



Assessed Coursework

Course Name	Networked Systems (H)			
Coursework Number	Exercise 1			
Deadline	Time:	4:00pm	Date:	26 February 2026
% Contribution to final course mark	20%			
Solo or Group	<input checked="" type="checkbox"/> Solo	<input checked="" type="checkbox"/> Group		
Anticipated Hours	20			
Submission Instructions	Submit via Moodle			
Please Note: This Coursework cannot be Re-Assessed				

Code of Assessment Rules for Coursework Submission

Deadlines for the submission of coursework which is to be formally assessed will be published in course documentation, and work which is submitted later than the deadline will be subject to penalty as set out below.

The primary grade and secondary band awarded for coursework which is submitted after the published deadline will be calculated as follows:

- (i) in respect of work submitted not more than five working days after the deadline
 - a. the work will be assessed in the usual way;
 - b. the primary grade and secondary band so determined will then be reduced by two secondary bands for each working day (or part of a working day) the work was submitted late.
- (ii) work submitted more than five working days after the deadline will be awarded Grade H.

Penalties for late submission of coursework will not be imposed if good cause is established for the late submission. You should submit documents supporting good cause via MyCampus.

Penalty for non-adherence to Submission Instructions is 2 bands

Networked Systems (H) 2025-2026 – Exercise 1

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12 February 2026

Introduction

The combination of TCP and TLS can be used to establish a reliable and secure connection over which data can be exchanged between a client and a server. TCP also includes congestion control algorithms to adapt the speed of transmission to match the available network capacity.

The goal of this exercise is to test your understanding of the TCP and TLS protocols, including the TCP and TLS handshakes, reliability mechanisms, and congestion control. The exercise further tests your ability to write code to work with, and extract and visualise information about, network packet traces as might be necessary when understanding or debugging network protocols and their performance.

You should review the material in Lectures 2, 3, 5, and 6, complete the exercises in Lab 5, and then answer the following questions about TCP, TLS, and congestion control. **This is an assessed exercise that is worth 20% of the marks for this course.**

Assessed Exercise 1

TCP Connection Establishment

Review and complete Section 3 of laboratory exercise 5 (“TCP Connection Handshake”) and answer the following:

Question 1: In the `lab05.pcap` file, what IP address and source port are used by the client that is opening the connection? What is the IP address of the server to which the client is connecting? [2 marks]

Question 2: In the `lab05.pcap` file, what is the initial sequence number chosen by the client? What is the initial sequence number chosen by the server? [2 marks]

Question 3: In the `lab05.pcap` file, what is the initial round-trip time from the client to the server? That is, what is the difference between the timestamp recorded when the first packet was sent and the time response was received (each line of the `tcpdump` output starts the timestamp of the event). [1 mark]

Question 4: The first two packets sent in `lab05.pcap` include the option `sackOK`. This indicates that the client and server are willing to use TCP Selective Acknowledgements (SACK). Do some background reading and, in your own

words, describe what is indicated by an acknowledgement in TCP, what is a TCP selective acknowledgement, and how do selective acknowledgements change what is acknowledged by TCP. Explain why selective acknowledgements are useful and what effect, if any, they have on TCP congestion control [10 marks].

Question 5: The `tcpdump` output for the first packet in the `lab05.pcap` file contains a specification of the receive window (“`win 65535`”) and the window scaling option (“`wscale 6`”). Do some background reading and explain what is the TCP receive window and what is the impact of window scaling on the receive window. State also the size of the receive window, in bytes, that will be used by the client in this connection. [5 marks]

Question 6: Explain the difference between the receive window and the congestion window in a TCP connection. Which is the limiting factor in TCP throughput? [5 marks]

Starting an HTTP Connection

Review and complete Section 4 of laboratory exercise 5 (“Starting an HTTP Connection”) and answer the following:

Question 7: Packets 5-8 sent in `lab05.pcap` comprise an acknowledgement followed by the TLS ServerHello. Discuss why the server might send an acknowledgement with no data before it sends the ServerHello [3 marks].

Question 8: Do some background reading about the TLS ServerHello message, and explain what parts of its content make it large enough that it needs three packets to send [2 marks].

Question 9: With reference to the blog post on “The Illustrated TLS 1.3 Connection” in the reading relating to Lecture 3, explain what are the contents of packets 9-13 in the `lab05.pcap` file [5 marks]

TCP Congestion Control

Review and complete Section 5 of laboratory exercise 5 (“TCP Congestion Control”) and answer the following:

Question 10: Submit the graph you prepared in lab 5, plotting the received TCP sequence number (y-axis) against its reception time (x-axis). Your graph should be legible without needing to zoom the PDF, with clearly labelled axes and clear data points. [5]

Question 11: Review the graph you prepared in lab 5, and discuss what aspect of TCP behaviour is illustrated during the first 0.2 seconds of the connection. Justify your answer with reference to features of the graph [5 marks].

Question 12: Review the graph you prepared in lab 5, and discuss what aspect of TCP behaviour is illustrated by the portion of your graph showing the sequence numbers of TCP packets received *after* the first 0.2 seconds of the connection. With reference to the underlying cause and behaviour of TCP, explain and justify your answer [5 marks].

Submission

You should submit a single report, in PDF format, that answers the 12 questions given above. A mark out of 50 will be assigned to your submission, weighted as noted earlier. This mark will be converted to a percentage, then used to assign a band on the University's 22 point scale.

Prepare your PDF file formatted for A4 paper, in two columns, using the Times Roman/Times New Roman font in 11pt, with 1.5cm margins, and with the exercise title, your GUID (matriculation number and initial letter of your surname), and the date at the top of the first page (i.e., using a format that matches the last two pages of the handout). If you use L^AT_EX to prepare your document, the following structure will format your submission appropriately:

```
\documentclass[11pt,a4paper,twocolumn]{article}
\usepackage[cm]{fullpage}
\usepackage{newtxtext}
\usepackage{newtxmath}
\begin{document}
\title{Networked Systems (H) Exercise 1}
\author{GUID goes here}
```

```
\maketitle
\section*{Question 1}
...your text here...
\end{document}
```

You are not required to use L^AT_EX when preparing your report. Your report must not exceed three pages in length, including all figures, tables, and any references. **Length is not an indication of merit.** If you can answer the questions in less than three pages, then please do so.

You must submit your report before 4:00pm UK time on 26 February 2026. Following the code of assessment, late submissions will be accepted for up to 5 working days beyond this due date. Late submissions will receive a two band penalty for each working day, or part thereof, the submission is late. Submissions that are received more than five working days after the due date will be awarded a band of H.

Submissions must be made via Moodle. This problem set is worth 20% of the mark for this course. You must submit a single PDF file, ns-ex1-*GUID*.pdf, replacing *GUID* with your GUID (your student number followed by the first letter of your surname). **Submissions that are formatted incorrectly, that have the wrong filename, or that otherwise do not follow the submission instructions will be given a two band penalty. Such penalties will be strictly enforced.**

If you are ill, or have other exceptional circumstances that may affect your submission, then you should contact the Student Support Team before the deadline to request an extension, following the usual procedure.

Feedback will comprise a breakdown of your mark by question, along with brief written justification for the marks assigned.