

**Presidential Initiative for Artificial Intelligence and Computing (PIAIC)**

https://www.piaic.org

**Cloud Native and Mobile Web Computing Specialist Program**

Course Syllabus

**Quarter I: CN-301 Fundamentals of Cloud Native Computing**

Version 1.0.0 - 2020 (12 Weeks)

**Teaching Team:** Hira Khan, **Aamir Pinger, Daniyal Nagori, Yusuf Qutubudin, Abdullah Mustaqeem, Ameen Alam, Faraz Jahangir, Irfan Ali, Muhammad Hanzala, Muhammad Osama, Muneeb Khan, Najam Shehzad, Osama Khan, and Zarak Mughal**

**Course Description:** Linux containers are poised to take over the world; we will start this quarter with an introduction of Linux and the command line. For many non-technical people, the command line (also referred to as CLI, Terminal, bash, or shell) is a place of mystery. However, you only have to know a handful of basic commands to start feeling comfortable. In this quarter we will cover the basic commands to get you started.

From the Linux command line we will move to learning core Docker technologies, including the Docker Engine, Images, Containers, Registries, Networking, Storage, and more. All of the behind the scenes theory will be explained, and all concepts are clearly demonstrated on the command line.

After we have mastered the containers we will move towards learning Kubernetes. The Kubernetes container orchestration system safely manages the structure and flow of a distributed application, organizing containers and services for maximum efficiency. Kubernetes serves as an operating system for your clusters, eliminating the need to factor the underlying network and server infrastructure into your designs. In this course we will teach you to use Kubernetes to deploy container-based distributed applications. We will start with an overview of Docker and Kubernetes before building your first Kubernetes cluster. We'll gradually expand your initial application, adding features and deepening your knowledge of Kubernetes architecture and operation. We'll explore high-value topics like monitoring, tuning, and scaling. By the end of the quarter you will be able to appear in the Certified Kubernetes Application Developer (CKAD) exam.

**Please bring a Laptop with you for the Classes (Required, but not mandatory)**

**Preparation for Cloud Native Computing Foundation (CNCF) Kubernetes Developer exam:**

[CNCF’s Certified Kubernetes Application Developer (CKAD) Exam](https://www.cncf.io/certification/ckad/)

Members: [Google, AWS, Microsoft, IBM, Oracle, SAP, Intel, Cisco and all major technology companies.](https://www.cncf.io/about/members/)

**Textbooks:**

1. [Linux: Easy Linux for Beginners by Felix Alvaro](https://www.amazon.com/LINUX-Beginners-Step-Step-Operating-ebook/dp/B01CF1FORK)
2. [Docker Deep Dive by Nigel Poulton](https://www.amazon.com/Docker-Deep-Dive-Nigel-Poulton-ebook/dp/B01LXWQUFF/ref=sr_1_1)
3. [Kubernetes in Action by Marko Lukša](https://www.manning.com/books/kubernetes-in-action)
4. [Learn Version Control with Git: A step-by-step course for the complete beginner by Tobias Günther](https://www.amazon.com/Learn-Version-Control-step-step-ebook/dp/B00K54OL8I/ref=sr_1_3)

**Reference books:**

1. [The Kubernetes Book by Nigel Poulton](https://www.amazon.com/Kubernetes-Book-Version-November-2018-ebook/dp/B072TS9ZQZ/ref=sr_1_2)
2. [Kubernetes for Application Developers by Matthew Palmer](https://matthewpalmer.net/kubernetes-app-developer/)

**Practice code:**

1. Linux: <https://docs.google.com/document/d/14FiE-zdP9A0c4AHj3IKDKoLmKzfrUeJqBzwJ30KtJQQ/edit?usp=sharing>
2. Docker: <https://github.com/aamirpinger/docker-slide-code>
3. Kubernetes: <https://github.com/aamirpinger/k8s-slides-yaml-files>

**PIAIC Announcements Facebook Group:** <https://www.facebook.com/groups/piaic/>

**Course Facebook Group:** <https://www.facebook.com/groups/cloud.native.edu>

**Chat on Telegram:**

Group Name: PIAIC-CN

https://t.me/piaic\_cn

**Portal for online and onsite students:**

<https://portal.piaic.org/>

**Grading:**

Students will be graded based on Percentile

<https://en.wikipedia.org/wiki/Percentile>

<https://en.wikipedia.org/wiki/Percentile_rank>

A-Grade: 78- 99 Percentile

B-Grade: 41- 77 Percentile

C-Grade: 23- 40 Percentile

D-Grade: 1 - 22 Percentile

F-Grade: Anyone who doesn’t appear in two or more exams

Note: Anyone who receives a F-Grade will be removed from the program. Students who receive a D-Grade will be put on probation, and be required to earn a grade of C or above in the next quarter, to remain in the program. Anyone absent from an exam will be deemed to have received a score of zero.

**Important Note:**

If a PIAIC candidate doesn’t appear in a Quiz at the scheduled time announced by management 10% score will be deducted from the test score for every week of delay.

**Course Outline:**

1. **Cloud Native: The Modern Way to Develop Software** (Week 1, and 2A)

What is Cloud-Native? Is It Hype or The Future of Software Development?

<https://stackify.com/cloud-native/>

What is cloud-native? The modern way to develop software

<https://www.infoworld.com/article/3281046/what-is-cloud-native-the-modern-way-to-develop-software.html>

Cloud Native: A New Wave of Digital Disruption

<https://www.accenture.com/t20181112T080927Z__w__/us-en/_acnmedia/PDF-90/Accenture-Cloud-Native-POV-Final.pdf>

The CNCF sees a surge in cloud-native adoption

<https://www.itopstimes.com/cloud/the-cncf-sees-a-surge-in-cloud-native-adoption/>

10 KEY ATTRIBUTES OF CLOUD-NATIVE APPLICATIONS

<https://thenewstack.io/10-key-attributes-of-cloud-native-applications/>

Why Developers And Business Leaders Are Going Cloud Native

<https://www.forbes.com/sites/forbestechcouncil/2018/07/16/why-developers-and-business-leaders-are-going-cloud-native/#21cd0a8327f3>

Cloud Native Case Study: Pinning its Past, Present, and Future on Cloud Native

<https://www.cncf.io/blog/2018/08/14/pinning-its-past-present-and-future-on-cloud-native/>

Why the Adoption of Kubernetes Will Explode

<https://www.upwork.com/hiring/for-clients/adoption-kubernetes-will-explode/>

Indeed Report Finds Kubernetes Job Market Hot

<https://containerjournal.com/2018/12/10/indeed-report-finds-kubernetes-job-market-hot/>

1. **Linux for Beginners** (Week 2B, 3 and 4)

Chapters 1, 2, 4, 5, 7, 8, and 9 from Linux: Easy Linux for Beginners by Felix Alvaro

Essential Linux commands: <https://docs.google.com/document/d/14FiE-zdP9A0c4AHj3IKDKoLmKzfrUeJqBzwJ30KtJQQ/edit?usp=sharing>

We will use Ubuntu:

<https://tutorials.ubuntu.com/tutorial/tutorial-ubuntu-on-windows#0>

or

<https://www.lifewire.com/run-ubuntu-within-windows-virtualbox-2202098>

**Linux for Beginners Quiz in Week 5**

Total Questions: 32, Total Time: 40 minutes

1. **Additional and Supplementary Material: Fundamentals of Version Control with Git**

(**Videos and reading material available on Student Portal to help students learn Git, this material will not be covered in class to save class time)**  
Chapters 1, 2, 3, and 4 Learn Version Control with Git: A step-by-step course for the complete beginner by Tobias Günther

We will also covers these readings:

<https://help.github.com/articles/markdown-basics/>

<http://stackoverflow.com/questions/5009600/difference-between-fork-and-branch-on-github>

<http://stackoverflow.com/questions/3329943/git-branch-fork-fetch-merge-rebase-and-clone-what-are-the-differences>

<https://git-scm.com/book/en/v2/Git-Branching-Rebasing>

<http://git-scm.com/book/en/v2/Git-Branching-Remote-Branches#Tracking-Branches>

For practice: <https://try.github.io/levels/1/challenges/1>

Homework:

<https://www.datacamp.com/courses/introduction-to-git-for-data-science>

**Git Quiz in Week 1 of Quarter 2**

Total Questions: 60, Total Time: 75 minutes

*Note: Git study material and videos are being made available in the first quarter so that students are able to use Git immediately. The Git Quiz will be conducted in the first week of the next quarter i.e. second quarter and not in this first quarter.*

1. **Docker Deep Dive** (Week 5, and 6)

Chapters 1 to 8 of Docker Deep Dive book by Nigel Poulton

You will also need to learn the mounting of host directories in the containers. To learn how to mount local directory with -v flag read from here:

<https://docs.docker.com/engine/admin/volumes/bind-mounts/#choosing-the--v-or-mount-flag>

Docker slides code: <https://github.com/aamirpinger/docker-slide-code>

Homework Videos:

<https://www.youtube.com/watch?v=EnJ7qX9fkcU>

<https://www.youtube.com/watch?v=cCTLjAdIQho>

<https://www.youtube.com/watch?v=76rX4s73MrM>

<https://docs.docker.com/engine/admin/volumes/bind-mounts/#choosing-the--v-or-mount-flag>

**Docker Quiz in Week 7**

Total Questions: 25, Total Time: 40 min

1. **Kubernetes in Practice Part 1** (Week 8)

* Chapter 1 of Kubernetes in Action

1. **Kubernetes in Practice Part 1** (Week 9, 10 and 10A)

* Chapter 2 of Kubernetes in Action
* Chapter 3 of Kubernetes in Action
* ReplicaSets, Jobs, and CornJobs
  + Sections 4.2 (Replication Controller which is now replicaSet) (all subsections), 4.3 (all subsections), 4.5, 4.5.1, 4.5.2, 4.5.3, 4.5.5, 4.6 (all subsections) of Kubernetes in Action
  + Note: ReplicaSet are now part of v1 api after 1.9 <https://kubernetes.io/docs/concepts/workloads/controllers/replicaset/>
* Kubernetes Slides YAML files: <https://github.com/aamirpinger/k8s-slides-yaml-files>

**Kubernetes in Practice Quiz 1 in Week 11**

Total Questions: 47, Total Time: 60 minutes

1. **Kubernetes in Practice Part 2** (Week 10B, 11 and 12)

* Services
  + Sections: 5.1 (all subsections), 5.2.3,5.3,5.3.1, 5.3.2, and 5.7
* Probes
  + Sections: 4.1 (all subsections) and 5.5 (all subsections)
* Volumes
  + Sections: 6, 6.1, 6.2.1, 6.3 (no subsections), 6.4 and only 6.4.1 (no other subsections), 6.5 and only 6.5.1, 6.5.2,6.5.3,6.5.4,6.5.5,
* Configuring applications
  + Sections: 7.1, 7.3, 7.3.1, 7.3.2, 7.4, 7.4.1, 7.4.2,7.4.3, 7.4.4, 7.5, 7.5.1,7.5.3
* Deployments
  + Sections: 9.1 (all subsections),
  + 9.2.1 (only the section on page 255 --- RUNNING THE APP AND EXPOSING IT THROUGH A SERVICE USING A SINGLE YAML FILE),
  + 9.3 and only subsection 9.3.1, 9.3.2, 9.3.3, 9.3.4, and 9.3.5,
* Making your apps easy to run and manage with the best practices in Kubernetes
* Sections: 17.4 and 17.5
* Kubernetes Slides YAML files: <https://github.com/aamirpinger/k8s-slides-yaml-files>

**Kubernetes in Practice Quiz 2 in Week 13**

Total Questions: 45, Total Time: 60 minutes

1. **The Ultimate Kubernetes Exam Final Projects**

**(ONLY for those who registers for International CKAD certification exams)**

Those who get registered for CKAD certification can have a 7 Exam Project in 13th week that will help them prepare for CKAD International certification. It is **NOT Mandatory to attempt** but highly recommended to those who have already registered and want to attempt CKAD soon.

**The Exam Project Preparation**

We have to review this <https://github.com/cncf/curriculum>

We will follow the following resources to learn

<https://github.com/walidshaari/Kubernetes-Certified-Administrator/blob/master/README-ckad.md>

<https://medium.com/@elliot_f/my-notes-for-certified-kubernetes-application-developer-part-1-core-concepts-d1bab7bc2446>

<https://github.com/aamirpinger/CKAD-exercises>

The exam project itself is made up of 7 distinct sections.

1. Core Concepts (13%) — This covers the API primitives and how to create and configure basic Pods
2. Configuration (18%) — This involves understanding ConfigMaps, SecurityContexts, defining an applications resource requirements, creating and consuming secrets and understanding ServiceAccounts
3. Multi-Container Pods (10%) —This tests your knowledge of the multi-container design patterns such as ambassador, adapter, and sidecar)
4. Observability (18%) — This is for understanding Liveness and Readiness Probes, understanding container logging, as well as how to monitor applications in K8s and understanding debugging.
5. Pod Design (20%) — This is things like how to use Labels, Selectors, and Annotations as well as how deployments work and how to perform rollbacks. Finally, it covers Jobs and CronJobs.
6. Services and Networking (13%) — The final section involves understanding services and demonstrating a basic understanding of NetworkPolicies
7. State Persistence (8%) — This requires knowledge of PersistentVolumeClaims for storage

We will learn and study the section from the above resources, then give an exam project. We will do it for all the seven sections one by one.

**The Exam Projects Details**

Each Kubernetes Exam Project consists of many questions. You will be given only one exam at a time, and will only be given the next exam after you have passed the current exam project. If you fail in the project exam you will have appear in it again, but in the second attempt you will have 50% less time.

These exam projects are designed to help you prepare for the CKAD exam.

It's a collection of questions around the topics in the CKAD exam curriculum.

You will appear in the following exam projects.

1. Exam Project 1 - Core Concepts (120 minutes) - Question 1-4
2. Exam Project 2 - Configuration (120 minutes) - Question 5-9
3. Exam Project 3 - Multi-Container Pods (120 minutes) - Question 10-12
4. Exam Project 4 - Observability (120 minutes) - Question 13-17
5. Exam Project 5 - Pod Design (120 minutes) - Question 18-23
6. Exam Project 6 - Services & Networking (120 minutes) - Question 24-27
7. Exam Project 7 - State Persistence (60 minutes) - Question 28

In the real CKAD exam you can seek help, but cheating is out of bounds, we will follow the same rules. The real exam console will be loaded in one Chrome browser tab, and you will be allowed to open new tabs to search the official kubernetes.io documentation.

<https://kubernetes.io/docs/home/?path=users&persona=app-developer&level=foundational>

The documentation is quite elaborate and covers everything you may need during the exam.

For detailed formal requirements and rules check the official Kubernetes Candidate Handbook.

<https://www.cncf.io/certification/candidate-handbook>