



NATIONAL UNIVERSITY
OF COMPUTER & EMERGING SCIENCES
PESHAWAR CAMPUS



Name:	Roll No:
Section:	Examination:	Final
Semester:	Spring 2020	Total marks:	80
Time allowed:	180 mins	Date:	July, 2020
Course:	CS220 Operating Systems	Instructor:	Dr. Nauman

Please read these instructions carefully:

- This is an open book exam. So, you are free to consult any material or resource that you wish to use. However, you are not allowed to discuss the exam with your peers. Any plagiarism will be strictly penalized.
- Attempt all questions on a clean sheet of paper and follow the instructions as shared by the Academics Office for submission. Course code for Operating Systems is CS220. For reference, your final submission PDF should follow the format:

Name_RollNumber_CourseCode (e.g. Jehangir Khan_13P-6121_CS220)

- Answer the questions as concisely as possible.
- Think about the question before answering. You have a lot of time to solve the paper but every question would require time to see what the examiner wants. Do not rush.

1 Study Statement

Let's begin by first defining the problem you have to solve. We are going to pick the domain that you will be solving your paper in. For that, we're going to use a simple algorithm:

1. Take your NU-ID and remove all non-digit characters from it. For instance, 20P-1024 is turned to 201024. We will call this your key.
2. You need to select the correct domain from the following topics. The ID of topic you need to work with in this paper is $((\text{key} \bmod 7) + 1)$. For 201024, the ID of the topic would be 6. Make sure you understand this and pick the correct topic. We are going to call this your Topic ID.

Now look at following list of topics. You **must** pick the topic corresponding to the **Topic ID** you computed above.

1. Student management system for a large public sector university with more than 10 campuses around the country.
2. An online real-time communication platform such as Slack that supports audio chats.
3. Accounting system for a company with franchises in more than 10 cities.
4. An online video course platform that plans on serving 5 different universities and a total of 10 campuses.
5. An app store designed specifically for artists. It hosts apps for Android AND iOS both and includes reviews and ratings for apps. It is expected to have more than 10,000 apps.
6. A messaging system similar to WhatsApp that supports groups and private chats.
7. A note taking application which supports calendar and To Do lists. I should support more than 2 million users.

Now, answer all the following questions based on the topic selected above. **Remember**, your answer must match and reflect upon the topic chosen. Random, generalized answers will not get you a good score.

1. Show the working you did to compute your Topic ID. Think for a few minutes about what is involved in such a system.

Recommended time for this part: 10 minutes.

[5]

2. Recall the scale architecture we created in class — the one with three web servers and three database servers all on separate machines. Also recall that each web server was not just a box but had a lot of detail inside it — for instance, a web server software or a database software. In turn, we studied separately that discussed how each of these softwares will have an internal structure. There are quite a few decisions we needed to make.

We may set up virtual machines on each server and then run different pieces of softwares in different machines. We may set up docker or another containerization technology in each server.

From a code perspective, the primary software will need some libraries. We might also want to set up supporting provisioning software such as puppet or chef. From all this discussion, you can see that there are quite a few decisions to be made by the system architect.

Keeping in mind the following constraints:

- (a) You are expecting a large user base. You may have more than 1000 users logging in and using your system at the same time.
- (b) You have a fairly large budget and can purchase around 10 physical server machines with adequate computing power.
- (c) At certain points in the month, you get a huge number of users coming in. The number of users at any instant during the month can shoot up to around 3000.
- (d) You need to utilize all 10 physical machines since you've already purchased them.

For this part of the question, you only need to draw the architecture in detail, connecting each machine with what they would need to communicate with through straight lines. If there is any detail that needs to be added inside the machine, please draw that as well. You also need to label each component in as much detail as you deem necessary. No written description of the architecture is needed in this part of the question. Number each of the 10 machines clearly for future reference.

(As an example, you may have a certain number of web servers, some database servers, some storage devices, some monitoring machines, possibly multiple VMs inside some physical machines, containers etc.)

(Recommended time for this part: 40 minutes.)

[20]

3. Pick any 2 machines (or virtual machines/containers) that you have designed in the first part of this question. Mention again what the primary software running on this machine is (e.g. database software, web server, monitoring software). Then describe whether the OS in each of these 2 machines would be best suited for kernel level threads or user level threads. Provide rationale for your choice.

(No more than two paragraphs. Recommended time: 20 minutes.)

[10]

4. Continuing from above, discuss which of the “programming patterns for threads” would be most suitable and why.

(No more than one paragraph. Recommended time: 10 minutes.)

[5]

5. Similar to the above, pick another 2 machines and discuss which scheduling algorithms would be best suited for this particular machine? Justify your answer based on whether the software running on the machine is IO bound or CPU bound.

(No more than two paragraphs. Recommended time: 10 minutes.)

[5]

6. Pick any two machines in your architecture. Do you feel there should be a need to secure the communication between these two machine? If so, which type of encryption would be a better option — symmetric or asymmetric? Why?

(No more than two paragraph. Recommended time: 10 minutes.)

[5]

7. In whatever architecture you have designed, is there a need for a central digital certification authority (CA)? Why?

(No more than one paragraph. Recommended time: 10 minutes.)

[5]

8. Is there any system in your architecture that would require storing of sensitive user information? If so, very briefly discuss what this sensitive information would be and how you would protect it in case there is a breach of your systems?

(No more than one paragraph. Recommended time: 20 minutes.)

[10]

9. If you were to set up a monitoring system in your architecture, what would you want to monitor in your architecture. You can just mention the machine/server that you would like to monitor and what metrics (qualities) would you be measuring?

(No more than two paragraphs. Recommended time: 10 minutes.)

[5]

10. For whatever architecture you have created, what difference would it make if you are suddenly informed at the end of the whole activity that you are not going to get 10 machines but only 4. What would you have to change? Very concisely mention if this change will affect your answers to the questions you have answered above.

(No more than two paragraphs. Recommended time: 20 minutes.)

[10]

2 Submission

1. Create a **single PDF** from all your page scans and name it as per instructions. This is very important. If you do not name your PDF file correctly, it may lead to administrative issues.
2. Upload the single PDF file on SLATE. If Slate is not available, submit it on the following link:
<https://www.dropbox.com/request/2LqEdpCoRSYb2ukdpooN>
3. Suggested time for review and submission: 20 minutes.