

# COMMUNITY COLLEGE CORNER

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## Creating 2+2 Education Pathways in Cybersecurity

*It is a well-documented fact that there are not enough cybersecurity students in the post-secondary pipeline to defend and protect our nation's critical information networks.*

Readers may recall my September 2013 column [1], "Multifarious Initiatives in Cybersecurity Education," where the discussion centered primarily on associate in applied science (A.A.S.) degrees that prepare two-year college graduates to enter the cybersecurity workforce immediately upon graduation. The focus of this column is on associate in science (A.S.) degrees in cybersecurity that are designed to transfer into baccalaureate programs of study, creating 2+2 education pathways.

The first A.S. degree program in the spotlight is *Secure Software Development* from the National CyberWatch Center, sponsored by the National Science Foundation (NSF) with a \$5 million grant award under the Advanced Technological Education (ATE) program. "The National CyberWatch Center is a consortium of higher education institutions, public and private schools, businesses, and government agencies focused on collaborative efforts to advance cybersecurity education and strengthen the national cybersecurity workforce." This national center plays many roles in the national cybersecurity landscape. A few of these roles include being an advoca-



tor and builder: "advocate for the role of community colleges in cybersecurity education and workforce development; build novel solutions for our nation's cybersecurity education and workforce development challenge." [4] As a builder of novel education solutions, the National CyberWatch Center has put forth the following transfer degree (Table 1) and technical certificate (Table 2) models in *Secure Software Development* for other community colleges to implement as is or modify as dictated by local transfer needs. These templates follow a typical

15-week semester, with the assumption that adjustments will be made for trimester, quarter and summer sessions, as well as international programs of study.

The second cybersecurity A.S. degree program exemplar is offered by Union County College (my comprehensive community college) located in the northeast region of New Jersey. The *Cybersecurity Transfer* degree is a mathematics program option consisting of a balance between mathematics and computer science courses. With assistance from a National Science Foundation award, this curriculum was designed in conjunction with Stevens Institute of Technology, a private research university in Hoboken,

New Jersey, with a satellite location in Washington D.C. All 63-credits of this associate-degree program also transfer to Pace University, a private university with multiple campuses in the New York metropolitan. Table 3 delineates the course sequencing that comprises this cybersecurity transfer degree, including 31-credits of general education requirements. The cyber ethics class is strongly recommended for the humanities elective, and either an introductory government, sociology or psychology course for the social science elective [5].

Creating 2+2 Education Pathways in Cybersecurity

TABLE 1: 60-CREDIT A.S. DEGREE IN SECURE SOFTWARE DEVELOPMENT NATIONAL CYBERWATCH CENTER

First Term	Second Term
<b>Introduction to Secure Programming</b> (3 credits)	<b>Computer Science I</b> (4 credits)
<b>Security Fundamentals</b> (3 credits)	Social and Behavioral Sciences* (3 credits)
Calculus I* (4 credits)	Discrete Mathematics/Structures (4 credits)
College Composition I* (3 credits)	College Composition II* (3 credits)
Transitioning to College** (1 credit)	Arts and Humanities* (3 Credits )
<b>Total Credits = 14</b>	<b>Total Credits = 17</b>
Third Term	Fourth Term
<b>Computer Science II</b> (4 credits)	<b>Computing Elective</b> (3 credits)
<b>Secure Coding</b> (4 credits)	Social and Behavioral Sciences* (3 credits)
Fundamentals of Speech* (3 credits)	Probability & Statistics <b>OR</b> Linear Algebra (4 credits)
Biological and Physical Sciences w/ Lab** (4 credits)	Biological and Physical Sciences w/ Lab** (4 credits)
<b>Total Credits = 15</b>	<b>Total Credits = 14</b>

\*Fulfills general education core curriculum  
 \*\*Required of students attending college for the first time

TABLE 2: 18-CREDIT TECHNICAL CERTIFICATE IN SECURE SOFTWARE DEVELOPMENT NATIONAL CYBERWATCH CENTER

First Term	Second Term	Third Term
<b>Security Fundamentals</b> (3 credits)	<b>Computer Science I</b> (4 credits)	<b>Computer Science II</b> (4 credits)
<b>Introduction to Secure Programming</b> (3 credits)	<b>Secure Coding</b> (4 credits)	
<b>Total Credits = 6</b>	<b>Total Credits = 8</b>	<b>Total Credits = 4</b>

TABLE 3: 63-CREDIT CYBERSECURITY TRANSFER-MATHEMATICS DEGREE OPTION UNION COUNTY COLLEGE

First Term	Second Term
<b>CSC 100: Computer Programming Fundamentals</b> (3 credits)	<b>CSC 101: Computer Algorithms</b> (3 credits)
<b>MAT 171: Unified Calculus I*</b> (4 credits)	<b>MAT 172: Unified Calculus II*</b> (4 credits)
General Physics I w/ Lab* (4 credits)	General Physics II w/ Lab* (4 credits)
College Composition I* (3 credits)	College Composition II* (3 credits)
Social Science Elective* (3 credit)	HIS 101: Western Civilization I* (3 Credits )
<b>Total Credits = 17</b>	<b>Total Credits = 17</b>
Third Term	Fourth Term
<b>CSC 102: Data Structures</b> (3 credits)	<b>CSC 222: Organization, Operation &amp; Assembly Language</b> (3 credits)
<b>CIS 201: Principles of Information Security</b> (3 credits)	<b>MAT 270: Probability and Statistics OR MAT 272: Differential Equations**</b> (4 credits)
<b>CSC 226: Intro. to Operating Systems</b> (3 credits)	<b>MAT 267: Discrete Mathematics (3 credits)</b>
<b>MAT 271: Unified Calculus III</b> (4 credits)	Humanities Elective* (3 credits)
<b>MAT 265: Linear Algebra</b> (3 credits)	
<b>Total Credits = 16</b>	<b>Total Credits = 13</b>

\*Fulfills general education core curriculum  
 \*\*Depends upon transferring institution and articulation agreement



The third A.S. program exemplar is the *Computer Science Transfer-Secure Software Development Concentration* from Middlesex Community College with campuses in Bedford and Lowell, Massachusetts. This A.S. degree provides the technical and general education courses necessary for transfer into baccalaureate programs in computer science, including the University of Massachusetts Lowell. It also includes general education core curriculum common to all degree programs offered by Middlesex Community College. This program is consistent with the framework for cybersecurity education developed jointly by the National Security Agency (NSA) and the Department of Homeland Security (DHS). Table 4 lists both the program and general education courses for this A.S. cybersecurity degree [3].

The last highlighted exemplar is a technical certificate in software assurance, *Assured Software Engineering*, from the Software Engineering Institute, Carnegie Mellon University. Software Assurance, as defined by Dr. Mead, et al., is the “Application of technologies and processes to achieve a required level of confidence that software systems and services function in the intended manner, are free from accidental or intentional vulnerabilities, provide security capabilities appropriate to the threat environment, and recover from intrusions and failures.” [2] This certificate program is intended for graduates already holding a bachelor’s degree in a closely-related STEM discipline who wish to enter into the field of secure software development. Table 5 shows the course sequence for this technical certification.

In summary, computing systems that run our governments, schools/colleges, and businesses are constantly under cyber attack and siege. As I noted at the outset,

**TABLE 4: 60-CREDIT COMPUTER SCIENCE TRANSFER-SECURE SOFTWARE DEVELOPMENT CONCENTRATION MIDDLESEX COMMUNITY COLLEGE**

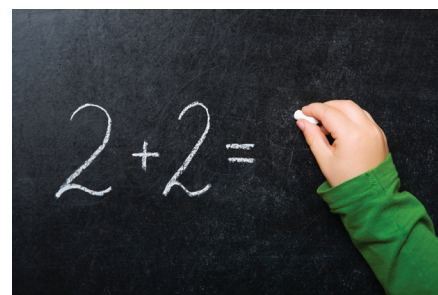
First Term	Second Term
<b>CSC 151: Programming I</b> (4 credits)	<b>CSC 252: Programming II</b> (4 credits)
<b>CSC 188: Introduction to Computer Security</b> (3 credits)	<b>CSC 156: Operating Systems Basics and Security</b> (3 credits)
ENG 101: College Composition I* (3 credits)	ENG 102: College Composition II* (3 credits)
Social Science Elective* (3 credits)	Behavioral Science Elective* (3 credits)
Laboratory Science Elective* (PHY 171, CHE 151, BIO 131) (4 credits)	Laboratory Science Elective* (PHY 172, CHE 152, BIO 132) (4 Credits)
<b>Total Credits = 17</b>	<b>Total Credits = 17</b>
Third Term	Fourth Term
<b>CSC 253: Programming III</b> (4 credits)	<b>CSC 257: Data Structures</b> (3 credits)
<b>CSC 289: Secure Programming</b> (3 credits)	<b>CSC 201: Computer Organization/ Assembly Language</b> (3 credits)
Humanities Elective* (3 credits)	<b>CSC 290: Information Assurance</b> (3 credits)
MAT 290: Calculus I for Engineering and Science* (4 credits)	MAT 291: Calculus II for Engineering and Science (4 credits)
<b>Total Credits = 13</b>	<b>Total Credits = 13</b>

\*Fulfills general education core curriculum

**TABLE 5: 30-CREDIT TECHNICAL CERTIFICATE IN ASSURED SOFTWARE ENGINEERING SOFTWARE ENGINEERING INSTITUTE, CARNEGIE MELLON UNIVERSITY**

First Term	Second Term
<b>Computer Science I</b> (4 credits)	<b>Computer Science II</b> (4 credits)
<b>Calculus I</b> (4 credits)	<b>Discrete Structures</b> (3 credits)
<b>Total Credits = 8</b>	<b>Total Credits = 8</b>
Third Term	Fourth Term
<b>Computer Science III</b> (4 credits)	<b>Secure Coding</b> (4 credits)
<b>Introduction to Computer Security</b> (3 credits)	<b>Assured Software Engineering</b> (3 credits)
<b>Total Credits = 7</b>	<b>Total Credits = 7</b>

The cyber ethics class is strongly recommended for the humanities elective, and either an introductory government, sociology, or psychology course for the social science elective.



it is a well-documented fact that there are not enough cybersecurity students in the post-secondary pipeline to defend and protect our nation's critical information networks. I urge all community colleges and universities to partner together to develop cybersecurity transfer programs of study in each of your geographic regions. The transfer program exemplars in this column should aid in paving the way for the creation of more 2+2 education pathways in cybersecurity. **IR**

#### References

- [1] Hawthorne, E. K. "Multifarious Initiatives in Cybersecurity Education," *ACM Inroads*, 4, 3 (2013): 46-47; DOI: 10.1145/2505990.2505999
- [2] Mead, M., Hawthorne, E., and Ardis, M., "Software Assurance Curriculum Project Volume IV: Community College Education," Technical Report CMU/SEI-2011-TR-017, 2011. (Pittsburgh, PA: Software Engineering Institute, Carnegie Mellon University, 2011); <http://resources.sei.cmu.edu/library/asset-view.cfm?AssetID=10009>. Accessed 2015 February 9.
- [3] Middlesex Community College, Computer Science Transfer-Secure Software Development Concentration; [http://catalog.middlesex.mass.edu/preview\\_program.php?catoid=16&pooid=2012&returnto=1372](http://catalog.middlesex.mass.edu/preview_program.php?catoid=16&pooid=2012&returnto=1372). Accessed 2015 February 9.
- [4] The National CyberWatch Center; [www.nationalcyberwatch.org](http://www.nationalcyberwatch.org). Accessed 2015 February 9.
- [5] Union County College, Cybersecurity A.S. - Mathematics Program Degree Option; <http://faculty.ucc.edu/committee-curriculum/Proposals%202013-2014/CybersecurityAS.pdf>. Accessed 2015 February 9.



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