

# ROBOTICS AND AUTONOMOUS SYSTEMS ENGINEERING, BACHELOR OF SCIENCE (B.S.)

The rapid advancement of robotics and autonomous systems is reshaping industries at an unprecedented pace. RAS technology fundamentally transforms the modern workforce and economy from self-driving vehicles and manufacturing robots to robotic surgical systems. The interdisciplinary nature of RAS development—spanning multiple engineering disciplines simultaneously—necessitates an integrative educational approach that traditional single-discipline curricula cannot provide.

The Bachelor of Science in Robotics and Autonomous Systems Engineering is a multi-disciplinary program that prepares students with critical competencies to design, implement and analyze modern robotic and autonomous systems. Beyond technical proficiency, the program emphasizes ethical considerations inherent in autonomous systems, particularly AI-based technologies. Students develop critical perspectives on responsibility, bias, fairness and unintended consequences, enabling them to contribute to the responsible development and deployment of these technologies.

The program's core objective is to equip students with foundational knowledge and critical thinking skills necessary to navigate future innovations and changes in robotics and autonomous systems technology.

## Student learning outcomes

Upon completing this program students will be able to:

1. Apply core concepts in electrical engineering, mechanical engineering, computer science and artificial intelligence to robotics and autonomous systems.
2. Analyze complex, real-world problems and devise innovative and effective solutions using robotics and autonomous systems.
3. Apply systems thinking to connect and apply knowledge from diverse engineering fields to robotics and autonomous systems applications.
4. Collaborate effectively in multi-disciplinary teams to achieve common goals and solve complex problems.
5. Explore the ethical and societal implications of robotic and autonomous systems.
6. Demonstrate effective written and oral communication skills.
7. Demonstrate the ability to acquire and apply new knowledge as needed, using appropriate learning strategies.

## Special requirements

Students must earn a minimum grade of C in all required engineering courses, in all courses used to satisfy engineering and professional elective requirements, and in the following:

Course	Title	Hours
MATH 200	Calculus with Analytic Geometry I	4
MATH 201	Calculus with Analytic Geometry II	4
MATH 301	Differential Equations	3
MATH 310	Linear Algebra	3

PHYS 207 & PHYZ 207	University Physics I and University Physics I Laboratory	5
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Students must maintain a minimum major (ENGR, EGRB, EGRE, EGMN, CMSC) GPA of 2.0

## Degree requirements for Robotics and Autonomous Systems Engineering, Bachelor of Science (B.S.)

Course	Title	Hours
<b>General education (<a href="https://bulletin.vcu.edu/undergraduate/undergraduate-study/general-education-curriculum/">https://bulletin.vcu.edu/undergraduate/undergraduate-study/general-education-curriculum/</a>)</b>		
Select 30 credits of general education courses in consultation with an adviser.		30
<b>Major core requirements</b>		
CMSC 436	Artificial Intelligence	3
EGMN 416	Mechatronics	3
EGMN 427	Robotics	3
EGRE 354	Introduction to Feedback Control Systems	3
EGRE 412	Introduction to Intelligent Autonomous Systems	3
ENGR 261	Introduction to Robotics and Autonomous Systems	3
ENGR 262	Foundations of Robotic Programming	3
ENGR 404	Senior Design Studio I (Laboratory/Project Time)	2
ENGR 405	Senior Design Studio II (Laboratory/Project Time) (Major Electives)	2
<b>Additional major requirements</b>		
CMSC 254	Introduction to Problem-solving	4
CMSC 302	Introduction to Discrete Structures	3
EGMN 102	Engineering Statics	3
EGMN 110	Engineering Visualization	2
EGMN 201	Dynamics and Kinematics	3
EGMN 315	Process and Systems Dynamics	3
EGRE 201	Fundamentals of Electrical and Computer Engineering	3
EGRE 206	Electric Circuits	4
EGRE 207	Electric Circuits II	4
EGRE 335	Signals and Systems	4
EGRE 337	Statistical Information Processing	3
EGRE 399	Fundamentals of Design and Analysis	3
ENGR 105	Engineering Foundations	3
or EGMN 190	Introduction to Mechanical and Nuclear Engineering	
or EGRE 101	Introduction to Engineering	
ENGR 395	Professional Development	1
MATH 201	Calculus with Analytic Geometry II	4
MATH 301	Differential Equations	3
MATH 307	Multivariate Calculus	4
MATH 310	Linear Algebra	3
MATH 415	Numerical Methods	3
<b>Ancillary requirements</b>		

CMSC 225	Essentials of Artificial Intelligence (satisfies general education AOI for scientific and logical reasoning)	3
ECON 205	The Economics of Product Development and Markets (satisfies general education BOK for social/behavioral sciences and AOI for global perspectives)	3
EGMN 111 or ENGR 125	Great Inventions: How They Work and Their Impact on Society (either satisfies general education AOI for creativity, innovation and aesthetic inquiry) Practical Artificial Intelligence	3
MATH 200	Calculus with Analytic Geometry I (satisfies general education quantitative foundations)	4
PHIL 201	Introduction to Ethics (satisfies general education BOK for humanities/fine arts and AOI for diversities in the human experience)	3
PHYS 207 & PHYZ 207	University Physics I and University Physics I Laboratory (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	5

<b>Restricted electives</b>		
Select elective courses from the list below.		6
<b>Total Hours</b>		<b>121</b>

The minimum number of credit hours required for this degree is 121.

### Engineering electives

Students must complete a combined total of six credits of engineering electives from the following list:

Course	Title	Hours
CMSC 531	3D Computer Vision for Robot Navigation	3
EGMN 568	Robot Manipulators	3
EGRB 523	Rehabilitation Engineering and Prostheses	3
EGRE 455	Control Systems Design	3
EGRE 513	Fundamentals of Modern Systems Engineering	3
EGRE 536	Introduction to Cyber-Physical Systems	3
EGRE 553	Industrial Automation	3
EGRE 554	Advanced Industrial Automation	3

Other engineering courses may be counted as electives with permission of the adviser.

All courses used to satisfy engineering elective requirements must be completed with a minimum grade of C.

Students who complete the above requirements will receive a Bachelor of Science in Robotics and Autonomous Systems Engineering.

What follows is a sample plan that meets the prescribed requirements within a four-year course of study at VCU. Please contact your adviser before beginning course work toward a degree.

## Recommended course sequence/plan of study

<b>Freshman year</b>		<b>Hours</b>
<b>Fall semester</b>		
CMSC 254	Introduction to Problem-solving	4
EGMN 110	Engineering Visualization	2
ENGR 105	Engineering Foundations	3
or EGMN 190	or Introduction to Mechanical and Nuclear Engineering	
or EGRE 101	or Introduction to Engineering	
MATH 200	Calculus with Analytic Geometry I (satisfies general education quantitative foundations)	4
UNIV 111	Introduction to Focused Inquiry: Investigation and Communication (satisfies general education UNIV foundations)	3
Play course video for Introduction to Focused Inquiry: Investigation and Communication		
<b>Term Hours:</b>		<b>16</b>
<b>Spring semester</b>		
EGMN 111 or ENGR 125	Great Inventions: How They Work and Their Impact on Society (either satisfies general education AOI for creativity, innovation and aesthetic inquiry) or Practical Artificial Intelligence	3
EGRE 201	Fundamentals of Electrical and Computer Engineering	3
ENGR 261	Introduction to Robotics and Autonomous Systems	3
MATH 201	Calculus with Analytic Geometry II	4
UNIV 200	Advanced Focused Inquiry: Literacies, Research and Communication (satisfies general education UNIV foundations)	3
<b>Term Hours:</b>		<b>16</b>
<b>Sophomore year</b>		
<b>Fall semester</b>		
EGMN 102	Engineering Statics	3
EGRE 206	Electric Circuits	4
ENGR 262	Foundations of Robotic Programming	3
MATH 301	Differential Equations	3
PHYS 207 & PHYZ 207	University Physics I and University Physics I Laboratory (satisfies general education BOK for natural sciences and AOI for scientific and logical reasoning)	5
<b>Term Hours:</b>		<b>18</b>
<b>Spring semester</b>		

CMSC 225	Essentials of Artificial Intelligence (satisfies general education AOI for scientific and logical reasoning)	3
EGMN 201	Dynamics and Kinematics	3
EGRE 207	Electric Circuits II	4
MATH 307	Multivariate Calculus	4
<b>Term Hours:</b>		<b>14</b>
<b>Junior year</b>		
<b>Fall semester</b>		
CMSC 302	Introduction to Discrete Structures	3
EGMN 416	Mechatronics	3
EGRE 335	Signals and Systems	4
EGRE 354	Introduction to Feedback Control Systems	3
MATH 310	Linear Algebra	3
<b>Term Hours:</b>		<b>16</b>
<b>Spring semester</b>		
EGMN 315	Process and Systems Dynamics	3
EGMN 427	Robotics	3
EGRE 337	Statistical Information Processing	3
EGRE 399	Fundamentals of Design and Analysis	3
MATH 415	Numerical Methods	3
<b>Term Hours:</b>		<b>15</b>
<b>Senior year</b>		
<b>Fall semester</b>		
CMSC 436	Artificial Intelligence	3
EGRE 412	Introduction to Intelligent Autonomous Systems	3
ENGR 404	Senior Design Studio I (Laboratory/Project Time)	2
General education course (select AOI in consultation with an adviser)		3
Restricted elective		3
<b>Term Hours:</b>		<b>14</b>
<b>Spring semester</b>		
ECON 205	The Economics of Product Development and Markets (satisfies general education BOK for social/behavioral sciences and AOI for global perspectives)	3
ENGR 395	Professional Development	1
ENGR 405	Senior Design Studio II (Laboratory/Project Time)	2
PHIL 201	Introduction to Ethics (satisfies general education BOK for humanities/fine arts and AOI for diversities in the human experience)	3
Restricted elective		3
<b>Term Hours:</b>		<b>12</b>
<b>Total Hours:</b>		<b>121</b>

The minimum number of credit hours required for this degree is 121.