COLLEGE OF ENGINEERING
DEPARTMENT OF COMPUTER SCIENCE
BACHELOR OF SCIENCE IN COMPUTER SCIENCE
DATA-CENTRIC COMPUTING MAJOR
FOR STUDENTS ENTERING UNDER UG CATALOG 2022-2023
CREDITS REQUIRED FOR GRADUATION: 123

FALL SEMESTER FIRST YEAR	Credits	SPRING SEMESTER FIRST YEAR	Credits
CHEM 1035 General Chemistry *Pre: Eligible to enroll; Co: MATH 1025 or MATH 1225*	3	PHYS 2305 Found of Physics I w/lab *MATH 1225 or MATH 1226; Co: MATH 1226*	4
CHEM 1045 General Chemistry Lab *Co: CHEM 1035*	1		
ENGL 1105 First-Year Writing	3	ENGL 1106 First-Year Writing *Pre: ENGL 1105*	3
MATH 1225 Calculus of a Single Variable **(C-)** *Pre: Eligible to enroll*	4	MATH 1226 Calculus of a Single Variable *Pre: MATH 1225 (C-)*	4
ENGE 1215 Foundations of Engineering **(C-)**	2	ENGE 1216 Foundations of Engineering **(C-)** *Pre: ENGE 1215 (C-)*	2
Pathways	3	CS 1114[1] Intro to Software Design **(C)** —**OR**— CS 2064[1] Intermediate Programming in Python **(C)** *Pre: CS 1064*	3[F, S, SI, SII]
TOTAL	16	TOTAL	16

FALL SEMESTER SECOND YEAR	Credits	SPRING SEMESTER SECOND YEAR	Credits
MATH 2204[1] Intro Multivariable Calculus *Pre: MATH 1226* **or** CMDA 2005[1] Integrated Quantitative Sciences *Pre: MATH 1226; Co: MATH 2114*	3	Communications Elective	3
MATH 2534[1] Intro Discrete Math *Pre: CS 1114 (C) or CS 2064 (C) or ECE 1574 (C-) or ECE 1004 (Note: Math double majors take MATH 3034)*	3[F, S, SI]	MATH 2114[1] Introduction to Linear Algebra *Pre: MATH 1225 (B) or MATH 1226*	3
CS 2114 Software Design & Data Structures **(C)** *Pre: 1114 (C) or 2064 (C)*	3[F, S, SI, SII]	CS 2505[1] Intro to Computer Organization I **(C)** *Pre: 2114 (C); Co: MATH 2534 or MATH 3034*	3[F, S, SI]
CS 1944 Computer Science 1st Yr Sem *Pre: 1114 (C) or 2064 (C) or ECE 2514 (C)*	1[F, S]	Statistics Elective	3
Pathways	3	Pathways	3
Natural Science Elective	4		
TOTAL	17	TOTAL	15

FALL SEMESTER THIRD YEAR	Credits	SPRING SEMESTER THIRD YEAR	Credits
MATH 3134 Applied Combinatorics *Pre: (MATH 1206 or MATH 1226), (MATH 2534 or MATH 3034) (Note: Math double majors take MATH 3124)*	3	Pathways	3
CS 2506[1] Intro to Computer Organization II **(C)** *Pre: (2114 (C) or ECE 3514 (C)), (2505 (C) or ECE 2564 (C)), (MATH 2534 or MATH 3034)*	3[F, S]	CS 3214[1] Computer Systems *Pre: (2506 (C), 2114 (C)) or (ECE 2564 (C), ECE 3754 (C-))*	3[F, S]
CS 3114[2] Data Structures and Algorithms **(C)** *Pre: (2114 (C) or ECE 3514 (C)), (2505 (C) or ECE 2564 (C)), (MATH 2534 or MATH 3034)*	3[F, S, SI]	CS 3604[1] Professionalism in Computing *Pre: 1944, 2114 (C), (COMM 2004 or COMM 2014)*	3[F, S]
Professional Writing Elective	3	Data-Centric Computing Elective[2]	3
CMDA/STAT/CS 3654[2] Introductory Data Analytics & Visualization *Pre: 1114, (MATH 2204 or CMDA 2005), (STAT 3006 or STAT 4705 or STAT 4714 or CMDA 2006)*	3	Pathways	3
TOTAL	15		15

FALL SEMESTER FOURTH YEAR	Credits	SPRING SEMESTER FOURTH YEAR	Credits
Data-Centric Computing Elective[2]	3	CS 4944 Senior Seminar *Pre: 3604*	1[F, S]
Data-Centric Computing Elective[2]	3	CS 4XXX Data-Centric Computing Capstone[2]	3
CS 3314 Programming Languages & Theory *Pre: 3114 (C), (MATH 2534 or MATH 3034)*	3	Data-Centric Computing Elective[2]	3
CS Technical Elective	3	CS 3/4/5XXX Elective	3
Free Elective	3	Pathways	3
		Free Elective	1
TOTAL	15	TOTAL	14

General Information about Checksheet: Superscripted annotation after the course number [1] indicates core course for the degree, or [2] requirement specific to the major. Superscripted annotation [F,S,SI,SII] in Credits column indicates that a course is known to be offered in the terms shown. Course offerings are subject to change and the availability of sufficient resources. Students should confirm course offerings in advance with their department.

Pathways to General Education

Consult the pathways course table: https://www.pathways.prov.vt.edu/about/table.html. Pathways courses must be completed prior to graduation.

Pathways Concept	Column 1	(cr)	Column 2	(cr)
Pathways Concept 1: Discourse (6 hrs foundational, 3 hrs advanced)	*Foundational:* **ENGL 1105**	(3)	*Foundational:* **ENGL 1106**	(3)
	Advanced:			(3)
Pathways Concept 2: Critical Thinking in the Humanities (6 hrs)		(3)		(3)
Pathways Concept 3: Reasoning in the Social Sciences (6 hrs)		(3)		(3)
Pathways Concept 4: Reasoning in the Natural Sciences (6 hrs)	**CHEM 1035 + 1045**	(4)	**PHYS 2305**	(4)
Pathways Concept 5: Quantitative and Computational Thinking (11 hrs)	*Foundational:* **MATH 1225**	(4)	*Foundational:* **MATH 1226**	(4)
	Advanced: **CS 3114**			(3)
Pathways Concept 6: Critique and Practice in Design and Arts (7 hrs)	*Arts (6a):*			(3)
	Design: **ENGE 1215 + ENGE 1216**			(4)
Pathways Concept 7: Critical Analysis of Identity and Equity in the US (3 hrs)				(3)

Pathways Concept 7 can be double-counted with another core concept. In this case, additional free elective credits must be taken to maintain a minimum of 123 credits.

Additional Requirements and notes:

1. **CS Non-Technical Course Requirement**. B.S. in CS students must complete 30 credits of non-technical courses. All courses are approved as non-technical courses except those in the departments of Biological Sciences, Chemistry, Geosciences, Physics, Mathematics, and Statistics, and all departments in the College of Engineering, except for engineering courses satisfying Pathways 7. Also excluded are courses listed as CS technical electives.
2. **Independent Study/Undergraduate Research**. No more than a total of 6 credits of CS Independent Study (4974) and/or CS Undergraduate Research (4994) may be used to fulfill CS degree requirements. To take Independent Study (2974 or 4974), a minimum overall and in-major GPA of 2.5 is required. To take Undergraduate Research (4994), a minimum overall GPA of 2.5 and an in-major GPA of 3.0 is required. CS 4974 and 4994 also require completion of CS 3114 with a grade of **C** or better.
3. **Double Major Restriction**: students pursing a Major in Data-Centric Computing may not double major in the Major in Computational Modeling and Data Analytics or one of the major concentrations/options listed under the Bachelor of Science in Computational Modeling and Data Analytics.
4. See checksheet page 3 for definitions of each elective category and a list of approved courses for each.

Change of Major Requirements: Please see http://www.enge.vt.edu/em

Foreign Language Requirements: Students must have had 2 years of a foreign language in high school or one year at the college level (6 credit hours) of the same language. College-level credits used to meet this requirement do not count towards the degree.

Satisfactory Progress Towards Degree: University Policy 91 outlines university-wide minimum criteria to determine if students are making satisfactory progress towards the completion of their degrees. The CS Department fully supports this policy. Specific expectations for satisfactory progress for Computer Science majors are as follows:

- Each student must meet the minimum University-wide criteria as described in Policy 91 and summarized in the Undergraduate Catalog (http://www.undergradcatalog.registrar.vt.edu/1920/academic-policies.html#22).
- Be registered in at least one 3-credit course required in the major during each on-campus semester of the regular academic year.
- Maintain an in-major GPA of 2.0 or better (calculated using all classes with a CS designator).
- Not take any CS course required in the major more than twice, including attempts ending in course withdrawal.
- Not repeat more than 3 CS courses required in the major, including attempts ending in course withdrawal.

Statement of Prerequisites: Pre-requisites for each course are listed after the course title. The (letter grade) notation, such as (C), indicates the minimum grade students must earn in the pre-requisite course. There are no hidden pre-requisites in the program of study. Prerequisites may change from what is indicated. Be sure to consult the University Catalog or check with your advisor for the most current pre-requisites.

Graduation Requirements: To qualify for a B.S. degree in CS, a student must:

- Earn a "C" (2.0) or better in CS 1114, CS 2104, CS 2114, CS 2505, CS 2506 and CS 3114.
- Complete at least 123 semester credit hours with a minimum overall GPA of 2.00 and a minimum in-major GPA of 2.00 (the in-major GPA is calculated using all classes with a CS designator).

Data-Centric Computing Electives

Note: Some elective courses may include prerequisites not required by this checksheet. It is the student's responsibility to be aware of prerequisites and to ensure that all prerequisites are completed prior to enrolling in the chosen course. Some courses may be restricted to majors other than CS in some semesters. Check the Undergraduate Course Catalog and consult with an academic advisor to confirm your eligibility for specific electives. Actual course offerings are subject to availability of sufficient resources, including faculty availability and student demand.

1. **Natural Science Elective**. A minimum of 12 hours of natural science is required. Of those hours, 8 hours must be in a sequence. In addition to the required CHEM 1035/45 and PHYS 2305, this requirement may be satisfied by taking (a) CHEM 1036/46), (b) PHYS 2306, or (c) an eight hour sequence in Biology: BIOL 1105-6 & 1115-6.

2. **Communications Elective**. Students must take one of the following:

   COMM 2004   Public Speaking *Pre: Completion of 30 hours*

   COMM 2014   Speech Communication

   Note: COMM 2004 can be used to satisfy Pathways 1A. Students who do not take COMM 2004 as their communications elective will need to satisfy Pathways 1A through a suitable professional writing elective or free elective.

3. **Professional Writing Elective**. Students must take one of the following:

   ENGL 3764   Technical Writing *Pre: ENGL 1106 or ENGL 1204H or COMM 1016*

   ENGL 3804   Technical Editing and Style *Pre: ENGL 1106 or ENGL 1204H or COMM 1016*

   ENGL 3814   Creating User Documentation *Pre: ENGL 1106 or ENGL 1204H or COMM 1016*

   ENGL 3824   Visual Rhetoric and Document Design *Pre: ENGL 1106 or COMM 1016*

   ENGL 3834   Intercultural Issues in Professional Writing *Pre: ENGL 1106 or ENGL 1204H or COMM 1016*

   ENGL 3844   Writing and Digital Media *Pre: ENGL 1106 or ENGL 1204H or COMM 1016*

   ENGL 4824   Science Writing *Pre: ENGL 1106 or ENGL 1204H or COMM 1016*

   Note: ENGL 3764 can be used to satisfy Pathways 1A. Students who do not take ENGL 3764 as their communications elective will need to satisfy Pathways 1A through a suitable communications elective or free elective.

4. **Statistics Elective**. Students must take one of the following:

   STAT 4705   Probability and Statistics for Engineers *Pre: MATH 2224 or MATH 2204 or MATH 2204H or MATH 2406H*

   STAT 4105   Theoretical Statistics *Pre: MATH 2224 or MATH 2204 or MATH 2204H or MATH 2406H*

   CMDA 2006 Integrated Quantitative Sciences *Pre: CMDA 2005, (MATH 2114 or MATH 2114H)*

5. **CS 3/4/5XXXX Elective**. Any 3-credit CS 3/4/5000-level course not otherwise used to fulfill a Data-Centric Computing requirement can be used as a CS 3/4/5XXX elective, including both Independent Study (CS 4974) and Undergraduate Research (CS 4994), except for the following: CS 5040, CS 5044, CS 5045, 5046, 5644, 5664, 5904, 5944, 5974, 5994.

6. **Data-Centric Computing Elective**. Students must take four of the following:

BIT 4604	Data Governance, Privacy and Ethics	*Pre: BIT 2405 or CMDA 2014 or CS 1114 or CS 1054 or CS 1064*
BIT 4624	Cybersecurity Analytics	*Pre: BIT 4614*
CMDA/STAT/CS 4654	Intermediate Data Analytics and Machine Learning	*Pre: (STAT 3654 or CMDA 3654 or CS 3654), (STAT 3104 or STAT 4705 or STAT 4714 or CMDA 2006)*
CS 3414 (MATH 3414)	Numerical Methods	*Pre: (1044 or 1705 or 1114 or 1124), (MATH 2214 or MATH 2214H), (MATH 2224 or MATH 22 24H or MATH 2204 or MATH 2204H)*
CS 4414 (MATH 4414)	Issues in Scientific Computing	*Pre: (MATH 2214 or MATH 2214H or MATH 2406H or CMDA 2006), MATH 3214, (CS 2114 or MAT H 3054)*
CS 4604	Introduction to Data Base Management Systems	*Pre: 3114*
CS 4804	Introduction to Artificial Intelligence	*Pre: 3114*
CS 4824/ECE 4424	Machine Learning	*Pre: ECE 2574 or CS 2114, (STAT 4604 or STAT 4705 or STAT 4714)*
STAT 3504	Nonparametric Statistics	*Pre: STAT 3006 or STAT 3616 or STAT 4106 or STAT 4604 or STAT 4706 or CMDA 2006*
STAT 4214	Methods of Regression Analysis	*Pre: STAT 3006 or STAT 3616 or STAT 4106 or STAT 4706 or STAT 5606 or STAT 5616 or CMDA 2006*
STAT 4444	Applied Bayesian Statistics	*Pre: (MATH 2224 or MATH 2224H or MATH 2204 or MATH 2204H or MATH 2406H or CMDA 2005), (STAT 3104 or STAT 4105 or STAT 4705 or CMDA 2006), (STAT 3006 or STAT 3616 or STAT 4706 or CMDA 2006)*

7. **Data-Centric Computing Capstone Requirement.** Students must complete one 4000-level CS capstone course in the data-centric computing area. Students may choose the course listed here, or other 4/5000-level CS courses that have received prior approval as fulfilling the data-centric computing capstone requirement.

CS 4624	Multimedia, Hypertext and Information Access	*Pre: 3114*
CS 4664	Data-Centric Computing Capstone	*Pre: 3114 (C), 3654*

8. **CS Technical Elective.** Data-Centric Computing majors must satisfy a 3 credit hour technical elective requirement by taking one of:

1. Any 3-credit CS 3/4/5000-level course meeting the CS 3/4/5XXX elective requirements under (5) above.

2. Any Data-Centric Computing Elective listed under (6) above that is not otherwise used to fulfill a Data-Centric Computing requirement.

3. Any approved 3000- or 4000-level course in another discipline that has significant technical content relevant to the science or application of computer science can be used as a technical elective.

   a. Requests to have a non-CS course approved as a technical elective are made by submitting a course syllabus to your CS advisor for review prior to enrolling in the course. This includes non-CS Independent Study (4974) and Undergraduate Research (4994) courses.

   b. Below is a listing of non-CS courses that are approved as technical electives.

Computer Science Technical Elective Courses

ACIS/BIT 4554	Networks & Telecommunications in Business	*(3H, 3C) Pre: ACIS 3504 or BIT 3424*
AOE 4434	Introduction to Computational Fluid Dynamics	*(3H, 3C) Pre: MATH 2214*
ART 3704	Topics in Computer Animation	*(3H, 3C) Pre: ART 2704*
BIT 4424	Business Information Visualization & Analytics	*(3H, 3C) Pre: BIT 2406*
BIT 4434	Computer Simulation in Business	*(3H, 3C) Pre: BIT 3414*
BIT 4444	Web-based Decision Support Systems	*(3H, 3C) Pre: BIT 3444*
BIT 4514	Database Technology for Business	*(3H, 3C) Pre: BIT 3424, BIT 4524*
BIT 4544	Advanced Methods in Business Analytics	*(3H, 3C) Pre: BIT 3444 or ACIS 2504*
BIT 4604	Data Governance, Privacy and Ethics	*(3H, 3C) Pre: BIT 2405 or CMDA 2014 or CS 1114 or CS 1054 or CS 1064*
BIT 4614	Information Security	*(3H, 3C) Pre: BIT 4554 or ACIS 4554*
BIT 4624	Cybersecurity Analytics	*(3H, 3C) Pre: BIT 4614*
CMDA 3606	Mathematical Modeling: Methods and Tools II	
COMM 4374	New Communications Technology	*(3H, 3C) Pre: COMM 2084 or COMM 4014*
ECE 3544	Digital Design I	*(3H, 3C) Pre: ECE 2504*
ECE 3574	Applied Software Design	*(3H, 3C) Pre: ECE 2574*
ECE 4524	Artificial Intelligence and Engineering Applications	*(3H, 3C) Pre: ECE 2574, STAT 4714*
ECE 4550	Real Time Systems	*(3H, 3C) Pre: ECE 4534 or CS 3214*
ECE 4560	Computer and Network Security Fundamentals	*(3H, 3C) Pre: CS 3214 or ECE 2504*
ECE 4564	Network Application Design	*(3H, 3C) Pre: ECE 2504, ECE 2574*
ECE 4580	Digital Image Processing	*(3H, 3C)*
ECE 4704	Principles of Robotic Systems	*(3H, 3C) Pre: (ME 3514, STAT 3704) or ECE 2704*
GEOG/GEOS 4084	Modeling with GIS	*(3H, 3C) Pre: GEOG 2084*
GEOG 4314	Analysis in GIS	*(3H, 3C) Pre: GEOG 4084*
GEOG 4324	Algorithms in GIS	*(3H, 3C) Pre: GEOG 4084, CS 1044*
MATH 4175	Cryptography I	*(3H, 3C) Pre: MATH 3034 or MATH 3124 or MATH 3134 or MATH 3144 or MATH 3224 or MATH 4134*
MATH 4176	Cryptography II	*(3H, 3C) Pre: MATH 4175 or (MATH 3034, MATH 3124) or (MATH 3034, MATH 3134) or (MATH 3034, MATH 3144) or (MATH 3034, MATH 3224) or (MATH 3034, MATH 4134) or (MATH 3124, MATH 3134) or (MATH 3124, MATH 3144) or (MATH 3124, MATH 3224) or (MATH 3124, MATH 4134) or (MATH 3134, MATH 3144) or (MATH 3134, MATH 3224) or (MATH 3134, MATH 4134) or (MATH 3144, MATH 3224) or (MATH 3144, MATH 4134) or (MATH 3224, MATH 4134)*
MATH 4445	Introduction to Numerical Analysis	*(3H, 3C) Pre: MATH 2406H or (CMDA 2005, CMDA 2006) or (MATH 2214 or MATH 2214H), (MATH 2224 or MATH 2224H) or (MATH 2204 or MATH 2204H)*
MATH 4454	Applied Mathematical Modeling	*(3H, 3C) Pre: MATH 3214*
ME 4524	Robotics and Automation	*(3H, 3C) Pre: ME 2004, ME3524, ME 3534; Co: ME 4584*
MUS 3064	Digital Sound Manipulation	*(3H, 3C)*
MUS 3065	Computer Music & Multimedia I	*(3H, 3C) Pre: MUS 2054*
MUS 3066	Computer Music & Multimedia II	*(3H, 3C) Pre: MUS 2054, MUS 3065*
PHYS 4755	Intro to Computational Physics	*(3H, 3C) Pre: PHYS 2306, CS 1044*