsion Preliminary Design                     | 4 |
| AE 440 | Jet Propulsion Detail Design                          | 4 |
| AE 442 | Experimental Dynamics and Control *                   | 1 |
| AE 443 | Experimental Dynamics and Control Laboratory          | 1 |

|  |   |   |
|--|---|---|
|  | Humanities or Social Sciences Lower or Upper-Level Elective | 3 |
|  | Humanities or Social Sciences Upper-Level Elective          | 3 |
|  | Approved Upper-Level Technical Electives                    | 3 |
|  | Approved AE Upper-Level Technical Electives                 | 3 |

**Credits Subtotal** **30.0**

**Credits Total:** **129**

### Technical Electives

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#### Footnotes

\* Lecture/Lab courses must be taken at the same time.

### Rocket Propulsion Plan of Study

Students should be aware that most courses in each academic year have prerequisites and/or corequisites (check the Undergraduate Courses section before registering for classes to ensure required sequencing). See

the AE flowchart(s) from the department for the recommended plan of study.

**Because of new courses (including design courses) being phased in, this option is recommended for new students only.**

NOTE: Students in the Aerospace Engineering program desiring to complete a minor must complete at least six credit hours of coursework applied to the minor that are not specifically required in the student's degree program.

#### Year One

|  |   |                      |
|--|---|----------------------|
|  | See the College of Engineering, Engineering Fundamentals Program for course selection | <b>Credits</b><br>33 |
|  | <b>Credits Subtotal</b>   | <b>33.0</b>          |
|  | <b>Credits Total:</b>   | <b>33.0</b>          |

### Rocket Propulsion Option

#### Year Two

|         |   |                |
|---------|---|----------------|
|         |   | <b>Credits</b> |
| AE 201  | Aerospace Flight Vehicles                 | 3              |
| COM 221 | Technical Report Writing                  | 3              |
| ES 201  | Statics                                   | 3              |
| ES 202  | Solid Mechanics                           | 3              |
| ES 204  | Dynamics                                  | 3              |
| ES 305  | Thermodynamics                            | 3              |
| MA 243  | Calculus and Analytical Geometry III      | 4              |
| MA 345  | Differential Equations and Matrix Methods | 4              |
| PS 160  | Physics for Engineers II                  | 3              |
| PS 250  | Physics for Engineers III                 | 3              |
| PS 253  | Physics Laboratory for Engineers          | 1              |
|         | <b>Credits Subtotal</b>                   | <b>33.0</b>    |

#### Year Three

|         |  |             |
|---------|--|-------------|
| AE 313  | Space Mechanics                                | 3           |
| AE 314  | Experimental Aerodynamics *                    | 1           |
| AE 315  | Experimental Aerodynamics Laboratory *         | 1           |
| AE 316  | Aerospace Engineering Materials                | 3           |
| AE 318  | Aerospace Structures I                         | 3           |
| AE 319  | Aerodynamics                                   | 3           |
| AE 323  | Spacecraft Systems                             | 3           |
| AE 414  | Space Propulsion                               | 3           |
| AE 426  | Spacecraft Attitude Dynamics                   | 3           |
| COM 219 | Speech   | 3           |
| EE 327  | Electrical Engineering Fundamentals *          | 3           |
| EE 328  | Electrical Engineering Fundamentals Laboratory | 1           |
| MA 432  | Linear Algebra                                 | 3           |
|         | <b>Credits Subtotal</b>                        | <b>33.0</b> |

#### Year Four

|        |   |   |
|--------|---|---|
| AE 416 | Aerospace Structures and Instrumentation *                  | 1 |
| AE 417 | Aerospace Structures and Instrumentation Laboratory *       | 1 |
| AE 429 | Space Environmental Applications                            | 3 |
| AE 434 | Spacecraft Control  | 3 |
| AE 441 | Rocket Propulsion Preliminary Design                        | 4 |
| AE 442 | Experimental Dynamics and Control *                         | 1 |
| AE 443 | Experimental Dynamics and Control Laboratory                | 1 |
| AE 451 | Rocket Propulsion Detail Design                             | 4 |
|        | Humanities or Social Sciences Lower or Upper-Level Elective | 3 |

|  |             |
|--|-------------|
| Humanities or Social Sciences Upper-Level Elective | 3           |
| Approved Upper-Level Technical Electives           | 3           |
| Approved AE Upper-Level Technical Electives        | 3           |
| <b>Credits Subtotal</b>                            | <b>30.0</b> |
| <b>Credits Total:</b>                              | <b>129</b>  |

## Technical Electives

Two upper-level Technical Electives needs to be selected from the BSAE Approved Technical Electives list, in the areas of Engineering and Science, maintained by the AE Department. One Technical Elective must be a non-duplicating AE undergraduate or graduate course. The second Technical Elective can be any course on the BSAE Approved Technical Elective list. Proposed courses not on the list may be submitted to the AE Curriculum Committee.

### Footnotes

\* Lecture/Lab courses must be taken at the same time.