



Twin Cities Campus

Computer Science B.S. Comp.Sc.

Computer Science and Engineering Administration

College of Science and Engineering

- Program Type: Baccalaureate
- Requirements for this program are current for Spring 2020
- Required credits to graduate with this degree: 120
- Required credits within the major: 77 to 78
- Degree: Bachelor of Science in Computer Science

Computer science is concerned with the study of hardware, software, and theoretical aspects of high-speed computing devices and with the application of these devices to scientific, technological, and business problems.

A bachelor's degree gives students a basic understanding of computer science. After completing a required set of fundamental courses, students arrange their subsequent work around one of several upper division tracks within either computer science or an interdisciplinary area involving computer applications. The degree prepares students for graduate work or for various industrial, governmental, and business positions involving the use of computers.

Program Delivery

This program is available:

- via classroom (the majority of instruction is face-to-face)

Admission Requirements

Students must complete 5 courses before admission to the program.

Freshman and transfer students are usually admitted to pre-major status before admission to this major

For information about University of Minnesota admission requirements, visit the [Office of Admissions website](#).

Required prerequisites

Mathematics Core

- [MATH 1371](#) - CSE Calculus I [MATH] (4.0 cr)
- or [MATH 1271](#) - Calculus I [MATH] (4.0 cr)
- or [MATH 1571H](#) - Honors Calculus I [MATH] (4.0 cr)
- [MATH 1372](#) - CSE Calculus II (4.0 cr)
- or [MATH 1272](#) - Calculus II (4.0 cr)
- or [MATH 1572H](#) - Honors Calculus II (4.0 cr)

Computer Science Introductory Core

- [CSCI 2011](#) - Discrete Structures of Computer Science (4.0 cr)

Options

Option 1

- [CSCI 1133](#) - Introduction to Computing and Programming Concepts (4.0 cr)
- [CSCI 1933](#) - Introduction to Algorithms and Data Structures (4.0 cr)

or **Option 2**

- [CSCI 1103](#) - Introduction to Computer Programming in Java (4.0 cr)
- or [CSCI 1113](#) - Introduction to C/C++ Programming for Scientists and Engineers (4.0 cr)
- [CSCI 1913](#) - Introduction to Algorithms, Data Structures, and Program Development (4.0 cr)

General Requirements

All students are required to complete general University and college requirements including writing and liberal education courses. For more information about University-wide requirements, see the [liberal education requirements](#). Required courses for the major or minor in which a student receives a D grade (with or without plus or minus) do not count toward the major or minor (including transfer courses).

Program Requirements

All freshmen in the College of Science and Engineering must complete CSE 1001: First-Year Experience.

Science Core



PHYS 1301W - Introductory Physics for Science and Engineering I [PHYS, WI] (4.0 cr)

or **PHYS 1401V** - Honors Physics I [PHYS, WI] (4.0 cr)

or **PHYS 1501V** *(Inactive)* [PHYS, WI] (4.0 cr)

Take 1 or more course(s) from the following:

- **ESCI 2201** - Solid Earth Dynamics (4.0 cr)
- **GCD 3022** - Genetics (3.0 cr)
- **PHYS 1302W** - Introductory Physics for Science and Engineering II [PHYS, WI] (4.0 cr)
- **PHYS 1402V** - Honors Physics II [PHYS, WI] (4.0 cr)
- **PHYS 1502V** *(Inactive)* [PHYS, WI] (4.0 cr)
- **PSY 3011** - Introduction to Learning and Behavior (3.0 cr)
- **Chemistry 1**
 - **CHEM 1061** - Chemical Principles I [PHYS] (3.0 cr)
 - **CHEM 1065** - Chemical Principles I Laboratory [PHYS] (1.0 cr)
- **Chemistry 1 Honors**
 - **CHEM 1071H** - Honors Chemistry I [PHYS] (3.0 cr)
 - **CHEM 1075H** - Honors Chemistry I Laboratory [PHYS] (1.0 cr)
- **Chemistry 2**
 - **CHEM 1062** - Chemical Principles II [PHYS] (3.0 cr)
 - **CHEM 1066** - Chemical Principles II Laboratory [PHYS] (1.0 cr)
- **Chemistry 2 Honors**
 - **CHEM 1072H** - Honors Chemistry II [PHYS] (3.0 cr)
 - **CHEM 1076H** - Honors Chemistry II Laboratory [PHYS] (1.0 cr)

Computer Science Core

STAT 3021 - Introduction to Probability and Statistics (3.0 cr)

CSCI 2021 - Machine Architecture and Organization (4.0 cr)

CSCI 2041 - Advanced Programming Principles (4.0 cr)

CSCI 3081W - Program Design and Development [WI] (4.0 cr)

CSCI 4041 - Algorithms and Data Structures (4.0 cr)

CSCI 4061 - Introduction to Operating Systems (4.0 cr)

CSCI 2033 - Elementary Computational Linear Algebra (4.0 cr)

or **MATH 4242** - Applied Linear Algebra (4.0 cr)

Upper Division Writing Intensive within the major

Students are required to take one upper division writing intensive course within the major. If that requirement has not been satisfied within the core major requirements, students must choose one course from the following list. Some of these courses may also fulfill other major requirements.

Take 0 - 1 course(s) from the following:

- **CSCI 3081W** - Program Design and Development [WI] (4.0 cr)
- **CSCI 3921W** - Social, Legal, and Ethical Issues in Computing [CIV, WI] (3.0 cr)
- **CSCI 4511W** - Introduction to Artificial Intelligence [WI] (4.0 cr)
- **CSCI 4970W** - Advanced Project Laboratory [WI] (3.0 cr)
- **CSCI 5127W** - Embodied Computing: Design & Prototyping [WI] (3.0 cr)

Upper Division Math Oriented Requirement

Students must take an upper division math oriented course. The course selected will count towards the 23 credit minimum of track requirements.

Upper Division Math Oriented Requirement options. The following MATH courses aren't accepted: MATH 4005, 4065, 4067W, 4113, 4116, 4118, 5067, 5068, 5075, and 5076.

Take 1 or more course(s) from the following:

- **CSCI 4011** - Formal Languages and Automata Theory (4.0 cr)
- **CSCI 5302** - Analysis of Numerical Algorithms (3.0 cr)
- **CSCI 5304** - Computational Aspects of Matrix Theory (3.0 cr)
- **CSCI 5403** *(Inactive)* (3.0 cr)
- **CSCI 5421** - Advanced Algorithms and Data Structures (3.0 cr)
- **CSCI 5471** - Modern Cryptography (3.0 cr)
- **CSCI 5481** - Computational Techniques for Genomics (3.0 cr)
- **CSCI 5525** - Machine Learning: Analysis and Methods (3.0 cr)
- **MATH 4xxx**
- **MATH 5xxx**

Approved Computer Science Track Electives

The following list can be used as track electives for all of the computer science tracks including the custom option. All 4000-5000 level CSCI courses are accepted as track electives except for the core requirements (4041, 4041H, and 4061) and CSCI 5996.

Take 1 or more course(s) from the following:

- **AEM 4601** - Instrumentation Laboratory (3.0 cr)



- [AST 4041](#) - Computational Methods in the Physical Sciences (4.0 cr)
- [BIOL 5272](#) - Applied Biostatistics (4.0 cr)
- [CHEM 4021](#) - Computational Chemistry (3.0 cr)
- CSCI 4xxx
- CSCI 5xxx
- [EE 4301](#) - Digital Design With Programmable Logic (4.0 cr)
- [EE 4303](#) - Introduction to Programmable Devices Laboratory (1.0 cr)
- [EE 4341](#) - Embedded System Design (4.0 cr)
- [EE 4363](#) - Computer Architecture and Machine Organization (4.0 cr)
- [EE 5371](#) - Computer Systems Performance Measurement and Evaluation (3.0 cr)
- [EE 5393](#) - Circuits, Computation, and Biology (3.0 cr)
- [EE 5505](#) - Wireless Communication (3.0 cr)
- [FNRM 5131](#) - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- [FNRM 5262](#) - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
- [FNRM 5462](#) - Advanced Remote Sensing and Geospatial Analysis (3.0 cr)
- [HSCI 4321](#) - History of Computing [TS, HIS] (3.0 cr)
- [IDSC 4204W](#) - Strategic Information Technology Management [WI] (4.0 cr)
- IDSC 4431 *{Inactive}* (2.0 cr)
- [IDSC 4441](#) - Electronic Commerce (2.0 cr)
- [IE 4011](#) - Stochastic Models (4.0 cr)
- [INET 4011](#) - Networking I: Network Administration (4.0 cr)
- [INET 4021](#) - Dev Ops I: Network Programming (4.0 cr)
- [INET 4041](#) - Networking II: Emerging Technologies (4.0 cr)
- [INET 4061](#) - Data Science I: Fundamentals (4.0 cr)
- [INET 4062](#) - Data Science II: Advanced (4.0 cr)
- [KIN 5001](#) - Foundations of Human Factors/Ergonomics (3.0 cr)
- [LING 5801](#) - Introduction to Computational Linguistics (3.0 cr)
- MATH 4xxx
- MATH 5xxx
- [ME 5228](#) - Introduction to Finite Element Modeling, Analysis, and Design (4.0 cr)
- [ME 5286](#) - Robotics (4.0 cr)
- [MICE 5035](#) - Personal Microbiome Analysis (3.0 cr)
- [PHYS 4041](#) - Computational Methods in the Physical Sciences (4.0 cr)
- [PHYS 4051](#) - Methods of Experimental Physics I (5.0 cr)
- [PSY 5018H](#) - Mathematical Models of Human Behavior (3.0 cr)
- [PSY 5038W](#) - Introduction to Neural Networks [WI] (3.0 cr)
- STAT 4xxx
- STAT 5xxx
- GDES and PDES course options**
Take 0 - 2 course(s) from the following:
 - [GDES 4371](#) - Data & Information Visualization (3.0 cr)
 - [GDES 5341](#) - Interaction Design (3.0 cr)
 - [GDES 5342](#) - Advanced Web Design (3.0 cr)
 - GDES 5372 *{Inactive}* (3.0 cr)
 - [GDES 5386](#) - Fundamentals of Game Design (3.0 cr)
 - [PDES 5704](#) - Computer-Aided Design Methods (3.0 cr)

Upper Division Track

A CSci track and the ud math oriented requirement must total 23 credits. 11 of the 23 credits must be from CSci courses.

Architecture and Hardware Systems

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 4203 or EE4363 and CSCI 5204. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

[CSCI 5204](#) - Advanced Computer Architecture (3.0 cr)

[CSCI 4203](#) - Computer Architecture (4.0 cr)

or [EE 4363](#) - Computer Architecture and Machine Organization (4.0 cr)

Architecture and Hardware Systems Sublist

Take 2 or more course(s) from the following:

- [CSCI 4211](#) - Introduction to Computer Networks (3.0 cr)
- [CSCI 5103](#) - Operating Systems (3.0 cr)
- [CSCI 5161](#) - Introduction to Compilers (3.0 cr)
- [CSCI 5451](#) - Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3.0 cr)
- [EE 4341](#) - Embedded System Design (4.0 cr)

-OR-



Artificial Intelligence/Robotics

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 4511W and CSCI 5512. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

[CSCI 4511W](#) - Introduction to Artificial Intelligence [WI] (4.0 cr)

[CSCI 5512](#) - Artificial Intelligence II (3.0 cr)

Artificial Intelligence/Robotics Sublist

Take 2 or more course(s) from the following:

- [CSCI 5521](#) - Machine Learning Fundamentals (3.0 cr)
- [CSCI 5523](#) - Introduction to Data Mining (3.0 cr)
- [CSCI 5525](#) - Machine Learning: Analysis and Methods (3.0 cr)
- [CSCI 5551](#) - Introduction to Intelligent Robotic Systems (3.0 cr)
- [CSCI 5552](#) - Sensing and Estimation in Robotics (3.0 cr)
- [CSCI 5561](#) - Computer Vision (3.0 cr)

-OR-

Big Data

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 4707 or CSCI 5105 and CSCI 5521 or CSCI 5523. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

Requirement 1

[CSCI 4707](#) - Practice of Database Systems (3.0 cr)

or [CSCI 5105](#) - Introduction to Distributed Systems (3.0 cr)

Requirement 2

[CSCI 5521](#) - Machine Learning Fundamentals (3.0 cr)

or [CSCI 5523](#) - Introduction to Data Mining (3.0 cr)

Big Data Sublist

Take 2 or more course(s) from the following:

- [CSCI 4511W](#) - Introduction to Artificial Intelligence [WI] (4.0 cr)
- [CSCI 5451](#) - Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3.0 cr)
- [CSCI 5481](#) - Computational Techniques for Genomics (3.0 cr)
- [CSCI 5512](#) - Artificial Intelligence II (3.0 cr)
- [CSCI 5609](#) - Visualization (3.0 cr)
- [INET 4061](#) - Data Science I: Fundamentals (4.0 cr)
- [INET 4062](#) - Data Science II: Advanced (4.0 cr)
- [MATH 5651](#) - Basic Theory of Probability and Statistics (4.0 cr)

-OR-

Bioinformatics and Computational Biology

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 5461 and CSCI 5481. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

[CSCI 5461](#) - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)

[CSCI 5481](#) - Computational Techniques for Genomics (3.0 cr)

Bioinformatics and Computational Biology Sublist

Take 2 or more course(s) from the following:

- [CSCI 4707](#) - Practice of Database Systems (3.0 cr)
- [CSCI 5421](#) - Advanced Algorithms and Data Structures (3.0 cr)
- [CSCI 5521](#) - Machine Learning Fundamentals (3.0 cr)
- [CSCI 5523](#) - Introduction to Data Mining (3.0 cr)

-OR-

Computational Science

This track is 23 credits minimum, split into two parts. Take four classes from the course list below, including the two required courses: CSCI 5302 and CSCI 5304. The second part to complete a track is enough track electives to reach the 23 credit minimum.

This track's required courses meet the upper division math oriented.

[CSCI 5302](#) - Analysis of Numerical Algorithms (3.0 cr)

[CSCI 5304](#) - Computational Aspects of Matrix Theory (3.0 cr)

Computational Science Sublist

Take 2 or more course(s) from the following:

- [CSCI 5451](#) - Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3.0 cr)
- [CSCI 5461](#) - Functional Genomics, Systems Biology, and Bioinformatics (3.0 cr)
- [CSCI 5481](#) - Computational Techniques for Genomics (3.0 cr)



- CSCI 5523 - Introduction to Data Mining (3.0 cr)
- CSCI 5609 - Visualization (3.0 cr)
- MATH 5075 - Mathematics of Options, Futures, and Derivative Securities I (4.0 cr)
- MATH 5467 - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)
- MATH 5587 - Elementary Partial Differential Equations I (4.0 cr)
- MATH 5588 - Elementary Partial Differential Equations II (4.0 cr)
- MATH 5711 - Linear Programming and Combinatorial Optimization (4.0 cr)
- AST 4041 - Computational Methods in the Physical Sciences (4.0 cr)
or PHYS 4041 - Computational Methods in the Physical Sciences (4.0 cr)

-OR-

Databases

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 4707 and CSCI 5708. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

CSCI 4707 - Practice of Database Systems (3.0 cr)

CSCI 5708 - Architecture and Implementation of Database Management Systems (3.0 cr)

Databases Sublist

Take 2 or more course(s) from the following:

- CSCI 4131 - Internet Programming (3.0 cr)
- CSCI 4211 - Introduction to Computer Networks (3.0 cr)
- CSCI 4511W - Introduction to Artificial Intelligence [WI] (4.0 cr)
- CSCI 5103 - Operating Systems (3.0 cr)
- CSCI 5421 - Advanced Algorithms and Data Structures (3.0 cr)
- CSCI 5523 - Introduction to Data Mining (3.0 cr)
- INET 4061 - Data Science I: Fundamentals (4.0 cr)

-OR-

Geographical Information Systems

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 4707 and CSCI 5708. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

CSCI 4707 - Practice of Database Systems (3.0 cr)

CSCI 5708 - Architecture and Implementation of Database Management Systems (3.0 cr)

Geographical Information Systems Sublist

Take 2 or more course(s) from the following:

- CSCI 5715 - From GPS, Google Maps, and Uber to Spatial Data Science (3.0 cr)
- FNRM 5131 - Geographical Information Systems (GIS) for Natural Resources (4.0 cr)
- FNRM 5262 - Remote Sensing and Geospatial Analysis of Natural Resources and Environment (3.0 cr)
- FNRM 5462 - Advanced Remote Sensing and Geospatial Analysis (3.0 cr)
- CSCI 4611 - Programming Interactive Computer Graphics and Games (3.0 cr)
or CSCI 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)

-OR-

Graphics and Visualization

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 4611 or 5607 and CSCI 5608 or 5609 or 5611 or 5619. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

Requirement 1

- CSCI 4611 - Programming Interactive Computer Graphics and Games (3.0 cr)
or CSCI 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)

Requirement 2

- CSCI 5608 - Fundamentals of Computer Graphics II (3.0 cr)
or CSCI 5609 - Visualization (3.0 cr)
or CSCI 5611 - Animation & Planning in Games (3.0 cr)
or CSCI 5619 - Virtual Reality and 3D Interaction (3.0 cr)

Graphics and Visualization Sublist

Take 2 or more course(s) from the following:

- CSCI 4611 - Programming Interactive Computer Graphics and Games (3.0 cr)
- CSCI 5607 - Fundamentals of Computer Graphics 1 (3.0 cr)
- CSCI 5608 - Fundamentals of Computer Graphics II (3.0 cr)
- CSCI 5609 - Visualization (3.0 cr)



- CSCI 5611 - Animation & Planning in Games (3.0 cr)
- CSCI 5619 - Virtual Reality and 3D Interaction (3.0 cr)
- CSCI 5115 - User Interface Design, Implementation and Evaluation (3.0 cr)
- CSCI 5125 - Collaborative and Social Computing (3.0 cr)
- CSCI 5302 - Analysis of Numerical Algorithms (3.0 cr)
- CSCI 5523 - Introduction to Data Mining (3.0 cr)
- CSCI 5561 - Computer Vision (3.0 cr)

-OR-

Human Computer Interaction

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 5115 and CSCI 5125. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

CSCI 5115 - User Interface Design, Implementation and Evaluation (3.0 cr)

CSCI 5125 - Collaborative and Social Computing (3.0 cr)

Human Computer Interaction Sublist

Take 2 or more course(s) from the following:

- CSCI 5117 - Developing the Interactive Web (3.0 cr)
- CSCI 5123 - Recommender Systems (3.0 cr)
- CSCI 5127W - Embodied Computing: Design & Prototyping [WI] (3.0 cr)
- CSCI 5609 - Visualization (3.0 cr)
- KIN 5001 - Foundations of Human Factors/Ergonomics (3.0 cr)

-OR-

Networks

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 4211 and CSCI 5221. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

CSCI 4211 - Introduction to Computer Networks (3.0 cr)

CSCI 5221 - Foundations of Advanced Networking (3.0 cr)

Networks Sublist

Take 2 or more course(s) from the following:

- CSCI 5103 - Operating Systems (3.0 cr)
- CSCI 5105 - Introduction to Distributed Systems (3.0 cr)
- CSCI 5231 *{Inactive}* (3.0 cr)
- CSCI 5271 - Introduction to Computer Security (3.0 cr)
- CSCI 5471 - Modern Cryptography (3.0 cr)
- EE 5505 - Wireless Communication (3.0 cr)
- INET 4011 - Networking I: Network Administration (4.0 cr)
- INET 4021 - Dev Ops I: Network Programming (4.0 cr)
- INET 4041 - Networking II: Emerging Technologies (4.0 cr)
- MATH 5251 - Error-Correcting Codes, Finite Fields, Algebraic Curves (4.0 cr)

-OR-

Security

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 4211 and CSCI 5271. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

CSCI 4211 - Introduction to Computer Networks (3.0 cr)

CSCI 5271 - Introduction to Computer Security (3.0 cr)

Security Sublist

Take 2 or more course(s) from the following:

- CSCI 5103 - Operating Systems (3.0 cr)
- CSCI 5471 - Modern Cryptography (3.0 cr)
- CSCI 5801 - Software Engineering I (3.0 cr)
- INET 4011 - Networking I: Network Administration (4.0 cr)
- MATH 5248 - Cryptology and Number Theory (4.0 cr)

-OR-

Software and Data Systems Development

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 4707 and CSCI 5801. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

CSCI 4707 - Practice of Database Systems (3.0 cr)

CSCI 5801 - Software Engineering I (3.0 cr)



Software and Data Systems Development Sublist

Take 2 or more course(s) from the following:

- CSCI 4131 - Internet Programming (3.0 cr)
- CSCI 4211 - Introduction to Computer Networks (3.0 cr)
- CSCI 5103 - Operating Systems (3.0 cr)
- CSCI 5106 - Programming Languages (3.0 cr)
- CSCI 5115 - User Interface Design, Implementation and Evaluation (3.0 cr)
- CSCI 5161 - Introduction to Compilers (3.0 cr)
- CSCI 5271 - Introduction to Computer Security (3.0 cr)
- CSCI 5708 - Architecture and Implementation of Database Management Systems (3.0 cr)
- CSCI 5802 - Software Engineering II (3.0 cr)
- INET 4061 - Data Science I: Fundamentals (4.0 cr)

-OR-

Software Engineering/Programming Languages

This track is 23 credits minimum, split into two parts. Take four classes from the course list below, including the three required courses: CSCI 4011, CSCI 5106, and CSCI 5801. The second part to complete a track is enough track electives to reach the 23 credit minimum.

This track's required courses meet the upper division math oriented.

CSCI 5106 - Programming Languages (3.0 cr)

CSCI 5801 - Software Engineering I (3.0 cr)

CSCI 4011 - Formal Languages and Automata Theory (4.0 cr)

SE/PL Sublist

Take 1 or more course(s) from the following:

- CSCI 5161 - Introduction to Compilers (3.0 cr)
- CSCI 5802 - Software Engineering II (3.0 cr)
- MATH 5165 - Mathematical Logic I (4.0 cr)

-OR-

Systems

A track is 23 credits minimum, split into three parts. Take four classes from the course list below, including the two required courses: CSCI 4211 and CSCI 5103. The second part is one math oriented requirement. The final part to complete a track is enough track electives to reach the 23 credit minimum.

CSCI 4211 - Introduction to Computer Networks (3.0 cr)

CSCI 5103 - Operating Systems (3.0 cr)

Systems Sublist

Take 2 or more course(s) from the following:

- CSCI 4131 - Internet Programming (3.0 cr)
- CSCI 5105 - Introduction to Distributed Systems (3.0 cr)
- CSCI 5143 - Real-Time and Embedded Systems (3.0 cr)
- CSCI 5161 - Introduction to Compilers (3.0 cr)
- CSCI 5221 - Foundations of Advanced Networking (3.0 cr)
- CSCI 5231 *{Inactive}*(3.0 cr)
- CSCI 5271 - Introduction to Computer Security (3.0 cr)
- CSCI 5551 - Introduction to Intelligent Robotic Systems (3.0 cr)

-OR-

Theory

This track is 23 credits minimum, split into two parts. Take four classes from the course list below, including the two required courses: CSCI 4011 and CSCI 5421. The second part to complete a track is enough track electives to reach the 23 credit minimum.

This track's required courses meet the upper division math oriented.

CSCI 4011 - Formal Languages and Automata Theory (4.0 cr)

CSCI 5421 - Advanced Algorithms and Data Structures (3.0 cr)

Theory Sublist

Take 2 or more course(s) from the following:

- CSCI 5403 *{Inactive}*(3.0 cr)
- CSCI 5451 - Introduction to Parallel Computing: Architectures, Algorithms, and Programming (3.0 cr)
- CSCI 5471 - Modern Cryptography (3.0 cr)
- CSCI 5481 - Computational Techniques for Genomics (3.0 cr)
- CSCI 5525 - Machine Learning: Analysis and Methods (3.0 cr)
- MATH 5165 - Mathematical Logic I (4.0 cr)
- MATH 5166 *{Inactive}*(4.0 cr)
- MATH 5707 - Graph Theory and Non-enumerative Combinatorics (4.0 cr)



- [MATH 5711](#) - Linear Programming and Combinatorial Optimization (4.0 cr)

-OR-

Custom Track

In rare instances, students may create their own track. Such tracks must be discussed with a CSci advisor. Custom tracks must be highly coherent, sufficiently advanced, in accordance with a computer science degree, and aligned with the student's goals. Students can choose their courses from the pre-approved track electives list. A custom track must still contain 23 credits minimum including an upper division math oriented requirement.