2024 EXAMINATIONS

Lancaster University

Part II

COMPUTING AND COMMUNICATIONS

Available Time **[3 Hours]**

Recommended Completion Time **[3 Hours]**

SCC.306 INTERNET APPLICATIONS ENGINEERING

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

Total pages: 7

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Lancaster University

Question 1

You have recently joined an organisation which owns a product that manages sensitive documents for their clients who can access the documents via a website. This website has been poorly maintained and you have been tasked with making some improvements.

1.a. A first step to improving the website is to identify existing problem with it. Explain what approach you would take to 1) identify accessibility issues, 2) assess if such an accessibility issue is present, and 3) argue that an accessibility issue has been resolved after changes are made.

[3 Marks]

1.b. Provide an example accessibility issue and how you would go through the three steps in Question 1.a. for the issue.

[2 Marks]

1.c. Now that basic accessibility issues have been addressed on the website, you have been tasked with revising the design of the website. Sketch the structure of a **single page** of a website that presents documents to users. You should draw the same page **twice**, one for a **desktop layout** and one for a **mobile phone layout**. You should include **three** main pieces of functionality on this page and indicate where this functionality is located on the webpage.

[5 Marks]

1.d. Explain the technique you would use to develop a single implementation for this single page that presents its contents differently depending on the width of the viewport.

[2 Marks]

1.e. Now that basic accessibility issues have been addressed on the website, you have been tasked with ensuring that the website is secure. What are the **four** goals when securing data transmission and what techniques can be used to facilitate these goals?

[4 Marks]

1.f. The website has been using a self-signed certificate, explain what a self-signed certificate is, and what security issues arise from using one for this website.

[2 Marks]

1.g. The website provides the ability for users to search for text inside documents using a HTML form. This input is nor correctly sanitised. Assuming an SQL database schema with a `documents` table that has a field called `document_name`, write an input to the search form that would list all document hosted on the server.

[4 Marks]

1.h. Provide two examples of different techniques could be used to mitigate an SQL injection attack. Explain why one of these approaches is better than the other.

[3 Marks]

[Total 25 Marks]

Question 2

2.a. A component of building management systems sense information (e.g., temperature) about a building and then automatically adjust the operation of the building (e.g., turning heaters on/off).

Using natural language tests written using the cucumber framework, write a test for the following scenario: 1) **given** a temperature sensor and a heater in the same room, 2) **when** the temperature sensor reports a temperature of 25 or more, 3) **then** turn off the heater.

You **should not** give an implementation and should **only specify** the natural language test case.

Identify how variables are indicated in the test case and describe what the different variables represent.

[8 Marks]

2.b. You have been asked to scale a small building management system from 10s of sensors and heaters into a system with thousands of sensors and heaters.

Draw a diagram of the system, which would include: 1) many temperature sensors, 2) many heaters, 3) a central server, 4) and any other infrastructure that would be necessary to implement this system.

Identify which **protocols** different components of the systems would use to interact and explain why this protocol is suitable.

[5 Marks]

2.c. What step would you take when designing the firmware of the sensors to ensure that it can be updated over-the-air once the sensors are deployed? Explain the disadvantage of this requirement.

[2 Marks]

2.d. As a significantly larger number of devices are part of the system many more people now want to access a website that is used to configure the heating for individual rooms. This has led to a higher reports of server errors due to the inability of a single webserver to handle the demand from users.

2.d.i. What **two** metrics could you use to justify the presence of a genuine performance issue?

[2 Marks]

2.d.ii. Describe **three** different approaches you could use to scale the website.

[3 Marks]

2.d.iii. Draw a system design of the website backend and **justify** the components present that could be used to scale the website to a larger number of users.

You should specify which components deliver: 1) primary capabilities, database / storage capabilities and 3) are used to enhance performance.

The website should allow users to customise heating settings, view historical temperatures, and any other feature you deem appropriate (ensure you explain what such features are).

[5 Marks]

[Total 25 Marks]

Question 3

3.a. An old website whose layout was obtained using HTML tables is being redesigned. The development team has come across two approaches (Intrinsic and Responsive) to ensure that content is displayed well across a range of different screen widths. Compare these two approaches and make a recommendation for **one** approach and explain why you have made this recommendation.

[5 Marks]

3.b. Give **three** examples of accessibility features this website could implement. These examples should be for at least **two** different types of impairments.

[3 Marks]

3.c. You have now been tasked with reducing the latency of the website. What **four** main factors could **exist that lead to high latency?**

[4 Marks]

3.d. Draw a representative histogram of a website with **high latency** and another for a website with **low latency**. Describe how the histogram is skewed and why long tails may occur. Ensure that the graphs are suitably labelled.

[6 Marks]

3.e. Which summary statistic is typically a better measure of centrality for these skewed distributions and why?

[2 Marks]

3.f. What is the difference between a histogram of page loads and a waterfall diagram?

[1 Marks]

3.g. While analysing the performance of the website you have encountered the owners of the website instructing your colleagues to intentionally slow it down for users with a disability to discourage them to use the website.

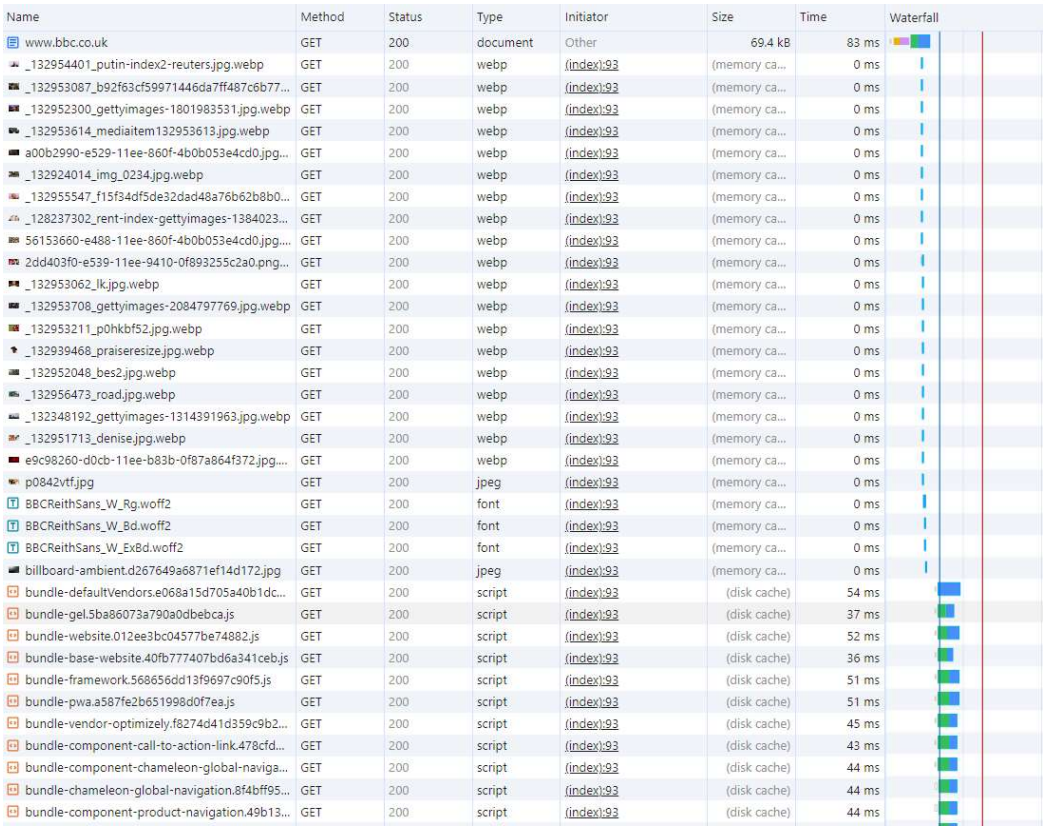
List **two** actions you could take and the possible consequences of those two actions to yourself.

[4 Marks]

[Total 25 Marks]

Question 4

4.a Figure 4.1 below shows a screen shot taken from Google Chrome Developer Tools. It depicts a network trace taken from the 'www.bbc.co.uk' web site.



Name	Method	Status	Type	Initiator	Size	Time	Waterfall
www.bbc.co.uk	GET	200	document	Other	69.4 kB	83 ms	
_132954401_putin-index2-reuters.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
_132953087_b92f63cf59971446da7ff487c6b77...	GET	200	webp	(index):93	(memory ca...	0 ms	
_132952300_gettyimages-1801983531.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
_132953614_mediaitem132953613.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
a00b2990-e529-11ee-860f-4b0b053e4cd0.jpg...	GET	200	webp	(index):93	(memory ca...	0 ms	
_132924014_img_0234.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
_132955547_f15f34df5de32dad48a76b62b8b0...	GET	200	webp	(index):93	(memory ca...	0 ms	
_128237302_rent-index-gettyimages-1384023...	GET	200	webp	(index):93	(memory ca...	0 ms	
56153660-e488-11ee-860f-4b0b053e4cd0.jpg....	GET	200	webp	(index):93	(memory ca...	0 ms	
2dd403f0-e539-11ee-9410-0f893255c2a0.png...	GET	200	webp	(index):93	(memory ca...	0 ms	
_132953062_lk.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
_132953708_gettyimages-2084797769.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
_132953211_p0hkbf52.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
_132939468_praiseresize.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
_132952048_bes2.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
_132956473_road.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
_132348192_gettyimages-1314391963.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
_132951713_denise.jpg.webp	GET	200	webp	(index):93	(memory ca...	0 ms	
e9c98260-d0cb-11ee-b83b-0f87a864f372.jpg....	GET	200	webp	(index):93	(memory ca...	0 ms	
p0842vtf.jpg	GET	200	jpeg	(index):93	(memory ca...	0 ms	
BBCReithSans_W_Rg.woff2	GET	200	font	(index):93	(memory ca...	0 ms	
BBCReithSans_W_Bd.woff2	GET	200	font	(index):93	(memory ca...	0 ms	
BBCReithSans_W_ExBd.woff2	GET	200	font	(index):93	(memory ca...	0 ms	
billboard-ambient.d267649a6871ef14d172.jpg	GET	200	jpeg	(index):93	(memory ca...	0 ms	
bundle-defaultVendors.e068a15d705a40b1dc...	GET	200	script	(index):93	(disk cache)	54 ms	
bundle-gel.5ba86073a790a0dbebca.js	GET	200	script	(index):93	(disk cache)	37 ms	
bundle-website.012ee3bc04577be74882.js	GET	200	script	(index):93	(disk cache)	52 ms	
bundle-base-website.40fb777407bd6a341ceb.js	GET	200	script	(index):93	(disk cache)	36 ms	
bundle-framework.568656dd13f9697c90f5.js	GET	200	script	(index):93	(disk cache)	51 ms	
bundle-pwa.a587fe2b651998d0f7ea.js	GET	200	script	(index):93	(disk cache)	51 ms	
bundle-vendor-optimizely.f8274d41d359c9b2...	GET	200	script	(index):93	(disk cache)	45 ms	
bundle-component-call-to-action-link.478cfd...	GET	200	script	(index):93	(disk cache)	43 ms	
bundle-component-chameleon-global-naviga...	GET	200	script	(index):93	(disk cache)	44 ms	
bundle-chameleon-global-navigation.8f4bff95...	GET	200	script	(index):93	(disk cache)	44 ms	
bundle-component-product-navigation.49b13...	GET	200	script	(index):93	(disk cache)	44 ms	

Figure 4.1: Network activity screen shot when loading the BBC website.

i. Figure 4.1 shows two lines: blue (leftmost) and red (rightmost) vertical lines under the Waterfall section at approximately 128 milliseconds and 238 milliseconds respectively.

Explain what the two lines represent.

[2 marks]

What is the significance of these two lines in terms of website performance.

[2 marks]

ii. Some of resources files are loaded before the blue line and some are loaded after.

What might explain this difference in behaviour between the two?

[2 marks]

iii. Figure 4.2 below shows and a more detailed timing breakdown of the 'home page' request. Explain the significance in time required of the following phases:

a. Queueing
b. DNS lookup
c. Initial connection
d. SSL
e. Waiting for server response

f. Content download

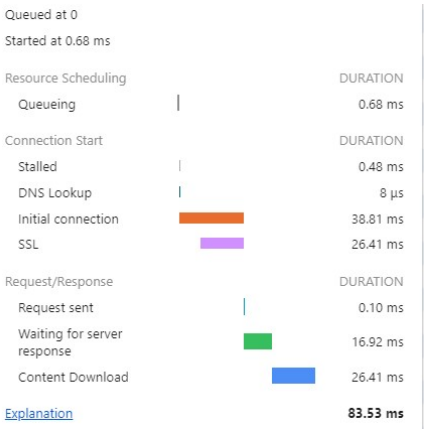


Figure 4.2: Time breakdown phases of the BBC website home page

[3 marks]

4.b Caching is used to improve website performance. Describe the different ways in which caching can be utilised effectively. Provide one example where the use of caching may be inappropriate.

[4 marks]

4.c Describe three deficiencies with HTTP/1.x and explain how each can be addressed in terms of current web performance best practice.

[6 marks]

4.d Explain how HTTP/2 has been designed to improve web performance. Describe three techniques that HTTP/2 uses and explain how each of them achieves an improvement in performance.

[6 marks]

[Total 25 Marks]

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