# THE REGISTERED APPRENTICESHIP OCCUPATIONS AND STANDARDS CENTER OF EXCELLENCE (AOSC)

# DevOps Engineer
# National Occupational Framework

**ONET Code: 15-1252.00**

**RAPIDS Code: 4003**

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# Introduction to Using This Document

Under the Registered Apprenticeship Technical Assistance Centers of Excellence award, the Urban Institute leads the Occupations and Standards work. One of the main objectives of Urban's project is to create high-quality, well-researched, consensus-based work process schedules that are nonproprietary and widely available. This document is a product of that work and contains three sections: the occupational overview, the work process schedule, and the related technical instruction.

The **occupational overview** is a general introduction, including alternative job titles, any prerequisites, and, if applicable, the total number of hours needed to complete a time-based or hybrid program.

The **work process schedule** outlines the major job functions, competencies, and/or hours an apprentice completes in a registered apprenticeship program. It outlines what apprentices are expected to learn on the job with the support of a mentor or journeyworker (a worker mastering the competencies of an occupation in a particular industry), including both core competencies and those deemed optional by experts in the field. The work process schedule is the foundational document guiding a program.

Urban works with numerous experts to ensure the content is thoroughly researched and vetted to reflect the expectations of industry, educators, labor unions, employers, and others involved in apprenticeship for this occupation. Sponsors and employers can use the work process schedule as their program standards with assurances it has been approved by experts in the field.

The **related technical instruction** presents considerations for the coursework that apprentices will undertake to supplement on-the-job learning. It is intended to serve as a reference to sponsors exploring their options for the accompanying classroom, virtual, or hybrid training.

## How to Use the Work Process Schedule

Sponsors can adapt the work process schedule to accommodate their needs for competency- or time-based or hybrid programs. In a **competency-based** apprenticeship, sponsors assess apprentices' progress across core and optional competencies listed in the work process schedule. In a **time-based** apprenticeship, apprentices complete a predetermined number of hours across major job functions and the program overall. In a **hybrid** apprenticeship, sponsors monitor apprentices' hours spent on major job functions and assess their proficiency across competencies.

Each program type has a different method of assessment:

- **For a competency-based program**, apprentices engage in activities and make progress toward proficiency in the identified competencies. Sponsors overseeing apprentices' work assess their mastery of the outlined competencies using the following rating scale:

  4—Competent/proficient (able to perform all elements of the task successfully and independently)

  3—Satisfactory performance (able to perform elements of the task with minimal assistance)

  2—Completed the task with significant assistance

  1—Unsuccessfully attempted the task

  0—No exposure (note the reason—absence, skill isn't covered, etc.)

  The competencies may be completed in any order. Apprentices must perform at a level 4 or 3 in all competencies listed as "core" to complete the apprenticeship program successfully.

- **For a time-based program,** sponsors monitor apprentices' completion of hours in training across major job functions. The total number of hours recommended for this occupation is listed in the occupational overview and is based on guidance from the US Department of Labor. Generally, apprentices must have at least 2,000 hours overall for on-the-job learning, but occupations of greater complexity may require more hours. Sponsors will provide apprentices with supervised work experience and allocate the total number of hours across the major job functions to adequately train their apprentices.

- **The hybrid approach** blends both competency- and time-based strategies. Sponsors measure apprentices' skills acquisition through a combination of completing the minimum number of hours of on-the-job learning successfully demonstrating identified competencies. Sponsors will assess apprentices' proficiencies as described for competency-based programs with a rating scale of 0–4 for every core competency. Generally, apprentices have at least 2,000 hours overall for on-the-job learning, but occupations of greater complexity may require more hours. Sponsors will document apprentices' completion within a minimum and maximum range of hours assigned for each major job function.

# DevOps Engineer Occupational Overview

## Occupational Purpose and Context

DevOps Engineers are tech professionals who bridge the gap between the development and operations sides of software delivery. DevOps engineers implement and manage continuous integration, delivery and deployment processes, using automation, AI, and AI-enabled DevOps toolchains and pipelines. Much of what they build either operates in or supports deployment in cloud-native, distributed architectures. DevOps engineers collaborate with teammates across a company to ensure a high-quality software development process. DevOps Engineers are creative and critical thinkers with excellent problem-solving skills and attention to detail. Although they are self-motivated and must work well independently, they must also be team-oriented, with strong written and verbal communication skills.

## Potential Job Titles

Platform engineer, DevSecOps engineer, site reliability engineer (SRE), site resiliency engineer, software reliability engineer, operations engineer, cloud engineer, systems engineer, delivery enablement engineer

## Apprenticeship Prerequisites

Many employers may require prior knowledge of particular software or DevOps tools. Knowledge of which particular tool(s) is needed will be unique to the individual employer. Some apprenticeships may require a bachelor's degree in a field related to computer science, credentials for certain technologies, basic knowledge of coding and hardware support, basic IT technical experience, or attendance at bootcamp or coding school.

## Recommended Length of Apprenticeship (Time-Based/Hybrid Programs Only)

The recommended length of time for on-the-job training in a DevOps Engineer apprenticeship is 2,000 to 4,000 hours.

# Work Process Schedule

## DevOps Engineer

**ONET Code: 15-1252.00**
**RAPIDS Code: 4003**

## Instructions for Use:

**Competency-based programs:** In the "performance level achieved" column of the work process schedule (see examples starting on the next page), assess apprentices' performances on each competency with the scale below. No monitoring of hours is required for this approach. See "Guidelines for Competency-Based, Hybrid and Time-Based Apprenticeship Training Approaches," US Department of Labor, Employment and Training Administration, Office of Apprenticeship, October 20, 2015, https://www.apprenticeship.gov/sites/default/files/bulletins/Cir2016-01.pdf.

4—Competent/proficient (able to perform all elements of the task successfully and independently)
3—Satisfactory performance (able to perform elements of the task with minimal assistance)
2—Completed the task with significant assistance
1—Unsuccessfully attempted the task
0—No exposure (note the reason—absence, skill isn't covered, etc.)

**Time-based programs:** In the "hours" row, specify the number of hours apprentices will fulfill for each job function. No assessment of competencies is required for this approach.

**Hybrid programs:** In the "performance level achieved" column, assess apprentices' performances on each competency using the 0–4 scale above. In the "hours" row, identify a range of hours apprentices should spend working on each major job function.

| Job Function 1: Collaborates across engineering and product teams | | |
|---|---|---|
| **Hours** (time-based and hybrid programs only): | | |
| **Competencies** | **Core or optional** | **Performance level achieved (0–4)** (competency-based and hybrid programs only) |
| A. Uses effective oral and written communication with all stakeholders | Core | |
| B. Liaises between the development, operations, and DevOps teams, and helps enable teams practicing DevOps | Core | |
| C. Supports the execution of the DevOps strategy for individual products | Core | |
| D. Effectively communicates through the company's established channels, such as Slack, Jira, Confluence, or a ticketing system, to best collaborate across teams | Core | |
| E. Attends and participates in regular team meetings following the organization's agile methodology, such as scrum, and comes prepared to report on work | Core | |
| F. Participates in meetings focused on improving the product and processes constructive feedback | Core | |
| G. Regularly communicates with team members on ways to be more effective and adjust practices accordingly | Core | |
| H. Fosters communication between departments | Core | |
| I. Utilizes agile methodology to plan and execute products with team members | Core | |
| J. Utilizes coaching techniques to help teams adopt security gates, trunk-based development, and feature flags | Optional | |

| Job Function 2: Configures technological infrastructure used to run software, subnetting, and networking | | |
|---|---|---|
| **Hours** (time-based and hybrid programs only): | | |
| **Competencies** | **Core or optional** | **Performance level achieved (0–4)** (competency-based and hybrid programs only) |
| A. Provisions infrastructure using modern techniques, including infrastructure as code tools | Core | |

| | | |
|---|---|---|
| B. Utilizes necessary computing, storage, and networking resources needed for application infrastructure | Core | |
| C. Utilizes appropriate deployment and configuration tools to provision different infrastructure | Core | |
| D. Configures infrastructure to the application's specifications | Core | |
| E. Repurposes existing infrastructure where appropriate | Core | |
| F. Updates infrastructure when necessary to fix critical vulnerabilities or bugs | Core | |

| **Job Function 3: Integrates unit tests into continuous integration and continuous delivery (CICD) flow** | | |
|---|---|---|
| **Hours** **(time-based and hybrid programs only):** | | |
| **Competencies** | **Core or optional** | **Performance level achieved (0–4)** (competency-based and hybrid programs only) |
| A. Develops code with unit and functional tests in coordination with supervisor or peer | Core | |
| B. Uses at least one common programming and scripting language for cloud systems like AWS such as Python, Ruby, JavaScript, and GO to code or automate software | Core | |
| C. Follows the practices of continuous integration and continuous delivery (CICD), merging work frequently | Core | |
| D. Utilizes source code control such as Git | Core | |
| E. Stores all code within the source code control system | Core | |
| F. Follows the principles of "continuous everything," from integration to delivery to deployment to feedback | Core | |
| G. Conducts different types of testing for infrastructure code such as unit testing, integration testing, acceptance testing, and end-to-end testing under the supervision of a manager or technical lead | Core | |
| H. Assesses and takes steps to mitigate the potential risks involved in integration | Core | |

| Job Function 4: Deploys new software to make it available for wider use | | |
|---|---|---|
| **Hours** (time-based and hybrid programs only): | | |
| **Competencies** | **Core or optional** | **Performance level achieved (0–4)** (competency-based and hybrid programs only) |
| A. Deploys applications to production and staging environments | Core | |
| B. Automates deployment whenever possible, ensuring continuous deployment | Core | |
| C. Practices continuous integration/continuous deployment throughout the development process | Core | |
| D. Integrates and delivers software as frequently as required | Core | |
| E. Creates build and release pipelines to automate appropriate test cases in test plans | Core | |
| F. Writes instructions on how to use the software being deployed and ensures enough information is provided for the user to use the software successfully | Core | |
| G. Deploys serverless functions | Optional | |
| H. Deploys functions to the cloud to run automatically | Optional | |
| I. Deploys applications to a container orchestration platform | Optional | |

| Job Function 5: Efficiently runs and monitors software and infrastructure | | |
|---|---|---|
| **Hours** (time-based and hybrid programs only): | | |
| **Competencies** | **Core or optional** | **Performance level achieved (0–4)** (competency-based and hybrid programs only) |
| A. Follows principles of continuous testing | Core | |
| B. Uses and understands appropriate test automation tools for tests that can be automated | Core | |
| C. Automates different kinds of tests such as unit tests, integration tests, and functional tests | Core | |
| D. Manages servers through version-controlled configuration | Core | |

| | | |
|---|---|---|
| E. Uses appropriate configuration management or infrastructure as code tools, such as Chef, Terraform, Pulumi, etc. | Core | |
| F. Understands how to use cloud platforms such as AWS, Azure, and GCP for server management | Core | |
| G. Automates management of servers, microservices, and containers | Core | |
| H. Monitors system health using observability, OpenTelemetry and AIOps | Core | |
| I. Proactively strengthens the systems using chaos engineering and responds to problems in the applications and infrastructure as they arise | Core | |
| J. Participates in managing and securing deployments, and maintains security according to organizational requirements | Core | |
| K. Configures infrastructure network with security built in using secure by design principles | Core | |
| L. Regularly checks the security of all software, including both deployed software and software used to deploy | Core | |
| M. Identifies and resolves security issues as they arise | Core | |
| N. Uses monitoring tools to check performance and agreed upon service levels and ensures the product is working as expected | Core | |
| O. Uses container management to schedule deployments, secure applications, and store and monitor software | Optional | |

| **Job Function 6: Resolves issues and assures site resiliency using IT service management principles and practices** | | |
|---|---|---|
| **Hours** **(time-based and hybrid programs only):** | | |
| **Competencies** | **Core or optional** | **Performance level achieved (0–4)** (competency-based and hybrid programs only) |
| A. Instruments and measures deployment frequency, MTTR, change failure rate, and lead time for change | Core | |
| B. Identifies issues in production | Core | |
| C. Recognizes common problems in application | Core | |
| D. Responds to alerts from monitoring software promptly | Core | |
| E. Follows alert and escalation policies | Core | |
| F. Diagnoses issues and resolves them | Core | |
| G. Troubleshoots broken deployments | Core | |

| | | |
|---|---|---|
| H. Troubleshoots system-level errors in both production and nonproduction environments | Core | |
| I. Continuously integrates and deploys changes to resolve issues as quickly as possible | Core | |
| J. Identifies, selects, and uses appropriate monitoring tools throughout each stage of the DevOps pipeline | Core | |
| K. Ensures that all tools and technologies are up to date | Core | |
| L. Backs up and restores data systems regularly | Core | |
| M. Monitors development milestones and tracks metrics | Core | |
| N. Communicates effectively on the status of issues with appropriate stakeholders and ensures issues are resolved | Core | |

# Related Technical Instruction

## Dev Ops Engineer

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### Instructions for Use:

Registered apprenticeships must include at least 144 hours of related technical instruction (RTI). Courses offered by accredited colleges and universities may be assigned a credit hour determination rather than a contact hour determination. In general, an academic credit unit is the equivalent of 15 clock hours of instruction.

**Development and Use of This RTI Outline:** Employers and academic institutions may approach RTI in markedly different ways. Our goal was not to identify the single best way to provide RTI or to identify a single provider whose content we deemed to be superior. Instead, our goal was to survey numerous education providers, including employers, institutions of higher education, high schools, private continuing education providers, labor organizations, professional associations and, in some cases, municipalities that provide worker training, to identify topics or courses common among those providers that align with the job functions included in this work process schedule. Those common topics or courses are reflected in the RTI outline provided below, which may be useful in developing your RTI program or communicating your needs to an educational partner.

**Licensure or certification requirements:** Although there are no state licensure requirements associated with this occupation, most employers expect applicants to hold relevant industry-based certifications or credentials. There are many different types of credentials available to IT professionals, and while some credentials are not platform-specific, others are directly linked to the platform or cloud computing service that a company or organization uses. Potential certifications of interest to employers include:

- AWS Certified DevOps Engineer
- DevOps Institute DevOps Foundation
- DevOps Institute DevOps Engineering Foundation
- Microsoft Certified DevOps Engineer Expert
- IBM DevOps and Software Engineer
- Certified Kubernetes Administrator
- Docker Certified Associate
- Puppet Certified Professional
- Google Cloud Certification

**Degree requirements for licensure or certification, if applicable:** None

**Accreditation requirements of instructional provider for licensure or certification, if applicable:** None

**Anticipated changes in licensure or certification requirements, if known:** None

**Examples of state licensure or certification requirements:** Not applicable

**Examples of RTI providers for this occupation**

**Professional associations and labor organizations:** Not applicable

**Military:** The US Army and US Air Force provide training relevant to DevOps. The US Army's Software Factory unit offers a technical bootcamp followed by one-on-one subject matter expert training leading to a 12-month internship or another form of work-based learning program (https://soldiersolutions.swf.army.mil/apply). The US Air Force provides training resources including online videos on DevSecOps, combining DevOps with security practices (https://software.af.mil/resources/agile).

**Federal:** The National Initiative for Cybersecurity Careers and Studies (NICCS) which is part of the Cybersecurity and Infrastructure Security Agency (CISA), provides resources for cybersecurity and related training including DevOps. For example, an online class on fundamentals of secure DevOps (https://niccs.cisa.gov/education-training/catalog/cmdctrl-security/fundamentals-secure-devops) is made available through training providers. The initiative also provides a catalog of cybersecurity resources available online and in-person across the US (https://niccs.cisa.gov/education-training/catalog).

**States/municipalities:** Not applicable

**Colleges and universities:** Universities such as Louisiana State University (https://ce.lsu.edu/public/category/courseCategoryCertificateProfile.do?method=load&certificateId=1019718) and University of Chicago (https://professional.uchicago.edu/find-your-fit/courses/devops?language_content_entity=en) provide online certificate courses on DevOps Engineering.

**No-cost online providers:** Online platforms like Udemy and Coursera offer courses on DevOps.

**Continuing education or specialty education providers:** There are multiple learning platforms focused on training relevant to DevOps. For example, the Linux Foundation offers training across multiple facets of software engineering, including DevOps. These include virtual learning and certification programs. Certified GitOps Associate (CGOA, https://training.linuxfoundation.org/certification/certified-gitops-associate-cgoa) is one of the certificate programs offered by the Foundation. "Implementing DevOps" is an example of an online course available for purchase or for access through subscription (https://training.linuxfoundation.org/training/implementing-devsecops-lfs262). Microsoft offers self-paced or instructor-led training programs that can lead to a DevOps Engineer Expert certification. (https://learn.microsoft.com/en-us/training/career-paths/devops-engineer). Amazon Web Services is another learning platform that offers specialized courses including live classroom trainings, workshops, and exam guides, that can lead toward a DevOps certification (https://aws.amazon.com/training/learn-about/devops). DASA (DevOps Agile Skills Association), based in Netherlands and India, provides virtual training for organizations and/or individuals in-house or in partnership with a training provider. An example of an organizational training program would be the DASA DevOps Leader program

(https://pcc.devopsagileskills.org/training/4335) with a focus on developing "autonomous high-performance teams." There are also self-paced and instructor-led courses provided at an individual level, such as DASA DevOps Fundamentals (https://mydasa.devopsagileskills.academy/catalog/course/5267). DevOps Institute similarly provides in-house or partner training resources for organizations and individuals—for example, the AIOps Foundation course (https://www.peoplecert.org/browse-certifications/devops/DevOps-13/aiops-foundation-v10-3841).

**Prerequisite knowledge, skills or experience typically required by RTI providers for this occupation**

Many employers and RTI providers require an individual to have experience as an IT generalist before moving into the specialized field of DevOps Engineering. DevOps Engineers often have considerable experience in software design or deployment prior to moving into this specialized field.

**Employer Onboarding**

**Hours: 1–3**

**Sample learning objectives**

- Explain the mission of the employer's organization.
- Explain the organizational structure of the employer's organization.
- Explain the chain-of-command in the employer's organization, as well as the steps and employee should take to report concerns about practices or behaviors in the workplace or to share ideas about how to improve processes or efficiencies.
- Explain the employer's policies for workplace conduct and ethics.
- Explain the employer's policies regarding medical leave and vacation.
- Explain the requirements of the apprenticeship program and the role of the apprentice in the organization's business activities.
- Demonstrate effective use of time management techniques, including prioritizing among outstanding tasks or deliverables, and communicating to others about the likely timeline for your response or product delivery.

| Communication in the Work Environment |
| --- |
| **Hours: 30–45** |
| **Sample learning objectives**<br>▪ Demonstrate the ability to properly use electronic communication technologies, such as email, text messaging, chat messaging, and client services software.<br>▪ Demonstrate the ability to properly format an email, a memorandum and a business letter, and to compose correspondence using proper sentence structure, grammar, punctuation, spelling, and word choices.<br>▪ Explain and access resources to enable communication with those who do not speak English, who have hearing or speech limitations, or who have intellectual disabilities or age-related cognitive deficiencies.<br>▪ Demonstrate the ability to engage in active listening and to summarize information provided by another person orally and in writing.<br>▪ Explain the importance of teamwork and describe strategies that effective teams use to engage all members of the team and exploit each members' unique talents and expertise.<br>▪ Demonstrate the ability to use problem-solving strategies when disagreements arise among team members. Explain the importance of having civil disagreements and demonstrate the ability to listen and understand to a position different from your own, and explain why that position may have merit.<br>▪ Discuss appropriate strategies for assisting others in the workplace who appear to be struggling, who demonstrate anxiety or anger, who are showing signs of stress or anxiety, or who may pose a threat to others.<br>▪ Explain the importance of responding promptly to calls, emails or messages, even if it will take additional time to resolve an individual's concern or provide the requested information or service.<br>▪ Demonstrate proper etiquette when initiating, receiving or responding to phone calls, voicemail, emails or text messages.<br>▪ Demonstrate the ability to leave a clear and concise voicemail that communicates the date, time and purpose for your call and the information or service you are requesting of the recipient. |

**Cloud Computing**

**Hours: 30–45**

**Sample learning objectives**

**PC-based**

- Describe the elements of a typical computer network, such as the user space, the kernel space, hardware, cloud storage, and print servers.
- Describe the five-layer model of computer networks.
- Describe the standard protocols involved in setting up a small office/home office network.
- Describe how TCP/IP protocols govern how data is transmitted over the internet.
- Explain how Wi-Fi and Ethernet work to connect devices on a network.
- Explain the types of tools and techniques used to troubleshoot networks.
- Explain how network services like DNS and DHCP work to make computer networks run.
- Explain the theory of cloud computing as a service provider and data storage utility.
- Compare and contrast cloud computing concepts.
- Set up client-side virtualizations.

**Apple-based**

- Explain and demonstrate the process used to update, upgrade, and reinstall macOS Mojave or current operating system.
- Explain the techniques used for managing file systems, storage, encryption, permissions, and file sharing.
- Use hidden items, shortcuts, file archives, metadata and Spotlight. Manage system resources and Time Machine.
- Discuss strategies and techniques for managing basic and advanced network settings; troubleshoot network issues.
- Discuss and describe techniques for managing network services, host sharing, and a personal firewall.
- Explain the process for managing printers and scanners; troubleshoot peripherals, startup, and other system issues.
- Set-up virtualizations that permit Mac users to utilize software designed for use on a Windows OS.

**CompTia A+ Certification**

- Compare and contrast the five basic operating systems currently available and explain the advantages and disadvantages of each.

- Configure, install and upgrade operating systems, including Windows, Apple/Mac OS X, Linux, iOS, Android, and Windows Mobile.
- Explain the role of virtualization systems and provide examples of when it might be necessary for an individual or organization to rely on virtualization to run apps written for a different operating system than the primary operating system in use.
- Install and image virtual machines.
- Set-up and troubleshoot peripheral devices.
- Assemble and disassemble computing hardware.
- Set up and support basic home and small office networks.
- Implement cybersecurity controls appropriate to help desk and technical support roles.
- Troubleshoot and support end-user access to applications and data.

**Software Design, Testing, and Maintenance**

**Hours: 40–60**

**Sample learning objectives**

- Explain the importance of software architecture as a blueprint for software development.
- Name and discuss the relevance of various types of software architecture—such as microservice, nanoservice, or microkernel—and their purposes in software development.
- Identify the subsystems and components of a software design project.
- Discuss the types of interfaces and communication required within a software system and describe how they are built into the overall software development plan.
- Discuss options available for the development or inclusion of a database in software design, as well as effective strategies and tools for securing and backing up data.
- Discuss the importance of system design principles, such as modularity, abstraction, encapsulation, decomposition, and concurrency, to enable better testing, modification, and maintenance of software systems.
- Discuss effective tools and strategies used to test software systems, such as end-to-end testing and unit testing.
- Discuss the importance of automation tools and describe the types of automation tools currently available.
- Explain the importance of client interviews in determining key software features of interest, such as scalability, security, fault tolerance, flexibility, and precision.
- Demonstrate the ability to develop a software system development budget and timeline and to evaluate progress against each during the development cycle.

- Explain the importance of technical documentation and demonstrate the ability to create a technical document as part of a software development project.

| **Programming in JavaScript** |
| --- |
| **Hours: 35–40** |
| **Sample learning objectives**<br>▪ Explain why JavaScript is the most popular language to learn and use.<br>▪ Explain how JavaScript is used to make websites and mobile applications more interactive.<br>▪ Explain how JavaScript is used for game development, animations, dropdown menus, and color-changing buttons.<br>▪ Explain the purpose of Code Editor, Selection Control Structures, and Loops.<br>▪ Describe core programming structures.<br>▪ Demonstrate the ability to use proper syntax in JavaScript and jQuery.<br>▪ Explain the purpose of and demonstrate the ability to use a jQuery library/plug-ins to create new objects and populate them with data.<br>▪ Demonstrate the ability to validate and manipulate data with JavaScript. |

| **Programming in C** |
| --- |
| **Hours: 35–40** |
| **Sample learning objectives**<br>▪ Explain the use of algorithms and problem-solving in programming.<br>▪ Develop a plan for what the program is supposed to do.<br>▪ Explain the key structure and syntax used in C programming.<br>▪ Compare and contrast earlier and later versions of C, such as C+ versus C++.<br>▪ Discuss how pointers are used in C to identify the location of another data source to be used.<br>▪ Discuss how arrays are used to bundle data.<br>▪ Identify errors and troubleshoot programs written in C. |

| Introduction to Python Programming |
| --- |
| **Hours: 30–45** |
| **Sample learning objectives**<br>▪ Accurately identify and define terms relevant to Python programming.<br>▪ Explain Python's logic and structure (key words, instructions, indentations).<br>▪ Explain numeral systems, data types, I/O operations, and control flow mechanisms used to program in Python.<br>▪ Demonstrate the ability to create data collections and functions using Python programming.<br>▪ Demonstrate the ability to use appropriate Python syntax, semantics, and runtime. |

| Linux Foundations |
| --- |
| **Hours: 20–30** |
| **Sample learning objectives**<br>▪ Explain the purpose, advantages and disadvantages of open-source software.<br>▪ Explain the history and uses of Linux operating systems.<br>▪ Explain the purpose of the shell, kernel and user spaces.<br>▪ Discuss the purpose of the graphical user interface.<br>▪ Explain the theory of file management in Linux as well as file system hierarchy.<br>▪ Discuss the process of editing files using Vim.<br>▪ Demonstrate the ability to set up users and user groups in Linux.<br>▪ Configure networks using Linux.<br>▪ Demonstrate the ability to define access rights for files, identify users and groups and adjust access permissions.<br>▪ Demonstrate the ability to configure systems, apply settings and customize the terminal window.<br>▪ Demonstrate the ability to configure networks and establish security protocols. |

| Introduction to Git and Git Hub |
| --- |
| **Hours: 10–20** |
| **Sample learning objectives**<br>▪ Discuss the various types of professionals, consultants, and business leaders who are likely to be involved in a software development project.<br>▪ Explain the importance of tracking changes made by each partner or contributor to a software development project.<br>▪ Explain how to use GitHub to create a repository, to add a file, and to implement changes.<br>▪ Discuss the use of branches in managing and merging changes.<br>▪ Discuss the advantages and disadvantages of using the web interface option to create and maintain GitHub repositories.<br>▪ Demonstrate the ability to use various Git commands to create repositories, track changes, and push/pull changes. |

| Database Structure and Function using Microsoft Azure (optional) |
| --- |
| **Hours: 45–60** |
| **Sample learning objectives**<br>▪ Describe the purpose of Azure database services.<br>▪ Explain options available for level of control for databases.<br>▪ Explain the purpose and function of relational database technologies.<br>▪ Describe the managed database services available through Azure, such as Azure SQL Database.<br>▪ Differentiate between IaaS and PaaS database infrastructure and the advantages and disadvantages of each.<br>▪ Explain the differences between Azure Managed Instance for Apache Cassandra and Aure Cosmos DB for Apache Cassandra.<br>▪ Discuss the tools available to graphically display data managed using Microsoft Azure. |

**IT Security**

**Hours: 35–40**

**Sample learning objectives**

- Explain the importance of antivirus software, and demonstrate the ability to select, install, and maintain antivirus software.
- Explain the importance of firewalls and demonstrate the ability to establish an effective firewall as well as to permit appropriate individuals access to penetrate the firewall.
- Discuss the nature of cyberthreats and threat origins of concern to individuals and organizations.
- Explain how various encryption algorithms and techniques work as well as their benefits and limitations.
- Differentiate between authentication and authorization systems and discuss the advantages and disadvantages of each.
- Demonstrate the ability to evaluate potential risks and recommend solutions for reducing or mitigating those risks.
- Describe the best practices used to secure a network.
- Demonstrate the ability to explain to others the most common types of cyberthreat they will encounter as well as strategies and procedures for protecting against data and security breaches.
- Discuss the utilization of AI in security analysis.

**IT Project Management**

**Hours: 30–40**

**Sample learning objectives**

- Explain the relevance of IT project management to executing a project on time, on budget, and that meets client specifications.
- Demonstrate the ability to identify project goals and establish outcomes that will be used to monitor project progress and success.
- Demonstrate the ability to interview stakeholders and develop a project scope as well as deliverable requirements.
- Develop a list of appropriate stakeholders for various IT projects as well as communications used to solicit their participation and input.
- Develop a schedule and timeline for executing an IT project.
- Develop a base budget and cost estimate for an IT project based on effort, duration, and equipment/technologies needed.

- Discuss the importance of teams in IT projects as well as effective strategies for engaging and managing teams.
- Explain effective strategies for tracking project progress and soliciting interim feedback from various stakeholders.
- Explain the appropriate process for making updates or changes to project specifications or deliverables.
- Demonstrate the ability to perform a project retrospective to identify ways to improve the development and management of projects.

**Relevant military experience**

**US Army:**

- 1E—Knowledge Management Professional
- 255A—Data Operations Warrant Officer
- 255N—Network Operations Warrant Officer
- 255S—Cyberspace Defense Warrant Officer
- 255Z—Senior Signal Warrant Officer
- 25B—Information Technology Specialist
- 26A—Network Systems Engineering
- 26B—Data Systems Engineering
- 26Z—Data Network Engineering
- C2—Cryptologic Computer Network Analyst
- E6—Interactive On-Net Operator

(https://www.cool.osd.mil/army/credential/index.html?cert=acde-p6996)

**US Navy:**

- 182X—Information Professional
- 682X—Information Professional LDO
- 782X—Information Systems Technician CWO
- B525—Cyber Warfare Technician
- B460—IT Information Technicians
- C260—IT Information Technician Submarines
- (https://www.cool.osd.mil/usn/credential/index.html?cert=pcde8796)

| Occupational insights |
| --- |
| 86.2 percent of DevOps engineers are male and 13.8 percent are female. 52.2 percent of DevOps engineers are white, 29.8 percent are Asian, 8.4 percent are Hispanic, 4.6 percent are Black, and 0.1 percent are American Indian or Alaskan Native (https://www.zippia.com/devops-engineer-jobs/demographics). |

# Works Consulted

Institute for Apprenticeships (IfATE), "DevOps Engineer," accessed September 2024, https://www.instituteforapprenticeships.org/apprenticeship-standards/st0825-v1-1.

O*Net Online, "Software Developers," https://www.onetonline.org/link/summary/15-1252.00.

The SFIA Foundation, "SFIA 9 DevOps View: Skills at a Glance," accessed January 2025, https://sfia-online.org/en/en/sfia-9/sfia-views/devops-view?path=/glance.

## STATEMENT OF INDEPENDENCE

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