RESOURCE GUIDE REV. 2

A GUIDE FOR MAPPING COURSES TO KNOWLEDGE UNITS (KUs)

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I. Introduction

To support institutions of higher education and research in information assurance, the National Security Agency and the Department of Homeland Security jointly sponsor the National Centers of Academic Excellence in Information Assurance/Cyber Defense (IA/CD). The goal of the CAE IA/CD program is to reduce vulnerability in our national information infrastructure by promoting higher education and research in Information Assurance/Cyber Defense (IA/CD) and to produce a growing number of professionals with expertise in IA/CD disciplines. All regionally accredited two-year, four-year and graduate level institutions in the United States (US) can apply for designation as a CAE IA/CD.

The CAE designation is an institutional designation; therefore, the benefits extend beyond the information assurance/cyber defense program of a school to the entire institution. Current CAE institutions report benefits that include national recognition, strong partnerships, external funding, and grant opportunities.

The CAE IA/CD application is online, but information needs to be collected and organized before the applicant sits down at the computer. The NSA has produced numerous guides and documents to facilitate the collection and organization process. The National CyberWatch Center, the Center for Systems Security and Information Assurance, and CyberWatch West also offer help including example curricula, mapping assistance, and examples of the CAE application.

At the heart of the application are the Knowledge Units (KUs). The KU are mandatory topics and associated objectives that must be included in an institution's degree or certificate program. The application process requires that the applicant provide evidence that they address each topic and objective of the required KUs. This evidence is provided through a process that is called mapping.

This guide provides detailed instructions for collecting and organizing program artifacts into a format which facilitates entering an institution's documentation into the online NIETP database tool. It also includes a walkthrough using the tool.

The CAE Program Office provides several pdf documents directly relevant to the application process for both two-year and four-year institutions. The list below can be found at and accessed/downloaded from https://www.iad.gov/NIETP/index.cfm.

- CAE CD Program Guidance - 2018
- CAE CD 2Yr Criteria - 2018
- CAE CDE Criteria - 2018
- CAE CDE/CAE2Y New Applicant Checklist - 2018
- CAE-CD Knowledge Units
- CAE-CD Focus Areas
- CAE CD Research Criteria (CAE-R) - 2018
II. Application for CAE Designation

The CAE designation application process consists of two components: mapping program curriculum to Knowledge Units (KUs), and providing evidence that the institution satisfies a set of criteria qualifying it to be considered academically excellent. This document addresses only the mapping component. The mapping process involves matching the instructional and experiential components of college level courses to the required KUs. This section offers a structured process for gathering data, laying out a mapping, and entering the mapping into the online NIETP database.

Knowledge Units (KUs) – What are They?

KUs are tightly targeted technology areas composed of a set of topics to be covered and expected student outcomes and masteries. They are the fundamental building blocks upon which the CAE in IA/CD rests. Although nearly 70 KUs are defined, fewer than two dozen need be referenced by four-year institutions and less than a dozen by community colleges to meet minimum mapping requirements for their respective CAE designations. The full set of KUs falls into three categories: 1 – Two-Year Institutions, 2 – Four-Year Institutions, and 3 - Optional Knowledge Units.

1. Two-Year Institutions

Specifically, a fixed set of eleven Core KUs make up the foundation of all mappings. Community colleges and other two-year institutions must map to all eleven of them (shown in Table 1).

1. Basic Data Analysis
2. Basic Scripting or Introductory Programming
3. Cyber Defense
4. Cyber Threats
5. Fundamental Security Design Principles
6. IA Fundamentals
7. Intro to Cryptography
8. IT Systems Components
9. Networking Concepts
10. Policy, Legal, Ethics, and Compliance
11. System Administration

Table 1: Core 2Y Knowledge Units
2. Four-Year Institutions

Four-year institutions must map to the same eleven Core KUs required of two-year institutions and an additional prescribed set of six, plus five more optional KUs that may be chosen from a set of more than four dozen. Thus, four-year institutions are required to map their courses to 22 KUs as indicated in Table 2.

| 1.     | Basic Data Analysis          |
| 2.     | Basic Scripting or Introductory Programming |
| 3.     | Cyber Defense                |
| 4.     | Cyber Threats                |
| 5.     | Fundamental Security Design Principles |
| 6.     | IA Fundamentals              |
| 7.     | Intro to Cryptography        |
| 8.     | IT Systems Components        |
| 9.     | Policy, Legal, Ethics, and Compliance |
| 10.    | Networking Concepts          |
| 11.    | System Administration        |
| 12.    | Database Management Systems  |
| 13.    | Network Defense              |
| 15.    | Operating Systems Concepts   |
| 16.    | Probability and Statistics   |
| 17.    | Programming                 |
| +5 Optional KUs (See Table 3) |

Table 2 – Core 4Y Knowledge Units
3. Optional Knowledge Units

The Optional KUs referenced at the bottom of Table 2 are both required and discretionary. In other words, an institution must select five, but they may be any combination of five from the list of 51 shown in Table 3, **Optional Knowledge Units List**.

| 1. | Advanced Cryptography | 26. | Industrial Control Systems |
| 2. | Advanced Network Technology & Protocols | 27. | Intro to Theory of Computation |
| 4. | Analog Telecommunications | 29. | Life-Cycle Security |
| 6. | Cybersecurity Planning | 31. | Mobile Technologies |
| 7. | Data Administration | 32. | Network Security Administration |
| 8. | Data Structures | 33. | Operating Systems Hardening |
| 10. | Digital Communications | 35. | Overview of Cyber Operations |
| 11. | Digital Forensics | 36. | Penetration Testing |
| 12. | Device Forensics | 37. | QA/Functional Testing |
| 13. | Host Forensics | 38. | RF Principles |
| 17. | Forensic Accounting | 42. | Software Assurance |
| 18. | Formal Methods | 43. | Software Reverse Engineering |
| 19. | Fraud Prevention & Management | 44. | Software Security Analysis |
| 20. | Hardware Reverse Engineering | 45. | Supply Chain Security |
| 22. | IA Architectures | 47. | Systems Certification & Accreditation |
| 23. | IA Compliance | 48. | Systems Security Engineering |
| 24. | IA Standards | 49. | Virtualization Technologies |
| 25. | Independent/Directed Study/Research | 50. | Vulnerability Analysis |

Table 3 – Optional Knowledge Units List
Focus Areas

In addition to the required mappings discussed above, an institution may differentiate itself from others by offering one or more Focus Areas (FA). As of this writing, NSA/DHS has defined 17 FAs. The purpose of an FA is to combine a closely related set of KUs that addresses a defined cybersecurity specialty. FAs are built by adding certain combinations of KUs from the Optional Knowledge Unit (Table 3) to the core CAE KUs. A few examples of designated FAs are: Cyber Investigations, Data Management Systems Security, Data Security Analysis, Digital Forensics, etc. A list of all FAs and the specific KU combinations required for each FA can be found at https://www.iad.gov/NIETP/documents/Requirements/CAE-CD_Focus_Areas.pdf. All CAEs, two- and four-year institutions, have the option to apply for one or more Focus Area (FA) designations.

To receive a FA designation in a specialty area an institution must:

- Map the institution's curriculum to all the KUs required in the FA,
- Demonstrate that a student can reasonably complete the necessary course of study to include all KUs identified in the FA, and
- Provide certificates of accomplishment to students who complete the FA course of study. The certificates must clearly identify the specific FA achieved.

Once an institution has decided to apply for a CAE designation, the next step is to review the preceding tables for the level of recognition it wants to obtain. To recap, community colleges need only comply with Table 1. Four-year institutions must comply fully with Table 2 and at least five KUs selected from Table 3.

Three Phases of Mapping

This document breaks the mapping process into three phases:

1. Data Gathering – select courses, syllabi, detailed course outlines, and textbook identification that cover KU topics and outcomes.
2. Course Data Entry – enter data collected in phase 1 into the database.
3. Formal Mapping of Courses to KUs – match or map course elements to KUs.

The first phase is performed offline, the other two, online. The remainder of this document discusses these phases.
Phase 1 – Data Gathering

Resources

Three resources are required to perform mappings:

1. All necessary CAE background materials and a formatted spreadsheet containing all the KUs: these can be downloaded from the National IA Education & Training Programs site at https://www.iad.gov/NIETP/index.cfm
2. Institution’s subject matter experts: professors who teach courses pertaining to the KUs.
3. Course supporting materials that map to the KUs’ Topics and Outcomes. Detailed course outlines that include references to KU mapping topics are an excellent resource for this part. Lab exercises, handouts, videos, team projects, etc. are also valuable. For Outcomes evaluation, examples of graded materials such as written tests, homework assignments, after chapter questions, and student presentations that test student mastery of topic material are good references.

Getting Started

NSA/DHS has developed and made available a spreadsheet titled, CAE KU Mapping Matrix, to facilitate an institution’s data gathering in support of mapping. (A link to this spreadsheet can be found at https://www.iad.gov/NIETP/index.cfm.) This is an especially useful tool. It consists of a main sheet (Fig. 1) displaying the hot-linked names of all Core and Mandatory KUs. The KUs are color coded and grouped into two-year, four-year, and optional categories.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>All links below take you to the datasheet for that KU.</td>
<td>Optional Knowledge Units</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Core 2Y Knowledge Units</td>
<td>Advanced Cryptography</td>
<td>Hardware Reverse Engineering</td>
<td>Secure Programming Practices</td>
<td></td>
</tr>
<tr>
<td>Basic Data Analysis</td>
<td>Basic Scripting</td>
<td>Advanced Network Technology and Protocols</td>
<td>Hardware/Firmware Security</td>
<td>Security Program Management</td>
</tr>
<tr>
<td>Cyber Defense</td>
<td>Algorithms</td>
<td>IA Architecture</td>
<td>Security Risk Analysis</td>
<td></td>
</tr>
<tr>
<td>Cyber Threats</td>
<td>Analog Telecommunications</td>
<td>IA Compliance</td>
<td>Software Assurance</td>
<td></td>
</tr>
<tr>
<td>Fundamental Security Design Principles</td>
<td>Cloud Computing</td>
<td>IA Standards</td>
<td>Software Reverse Engineering</td>
<td></td>
</tr>
<tr>
<td>Information Assurance Fundamentals</td>
<td>Cybersecurity Planning and Management</td>
<td>Independent/Directed Study/Research</td>
<td>Software Security Analysis</td>
<td></td>
</tr>
<tr>
<td>Introduction to Cryptography</td>
<td>Data Administration</td>
<td>Industrial Control Systems</td>
<td>Supply Chain Security</td>
<td></td>
</tr>
<tr>
<td>Information Technology System Components</td>
<td>Data Structures</td>
<td>Intro to Theory of Computation</td>
<td>Systems Programming</td>
<td></td>
</tr>
<tr>
<td>Networking Concepts</td>
<td>Database Management Systems</td>
<td>Intrusion Detection</td>
<td>Systems Certification and Accreditation</td>
<td></td>
</tr>
<tr>
<td>Policy, Legal, Ethics and Compliance</td>
<td>Digital Communications</td>
<td>Life-Cycle Security</td>
<td>Systems Security Engineering</td>
<td></td>
</tr>
<tr>
<td>Systems Administration</td>
<td>Digital Forensics</td>
<td>Low Level Programming</td>
<td>Virtualization Technologies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Device Forensics</td>
<td>Mobile Technologies</td>
<td>Vulnerability Analysis</td>
<td></td>
</tr>
<tr>
<td>Core 4Y Knowledge Units</td>
<td>Host Forensics</td>
<td>Network Security Administration</td>
<td>Wireless Sensor Networks</td>
<td></td>
</tr>
<tr>
<td>Databases</td>
<td>Media Forensics</td>
<td>Operating Systems Hardening</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network Defense</td>
<td>Network Forensics</td>
<td>Operating Systems Theory</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Network Technology and Protocols</td>
<td>Embedded Systems</td>
<td>Overview of Cyber Operations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating System Concepts</td>
<td>Forensic Accounting</td>
<td>Penetration Testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Probability and Statistics</td>
<td>Formal Methods</td>
<td>QA / Functional Testing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Programming</td>
<td>Fraud Prevention and Management</td>
<td>RF Principles</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1 Main Sheet - 2014 CAE KU Mapping Matrix

A good starting point for two- and four-year institutions is for a panel of content experts, i.e., professors and instructors of the courses, to review all mandatory and optional (if any) KUs. Before mapping begins, institutions should identify which Optional KUs they wish to map.
To make this initial determination, the panel can refer to the CAE KU Mapping Matrix (Fig. 1) or alternatively inspect the CAE-CD Knowledge Units document available for downloading from the same page noted above. While both documents contain the same information, the format of the latter may be found easier to reference for this initial step.

The next step can be done individually or collaboratively as a team. Clicking on the name of any KU on the sheet shown in Fig. 1 brings up the topics and expected outcomes in spreadsheet form for that KU (see Figs. 2 and 3).

Consider the structure of the simplest KU, Basic Data Analysis (Fig. 2). It consists of only four topics: Summary Statistics, Graphing/Charts, Spreadsheet Functions, and Problem Solving. Additionally, this KU has just one outcome: “Student will be able to apply standard statistical inference procedures ...”

Through the process of mapping, it is the task of each institution to specify how each of those KU topics will be met and how the outcome will be determined. Even though other KUs have more topics and more expected outcomes than the Basic Data Analysis KU, their designs are all the same, i.e. a list of topics and a series of expected outcomes. See Fig. 3 as another example of the similar structure.

Institutions that have never mapped before may find it advantageous to use these spreadsheets to identify courses appropriate for mapping particular KUs. (Institutions that have mapped courses previously in CAE applications will already have a good sense of which courses will be used for mapping and may choose to skip this step.) In the spaces provided in the spreadsheet (row 1), the institution’s content experts enter candidate courses that address the topics (columns B and C).
Those who have mapped previously agree that the mapping process can be time consuming. Therefore, to minimize the time required to complete the application, it is recommended that the content experts select the minimum number of courses necessary to cover a KU’s topics. After the content experts list the appropriate courses into the spreadsheets (row 1, columns D, E, …), the next step is to place an “X” in the cell which indicates the topics or outcomes that the course covers. Courses may come from any department in the institution, but the set of mapped courses must all be part of the program of study that is applying for CAE designation. One course may cover more than one KU, and conversely, one KU may require more than one course for coverage. The preliminary mapping result will look something like Figs. 4 and 5.

Option 1 – Capturing Course Topics and Objectives

In subsequent iterations and refinements, the cells containing “Xs” may be widened and the “Xs” replaced with references to specific course elements as in an identified textbook, course outline, handout, lab, etc. which covers the topic. Outcomes validation may also be mapped in their respective course cells with statements specifying the course objectives that address the outcomes and test instrument(s) that will be used (Fig. 6)
Option 2 - Capturing Course Topics and Objectives

Much of the foregoing effort in Option 1 can be shortcut, however. A well-structured syllabus containing a detailed outline, i.e., showing course topics and objectives keyed to KU topics and outcomes, can serve as a highly efficient tool for the mapping phase. Fig. 7A proposes a common format used by many instructors.

**Network Security Fundamentals**  
**COMSEC 215**  
Fall Term, 2014

<table>
<thead>
<tr>
<th>Week</th>
<th>Topics</th>
<th>Chapter Readings</th>
<th>Labs &amp; Exams</th>
</tr>
</thead>
</table>
| 1    | **Introduction to Security**  
• Challenges of securing information  
• Importance of information security  
• Types of attackers – hackers, script kiddies, spies, insiders  
• Attack types and defenses - 5 basic principles of defense | Chapter 1 | Review lab procedures  
Scan for malware  
*End of Chapter questions* |
| 2    | **Malware and Social Engineering Attacks**  
• Types of malware  
• Worms, trojans, rootkits, backdoors, botnets, spyware, adware, keyloggers  
• Social Engineering – psychological, phishing, impersonation, spam, hoaxes  
• Physical – dumpster diving, tailgating | Chapter 2 | USB blocking  
Rootkit scanning  
Sw keylogger  
*End of Chapter questions* |
| 3    | **Application and Network Attacks**  
• XSS, SQLi and SML injection  
• Cookies, attachments, hijacking, malicious add-ons, DoS, buffer overflows, man-in-the-middle, replay, ARP and DNS poisoning, privilege escalation | Chapter 3 | *Quiz Ch 1 & 2*  
Browser security  
Create HTTP header  
*End of Chapter questions* |
| 4    | **Vulnerability Assessment and Mitigating Attacks**  
• Identify assets, evaluate threats, appraise vulnerability, assess & mitigate risk  
• Baseline, sw program development | Chapter 4 | Port Scanning  
Penetration tests |
| 5    | **Host, Application, and Data Security**  
• Physical, hardware, mobile device, OS security  
• Baselining  
• Anti-malware, firewalls, logs  
• Applications, secure coding, hardening, patching  
• Securing data | Chapter 5 | *Quiz Ch 3 & 4*  
Setting firewalls  
MS Event Viewer  
*End of Chapter questions* |

Fig. 7A Example: Segment of a Detailed Course Outline
Fig 7B is an example compilation of course objectives that might be provided by a text's author via section headers within chapters of the textbook. It can be trimmed or augmented to address the requirements of the KUs.
Course outline data in either of these formats (Figs. 7A or 7B) will greatly facilitate inputting data into the NIETP database by using cut and paste operations. Of course, there are many other acceptable versions of detailed course outlines that can clearly encapsulate course content viz a viz KUs.

The common element that “good” outlines share is that their course topics, objectives, and evaluation instruments line up with the KU topics and outcomes they are intended to map to. In other words, a KU’s topics and outcomes should be clearly reflected in course outlines. KUs that will be mapped should be reviewed for explicitly required elements, and those elements should be included in the section of the detailed course outlines where they are addressed. (This would be a good time to review and update, if necessary, courses’ detailed outlines so that topics and objectives explicitly line up with KUs.)

Once all individual content experts’ contributions have been gathered and merged for the requisite KUs, culled to remove redundancy, and mapped into the spreadsheet, the spreadsheet may be used as a source document for entering data into the NIETP database.

Course and textbook information also needs to be gathered at this stage for entry during Phase 2. Figs. 8 (Course Summary Information Mapping Worksheet) and 9 (Textbook Form) list the comprehensive set of general information that the database requires. Typically, a course syllabus will already contain some of this information. It is recommended that items not included in the syllabus be completed on this form (or one like it) for every course and textbook that will be entered into the NIETP database. The following are required:

- Course Number
- Course Title
- Course Creation Date
- Course Last Review Date
- Course Link (http://)
- Course Login (Username and Password)
- Course Description
- Is the course currently being taught (Y/N)?
- Course Length: hours/week & no. of weeks
- Evaluation Methods (select all that apply)
  - Chapter review
  - Weekly Quiz
  - Lab Projects
  - Exams
- Instruction Methods (select all that apply)
  - Interactive computer
  - Demos
  - Labs
- Projects
- Presentations
- Teamwork
- Video
- Remote Learning

- Current Enrollment:
- Syllabus pdf (upload)
- Course Outline (upload)
- Is course active (Y/N)

Fig. 8 Course Summary Information Mapping Worksheet
Mapping Suggestions

Here are some suggestions to keep in mind before and during the mapping process.

- Get as many faculty subject matter experts involved as possible to identify course topics and objectives that satisfy KU topics and outcomes.

- Refer to the textbook table of contents, index and the syllabus/detailed course outline to match course topics with KU topics requirements.

- Copy and paste author provided course objectives from slide show presentations into a text document that can later be used to facilitate entering objectives into the NIETP database.

- Identify how outcomes will be measured.

- Use the fewest number of courses possible; a single course is more desirable than two.

- One course may be used to map more than one KU.

- Finally, consolidate all the “mapping work-product” (i.e., completed spreadsheets, course worksheets, detailed course outlines, syllabus) to expedite data entry.

End of Phase 1
Phase 2 – Course Data Entry

Check list of materials to have on hand to begin Phase 2.

- Course Form(s)
- Textbook Form(s)
- Syllabus/Detailed Course Outline(s) in PDF form
- Mapped spreadsheet matrices

Armed with these items, Phase 2 can begin. Figs. 10 and 11 show flowchart and step-by-step views through the process.

Fig. 10  Course Data Entry Flowchart
### Phase 2 (Enter Courses, Topics, Objectives)

<table>
<thead>
<tr>
<th>Step</th>
<th>Operation</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Login</td>
<td><em>(Welcome, Login/Join)</em></td>
</tr>
<tr>
<td>2</td>
<td>Select Institution to be mapped</td>
<td><em>(Institution List)</em></td>
</tr>
<tr>
<td>3</td>
<td>Select “Apply CAE IA/CD” option</td>
<td><em>(Welcome)</em></td>
</tr>
<tr>
<td>4</td>
<td>In opening screen, select “Add New Courses”</td>
<td><em>(CAE Submission xYr Submission)</em></td>
</tr>
<tr>
<td>5</td>
<td>Enter all Course Information as required on form</td>
<td><em>(Add Course)</em></td>
</tr>
<tr>
<td>6</td>
<td>Select “Save and Add Major Topics”</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Using the form, enter a general <strong>course</strong> topic from the current course</td>
<td><em>(Add Major Topics for xx)</em> Course topics come from textbook, syllabus,</td>
</tr>
<tr>
<td></td>
<td>that has been identified by content experts to address any Topic in any</td>
<td>supplementals, etc.</td>
</tr>
<tr>
<td></td>
<td>required KU</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Select “Save &amp; Add Another” and repeat until all relevant course topics</td>
<td></td>
</tr>
<tr>
<td></td>
<td>have been entered</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>After entering the last course topic, select the “Save and Add</td>
<td><em>(Add Objectives for xx)</em> The terminology used in the Objectives</td>
</tr>
<tr>
<td></td>
<td>Objectives** at the bottom of the form</td>
<td>should correlate closely with that in the KUs' required Outcomes</td>
</tr>
<tr>
<td>10</td>
<td>Using the form, enter the general topic objectives keyed to the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Outcomes requirements of every KU</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Select “Save &amp; Add Another” and repeat until all relevant course</td>
<td></td>
</tr>
<tr>
<td></td>
<td>objectives have been entered</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>After entering the last course objective, select the “Save” option at</td>
<td></td>
</tr>
<tr>
<td></td>
<td>the bottom of the form</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Once all courses have been identified with topics and objectives</td>
<td>This concludes identifying the courses, their topics, and objectives</td>
</tr>
<tr>
<td></td>
<td>relevant to the KUs, the next phase starts.</td>
<td></td>
</tr>
</tbody>
</table>

*Fig. 11 Course Data Entry Step-by-Step*
Online Application Tool

The next three figures (Figs. 12, 13, and 14) show the first NIETP database screens that are encountered when initiating data entry.

The Welcome screen (Fig. 12) initially appears at www.iad.gov/NIETP/. The left-hand panel of the screen contains a dashboard of user options. The Login/Join selection opens the screen seen in Fig. 13 where a user may: 1 – login, 2 – register an institution, 3 – reset a forgotten password, or 4 – retrieve a forgotten user name.
Once logged into the system, users must identify the institution for which they are performing the data entry. This is achieved by picking the institution from the drop-down box and clicking on the **Select Institution** button (Fig. 14).

![Fig. 13 Login Screen](image1.png)

![Fig. 14 Institution List](image2.png)
Successful login and selection of an institution, results in a new Welcome screen similar to that previously seen in Fig. 12 but with an expanded dashboard of options for moving among mapping operations as seen in the left panel of Fig. 14. The new dashboard will appear on virtually every screen of the database tool during the Course Data Entry phase.
Add New Course

Adding courses to the database begins the mapping process. All the information gathered about the courses earlier in Phase 1 will now be input. There are two ways to access the screen for entering a course – click on the Add New Courses or Apply CAE CD option. Selecting the Add New Courses button from the left panel of options opens the screen in Fig. 16. Alternatively, selecting the Apply CAE CD button brings up the multipurpose Submission Progress screen in Fig. 15 which also allows entering a new course (or editing existing courses plus identifying KUs that will be mapped – discussed later). Either method leads to Fig. 16, Add Courses.

This phase (i.e., 2) involves entering extensive course information into the database. A lot of time and effort can be saved by referring to the documents created in Phase 1 and employing copy and paste to transfer the data on those forms to fields in the database.

![Add New Course](image-url)

Fig. 15 Submission Progress
The Add Course screen is shown as two pieces in Figs. 16 and 17. It consists of mandatory data fields (marked with an asterisk). Use the form provided in Fig. 8 to complete this screen for each course that will be mapped to a KU.

Fig. 16 Top Half of Add Course Screen
Once a course has been entered into the database (Figs. 16 and 17), its major topics can be specified. This information comes from syllabi, detailed course outlines, textbooks, data incorporated in the mapping spreadsheets (Fig. 6) and/or other course/instructional specific elements (Figs. 7A and 7B).

**Add Major Course Topics and Objectives**

Fig. 18 shows the required fields for major course topics. Only one course topic is intended to be entered for each screen. Multiple topics are entered using additional screens – see the **Save & Add Another** button at the bottom of the screen (Fig. 18).
Course objectives can also be added now by selecting the **Save & Add Objectives** button (Fig. 18). Data entry of Topics or Objectives may be interrupted at any time without loss of data by selecting the **Save** button.

Additional Course Topics and Objectives can later be added following the steps shown in Figs 19 through 21. Specifically, …

1. Select **Edit Existing Courses** option on the dashboard,
2. Select the **Edit/Delete** (pencil icon) cell of the course to be edited (Fig. 19). This will open the course summary screen (Fig. 20), and
3. Select **Add a Major Topic for Course**, or **Add an Objective for Course**
**Step 1: Select Edit/Delete Existing Course**

Once a course or portion of a course has been entered into the database, it can be added to, edited, or even deleted. For example, Major Course Topics or Objectives can be inserted into a course in this manner. Select **Edit Existing Courses** button from the left-hand panel of any screen. This will open the **Edit Course List** screen shown in Fig 19.

![Fig. 19 Edit Course List](image)

**Step 2: Select Pencil Icon**

Select the pencil icon under the **Edit/Delete** column for the course to be modified. This will open the **Course Summary** screen shown in Fig 20.
Step 3: Add (Edit/Delete) a Major Course Topic or Objective

Finally, select **Add** or **Edit/Delete** and either a **Major Topic** or **Objective**. Fig 21 shows the screen that appears when the **Add an Objective for Course** button is selected.
Entry of course objectives follows a simple format of an identifying number (Objective Number) and a description of the objective (Objective) as seen in Fig. 21. Multiple objectives are added by selecting the Save & Add Another button.

Once all courses, their topics and objectives have been entered into the database, Phase 2 is complete.

End of Phase 2
Phase 3 – Formal Mapping

Phases 1 and 2 prepared the way for mapping to take place. With the conclusion of Phase 2, all courses reside in the database. Since all the KUs are preloaded into the database, they require no data entry effort on the part of the mapping institution. The final step maps (i.e., links) course topics and objectives to KU topics and outcomes.

Fig. 22 Phase 3 Flowchart
### Phase 3 (Enter Courses, Topics, Objectives)

<table>
<thead>
<tr>
<th>Step</th>
<th>Operation</th>
<th>Note</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Repeat steps 1, 2, and 3 of Phase 2</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Under “Step 2: Identify KUs and FAs” of the opening form, select “Identify KU” box</td>
<td>(Submission Progress)</td>
</tr>
<tr>
<td>16</td>
<td>The next screen selects all mandatory KUs for the level of your institution. If institution is 4 yr, 5 additional KUs must be selected. Select “Save Knowledge Unit Intent” at bottom of the page</td>
<td>(Submission Intent List) At the conclusion of this step, all KUs that are intended to be mapped by this institution should have been identified</td>
</tr>
<tr>
<td>17</td>
<td>This screen returns to the Submission Progress screen lists all KUs that the institution plans to map. “Start” identifies a KU, none of whose Topics or Outcomes has yet been addressed. “Continue” identifies a KU whose mapping has been initiated.</td>
<td>(Submission Progress)</td>
</tr>
<tr>
<td>18</td>
<td>Click “Start” (or “Continue”) on a KU to be mapped</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>A screen appears with a list Topics and Outcomes defining that KU. Select a Topic or Outcome to map.</td>
<td>(Map Knowledge Unit)</td>
</tr>
<tr>
<td>20</td>
<td>On the next screen, select a course from the drop down box which has course material (topics) that satisfy this KU's Topic</td>
<td>(Add KU Justification and Course Mapping)</td>
</tr>
<tr>
<td>21*</td>
<td>In the “Major Topics” box, move the relevant course topics to the “Selected Major Topics” box by using the “Add” button.</td>
<td></td>
</tr>
<tr>
<td>22*</td>
<td>Repeat the process for the “Objectives” section.</td>
<td></td>
</tr>
<tr>
<td>*</td>
<td>Alternative to steps 21 &amp; 22, enter “Justification” Use Justification when KU is satisfied by pre-req or means other than coursework.</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>“Save”</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>Repeat the process from step 18 until every KU Topic and Outcome has been mapped by current course.</td>
<td>(Map Knowledge Unit)</td>
</tr>
<tr>
<td>25</td>
<td>Repeat the process from step 17 until all KUs have been mapped for all courses.</td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 23 Phase 3 Step-by-Step**
Identify KU

The formal mapping process starts on the Submission Progress screen seen during Phase 2 (Fig. 15). The job now is to identify the KUs that must be mapped by the institution. Selecting the Identify KU button on the Submission Progress screen (Fig. 24) starts the process by bringing up the Submission Intent List display, Fig. 25.

Select Intent to Map KU

An institution declares the KUs it plans to map via the Submission Intent List screen. The display will differ somewhat depending on whether the mapping institution is two-year or four-year. The number of Mandatory Knowledge Units for a two-year institution is eleven, for a four-year institution, seventeen. (Note that Figs. 25 and 26 show the screen for a four-year school.) All the Core KUs must be mapped for their respective types of institutions. In this example, the column headed Intend to Map?, all required Core KUs are marked Yes by default.
Also, four-year institutions must select five optional KUs from the lower section of the screen (Figs. 25 and 26). The intended optional KUs are selected by setting their radio buttons to Yes. When all KUs intended for mapping are identified, select **Save Knowledge Unit Intent** at the bottom of the screen (Fig. 26).
In addition to mapping the minimum number of required KUs, some institutions may wish to distinguish their programs by offering additional IA/CD emphasis. NSA/DHS recognizes certain combinations of mandatory and optional KUs formally as Focus Areas. Selecting the “+” next to the name of any KU in Figs. 25 or 26 expands that KU to reveal the FAs in which they are a component. (The Identify FA button in the Submission Progress screen does the inverse, i.e., reveals the set of KUs that compose an FA.) Clicking Save Knowledge Unit Intent at the bottom of the screen returns to the Submission Progress screen which will be populated with all the KUs selected in the previous step (Figs. 25 & 26).

Map Knowledge Unit

Initially, all KUs on the Submission Progress screen (Fig. 27) have Start buttons in the right column of the form. Clicking a Start brings up a Map Knowledge Unit screen which reveals that KU’s defining topics and outcomes (Fig. 28). (Once a KU mapping has been started, the Action column on the screen marks it with a Continue button.)
**Linking Courses to KUs**

The topics and outcomes are underlined hot buttons. Picking one of the topics say, Graphing/Charts, in Fig. 28, causes the **Add Justification and Course Mapping** screen to appear (see Figs. 29, 30 & 31). This is where the actual linkage between course and KU takes place.

![Fig. 28 Map Knowledge Unit Topic](image)

**Map Course Topics and Objectives to KU Topic**

Next, choose **Select Course** (Fig. 29) from the dropdown box on the **Add KU Justification and Course Mapping** screen.

![Fig. 29 Add Justification and Course Mapping – Topics (Top Third)](image)
All the topics previously entered for that course during Phase 2 will populate Major Topics box (Fig. 30). The topic or topics that address the KU’s current major topic are selected from the box and moved to the Selected Major Topics box with the Add button. Likewise, the objectives associated with the course appear in the Objectives box. The relevant ones, too, must be moved to the Selected Objectives box with the Add button.

Fig. 30  Add Justification and Course Mapping – Topics (Middle Third)
**The Justification Box**

The Justification box (Fig. 30) is only required when a course topic matching the KU topic is not explicitly covered in the course material but is either required prerequisite knowledge for the course (e.g., CCNA, CISSP, Network+, etc.) or will be achieved through an activity in the course.

![Justification Box](image)

**Fig. 31 Add Justification and Course Mapping - Topics (Bottom Third)**

Repeat the process of matching course topics and objectives to KUs until all KU topics and objectives have been mapped.

**Map Course Topics and Objectives to KU Outcomes**

The lower portion of the Map Knowledge Unit screen shown in Fig. 32 provides the path to KU Outcomes. Selecting an outcome from the list opens the Outcome screen shown in Figs. 33, 34, and 35.
Mapping courses to KU Outcomes follows the same procedure as mapping courses to KU Topics above. Even the screen layouts are nearly identical. As was the case for mapping KU topics, when a course is selected from the drop-down box (Fig. 33), all the topics and objectives previously entered for that course will populate the Major Topics and Objectives boxes (Fig. 34). The topic(s) and objective(s) that satisfy the KU’s currently selected outcome must be picked from the boxes and moved to their respective Major Topics or Objectives boxes with the Add button.
A Justification (Fig. 35) is required for an Outcome only if the Outcome is not mapped by a topic or objective of one or more courses. It must describe what means will be used to determine that the outcome is achieved. The form states: “Examples may include any projects, exercises and/or labs that support this outcome. Outcomes may also be met by pre-requisite knowledge gained from previous courses at a prior institution, alternative coursework, exposure to labs, internship opportunities or any information that establishes an equivalency that adequately prepares the student to meet the outcomes of this Knowledge Unit.”
This process is repeated until all KUs' Outcomes have been satisfied.

After KU Topics and Outcomes have been linked to course instructional materials, the mapping portion of the CAE application is complete.

End of Phase 3
Application Criteria

Besides mapping courses to KUs, an institution must submit a Letter of Intent and show that it meets seven Criteria. These submissions are also performed through the NIETP site interface. Fig. 36 shows the process.

To get to the criteria entry screen, select the Apply CAE CD in the left-hand panel of any screen. This opens the Submission Progress form. The section titled Program Criteria appears midway down the form (see Fig. 24). Clicking on the single criterion entry’s Start (or Continue if previously used) button leads to the screen showing all Measurement Criteria as in Fig. 37. Clicking on a “+” next to any criterion expands it to reveal its components. Each of those underlined components is a hotlink to a screen form that facilitates user input for that criterion (see Fig. 38).
Alternatively, all criteria can be expanded simultaneously by selecting the **Expand All** button. The **Collapse All** button returns all expanded criteria to the minimum state and **Display CAE Application** shows the current data entry status of all criteria.
For example, the hotlink for a component of “1. Cyber Defense Curriculum Path” brings up the screen shown in Figs. 39, 40, and 41. This is the standard format for all criteria. It provides fields for http links, uploads of pdf attachments, and a justification statement to support the fulfillment of the respective criterion. (Note: Sub-criteria 1.c. and 1.d. only require statements in the Justification box. Neither links nor attachments are necessary.)
Finally, the **Display CAE Application** button seen in Figs. 37 and 38 produces a summary of the contents **Application Criteria** status (Fig. 42).

**Fig. 42 View Application Criteria – Summary Status (First segment of continuous page ...)**

**End of Application Criteria Data Entry**
Conclusion

Without suitable organization and preparation, the mapping process can (will) be time consuming and labor intensive. Following the processes and procedures discussed in this manual can greatly facilitate a successful mapping. This manual presents the major elements involved in matching course elements to KUs. The best way to learn the system is to “jump in” by selecting a single course that maps to one or more KUs and follow the methods and flowcharts in the manual.

Happy mapping!

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