2022 EXAMINATIONS

Lancaster University

Part II

COMPUTING AND COMMUNICATIONS – On-line Assessment [150 Minutes]

SCC.306 INTERNET APPLICATIONS ENGINEERING

*Candidates are asked to answer **THREE** questions from **FOUR**; each question is worth a total of 25 marks.*

[Please turn over]

Question 1

1.a. Developer tools in web browsers come with powerful features in order to analyse the performance of websites. This includes information on the time taken by different stages in a network request for a resource from a web server. State **three** different pieces of timing information that may be available and describe the specific activities that are involved.

[6 Marks]

1.b. You are working for a company which has identified that the speed of a webpage might be negatively impacting user engagement. Describe **two** different approaches to optimise the content of a webpage in order to reduce the time to last contentful paint and the intended impact it would have.

[4 Marks]

1.c. The company that you worked for implemented changes that you proposed and found that they did not have the intended effect.

1.c.i. Describe **one** possibility for **two** different website content optimisations that could lead to a slow down in page load and explain why.

[2 Marks]

1.c.ii. Identify **two** methodological errors that the company could have made which presented an incorrect summary of a website's performance. For each error, propose how the company could correct their methodology for gathering data in order to analyse the website's performance.

[4 Marks]

1.d. Draw **two** representative graphs that you could use to show data of the website's network performance to the company's management. One graph should show a single page load and a second graph should show the aggregate performance of page loads over a period of time. Identify the primary features of each graph, clearly state what information would be shown on their axes, and explain why these graphs have this shape.

[9 Marks]

[Total 25 Marks]

[Please turn over]

Question 2

2.a Your website has recently encountered a significant increase in the number of users frequently visiting it and some of them are encountering server errors loading the website. What **three** simple modifications could be made to your server architecture in order to reduce the likelihood of these errors and what is their intended impact?

[6 Marks]

2.b One of the pages of your website has highly dynamic content. What trade-offs exists when applying some of the optimisation techniques from the previous questions and why is this important?

[4 Marks]

2.c Describe the differences between Infrastructure as a Service, Platform as a Service and Software as a Service. Choose one of these three and reason why you would deploy your website on a cloud vendor that provides this service. Clearly explain the assumptions about the website and use these to explain your choice.

[5 Marks]

2.d One of the features of your website that is causing high loads is a computational and bandwidth expensive video delivery service. As the website is highly monolithic, it has been suggested that dividing up the website into nanoservices could be beneficial for the service's performance. Consider the content of popular video delivery websites, identify what elements the website could be divided up into API/Database, cache and webserver elements, and describe how you would architect this system. Draw the website and indicate where the output from each nanoservice would be displayed on a webpage.

[10 Marks]

[Total 25 Marks]

[Please turn over]

Question 3

3.a. HTTP/3 is an evolution of the HTTP standard. What issue is HTTP/3 primarily aiming to address, via what mechanism does it address this issue and how is that issue addressed?

[4 Marks]

3.b. You are an engineer responsible for architecting a future complex web system involving gathering data using resource-constrained IoT devices over a large area, analysing and displaying that data to users, and providing the capability for users to issue commands to resource-constrained devices. Present a diagram of the components and their interactions for such a system, state which protocols you expect to be used to achieve specific functionality, and why they should be used.

[10 Marks]

3.c. Sketch the structure of a webpage in the website from question 3.b. that is showing: (1) gathered data in a graph, and (2) controls for submitting commands to the IoT devices. Describe the interface and what steps you will take to ensure that it is enabling for different accessibility requirements.

[6 Marks]

3.d. After the design phase and during the implementation of this system, you discover that its purpose is for surveillance of users. The system will be implemented and deployed without notifying users of the surveillance and without requesting their consent.

3.d.i. As a professional software developer bound by the ACM code of ethics and the BCS code of conduct, what actions would you take in this case and why? What are the risks involved to yourself and the user?

[3 Marks]

3.d.ii. In the United Kingdom, are you protected by law if you choose to act? If so, which law should be used?

[2 Marks]

[Total 25 Marks]

[Please turn over]

Question 4

4.a. A website critical to delivering a service to an organisation's users is undergoing a security audit.

4.a.i You have discovered that one page on the website contains a form that takes input from a user and uses that input to query information in a database. Given the SQL query below, write two inputs that could be assigned to $input that would (1) allow information on all users to be obtained and (2) modifies the contents of the database.

```
SELECT * FROM users WHERE email='$input'
```

[2 Marks]

4.a.ii Describe **two** approaches to prevent this SQL query from being vulnerable to SQL injection and explain how they prevent SQL injection attacks.

[2 Marks]

4.a.iii Data breaches have occurred at other organisations. What impacts might this have on the security of the users of your system and what steps should you take in order to mitigate these impacts?

[3 Marks]

4.a.iv When an attacker is trying to gain access to a system by brute force guessing passwords, what user experience steps can be taken to mitigate such an attack.

[2 Marks]

4.a.v Future internet connected systems (such as Internet of Things devices or connected vehicles) will have different security considerations due to their characteristics. Identify **two** specific security considerations that will differ to typical internet connected devices and explain why this different approach is necessary.

[4 Marks]

4.b.i Describe the four main advantages of blockchain.

[2 Marks]

4.b.ii Using pseudocode implement the proof-of-work function utilised in Bitcoin.

The function should take two parameters: 1) `block` – the new block to be added to the blockchain, and 2) `difficulty` – with what level of difficulty you want to find an appropriate hash. The function should return the `nonce` used to obtain the hash compared with the difficulty. Use the symbol || to indicate concatenation of a `nonce` and the `block`.

[Please turn over] **[5 Marks]**

4.b.iii Using pseudocode implement the function used to check that the result from proof-of-work is correct. This function should take three parameters: 1) `block` – the block to check the integrity of, 2) `hash` – the expected hash of the block, and 3) `nonce` – the number prepended to `block` during the original proof-of-work function. The function should return `true` if the check succeeds, otherwise `false`.

[2 Marks]

4.b.iv Explain why proof-of-work is effective at providing the distributed consensus and resistance to tampering required by Bitcoin.

[3 Marks]

[Total 25 Marks]

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