Lesson Plan for: Cybersecurity & Cryptography

Tutor: Omar Choudhry Tutor's Email: O.Choudhry@leeds.ac.uk

Colour codes: Assessment, Lectures, Practicals/Debates/Discussions/Workshops

Lesson Date	Learning Objectives				
	Course topic (according to course outline)	**Type of class (e.g. format, specific skills taught)**	**Description of class (e.g. sub-topics, key questions)**	**Location**	**Time**
WEEK 1 30 June Sunday	a) Course Introduction		Student introductions and discussing what they hope to achieve from the program, including plans for future studies and employment, such as goals for the next 1-, 5- and 10 years,	Computer Lab	8:30-9:00
	b) Career Paths in Cybersecurity	Lecture	Begin by potentially instilling additional motivation in students. I would discuss certifications, courses, competitions and potential jobs and salaries. This should be in the first lecture (immediately following my introduction to students).	Computer Lab	9:00:9:15
	c) Career Paths in Cybersecurity	Practical activity + Q&A	Give students an opportunity to refine their original goals and read them out. Use this time for a question-and-answer session, too.	Computer Lab	9:15-9:30
	d) Critical Cybersecurity Case Studies	Lecture	This is to provide additional motivation and to refer back to it as we teach future core topics. This way, students will clearly understand that the theory they are learning is entirely applicable in practice and potentially give some	Computer Lab	9:30-10:00

			excitement at the beginning (I mean, how does the US Pentagon get hacked?…). As a side point, the rest of this lecture can be used to discuss some bases around security, hackers and threats and perhaps authentication (including entropy, physical tokens, two-factor authentication (2FA) and biometrics).		
	e) Assessment	Critical Cybersecurity Case Studies Assessment	Given a case study, answer some relevant questions. **Closed-book assessment worth 5%.**	Computer Lab	10:00-10:15
	f) Basic Coding	Coding Lab: IDE Setup	Get students to set up the VSCode IDE on their devices/computers with Python, pip, and relevant packages. If there are issues, focus on setting up with Google Colab.	Computer Lab	10:15-10:30
	g) Basic Coding	Coding Lab: Learn Python	Begin going through coding exercises. Learn how to use interactive python notebooks, write and run code.	Computer Lab	11:00-11:45
	h) Assessment	Basic Coding Assessment	Simple exercises in Python. The main form of assessment is not to see correct answers but rather to observe the students and monitor their effort and focus. **Open-book assessment worth 5%.**	Computer Lab	11:45-12:00
	i) Specialist Topic: Advanced Coding	Coding Lab: Version Control	Half an hour to introduce and use version control. Students would make *GitHub* accounts, create repositories using the IDE, attempt to create branches, make commits, and perform push and pull requests. All students could use this repository to store all	Computer Lab	12:15-12:45

			their previous work and future work from this point on. Though this is a specialist topic, it will be useful to have this done early on to help with the rest of the course.		
1 July Monday	a) Architecture of Computers	Architecture of Computers Workshop	Discussing computer architecture (*Boolean logic*, *truth tables*, *number systems*, *memory*, *operating systems*, *CPUs*, *GPUs*). We will provide some assembly code examples and show buffer overflow in action. There will be a supplied worksheet (a Python interactive workbook) they will be able to complete throughout this 2 hour session (providing an exact breakdown may not be feasible here).	Computer Lab	8:30-10:30
	b) Architecture of Computers	Practical Lab: Dissecting a PC	Show students how real computers are built from beginning to end, including how to install an operating system. We will not actually build the computer – instead, we will focus on removing certain components and showing its insides.	Computer Lab	11:00-12:00
	c) Assessment	Architecture of Computers Assessment	Pick a computer component and explain its role. Describe its inputs and outputs and what it interfaces with. Take a question with some logic gates and describe what they do, as well as a complete truth table. **Open-book assessment worth 10%.**	Computer Lab	12:15-12:45
2 July Tuesday	a) Database Systems	Practical Database Systems Workshop	We will go over database systems (*database architecture, relational algebra, ER modelling, normalisation,* and *database design*). To	Computer Lab	8:30-10:00

			supplement this workshop, we will use online modelling software.		
	b) Database Systems	Lecture: The Data in Database	Discussions on *big data*, *database management systems*, maintaining *data privacy regulations*, and *visualising*.	Computer Lab	10:00-10:15
	c) Database Systems	Lecture: Data Ethics and Case Studies	We will discuss ethics and look at cyber case studies.	Computer Lab	10:15-10:30
	d) Database Systems	Practical SQL Lab	We will examine relational data in SQL, learn how to exploit vulnerabilities, perform SQL injections, and supplement this with exercises in SQL and Python.	Computer Lab	11:00-12:00
	e) Assessment	Database Systems Assessment	Design an SQL schema from a list of requirements and perform ER modelling. Question on SQL query. **Open-book assessment worth 10%.**	Computer Lab	12:15-12:45
3 July Wednesday	a) Cryptographic Techniques	Lecture: Cryptography	Introduction to this area. This would give an overview of what happens in the entire encryption/decryption process. We will mention public and private cryptography.	Computer Lab	8:30-9:30
	b) Cryptographic Techniques	Practical Cryptography Encryption	Showing how we can actually **encrypt** and **decrypt** messages **mathematically**.	Computer Lab	9:30-10:00
	c) Cybersecurity Legislation and Regulation	Group Debate	Allow students to choose from a list of questions. Then, divide them into two groups, each arguing its own side.	Computer Lab	11:00-12:30

4 July Thursday	a) Assessment	Cryptographic Techniques Assessment	A group activity to encrypt a message and then compete with each other in a race to decrypt each others' messages.	Computer Lab	8:30-10:30
	b) Network Security Concepts	Lecture: Introduction to Network Security	One of the most important topics. Introduction to the Internet infrastructure and network architecture.	Computer Lab	11:00-12:00
	e) Week 1 survey			Computer Lab	12:30-12:45
WEEK 2 7 July Sunday	a) Network Security Concepts	Lecture: Introduction to Network Security	One of the most important topics. Introduction to the Internet infrastructure and network architecture.	Computer Lab	8:30-9:00
	b) Network Security Concepts	Practical: Design Practical	Students should design a theoretical system interacting with the internet and research potential vulnerabilities.	Computer Lab	9:00-10:30
	c) Network Security Concepts	Practical: Identifying and Mitigating Vulnerabilities	Analyse your designed system in the previous practical and identify the vulnerabilities. Research ways to fix the problems online. Prepare a lightning talk to present.	Computer Lab	11:00-12:30
8 July Monday	c) Network Security Concepts	Lecture: Network Security Concepts	Discuss *TCP/IP networking threats* and *architecture*, *network defences (TLS and firewalls)* and *packet filtering*.	Computer Lab	8:30-9:30
	e) Network Security Concepts	Group Discussion	Lightning talks of all students.	Computer Lab	9:30-10:30
	f) Network Security Concepts	Lecture: Network Security Concepts Continued	Continue discussing network security concepts. Focus on *defence against man-in-the-middle attacks, firewalls* and *domain name systems (DNS)*.	Computer Lab	11:00-12:30
9 July Tuesday	a) Cyber Attacks	Lecture: Cyber Attacks	Many core topics revolve around attacks. We would combine this all under *Hacking and*	Computer Lab	8:00-8:15

			Cyber Attacks, initially beginning with an introduction, followed by analysing case studies for **Brute Force Attacks** and **DDoS Attacks.**		
	b) Network Security Concepts	Practical Wireshark Lab	Look at how we can use the Wireshark software tool.	Computer Lab	8:15-8:45
	c) Assessment	Network Security Concepts Assessment	Describe how the internet works, why we need security and how we implement it. **Open-book assessment worth 15%.**	Computer Lab	8:45-9:30
	d) Network Security Concepts	Practical HackTheBox Lab	Look at how we can use Linux and some of its commands to break into a virtual machine.	Computer Lab	9:30-10:30
	e) Cybersecurity Legislation and Regulation	Lecture: Cybersecurity Legislation and Regulation	Based on all the information we have covered so far, we should discuss legislation and regulations (including those in Saudi Arabia, the United Kingdom, the United States, and the EU).	Computer Lab	11:00-11:30
	f) Cyber Attacks	Research Lab	Reseach task. Students will split up into groups to find an example of either a DDoS attack or malware/virus, how it occurred and why, consequences and following preventative/safeguarding measures. Students to work in groups and present at the end of the session.	Computer Lab	11:00-12:30

10 July Wednesday	a) Hacking	Lecture: Hacking	Malware discussed would be **logic bombs, backdoors, viruses, supply chain tracks, Trojan horses** and **worms**. This would also include methods to prevent malware and viruses, such as **anti-viruses, command injections** and **input validation**.	Computer Lab	8:00-10:30
	b) Assessment	Written Assessment	This is the final assessment. There will be one question on each previous major topic. We will not include hacking or cyber-attacks here, as this will be in the following assessment. The decision to move this written assessment to week 2 was due to the potential lack of time marking. This closed-book assessment is **worth 20%.**	Computer Lab	11:00-12:00
	c) Assessment	Hacking and Cyber Attacks Assessment	This test will ask questions about different attacks and potential mitigations. **Open-book assessment worth 20%.**	Computer Lab	12:00-12:30
11 July Thursday	**Field Trip**	**See the STEM Field Trip Proposal below.**			**All Day**
WEEK 3 14 July Sunday	a) Specialist Topic	Setup Linux Lab	We will spend this session in the Linux lab and set up environments for Python programming.	Computer Lab	8:30-9:00
	b) Specialist Topic	Python Programming: Basics	Lecture to discuss basic programming concepts, fundamental data structures, data science workflow and IDEs.	Computer Lab	9:00-9:30
	c) Specialist Topic	Python Programming: Basics	We will work through Python programming to reinforce information learnt in the previous lecture.	Computer Lab	9:30-10:30

	d) Specialist Topic	Python Programming: Operators	Lecture to discuss basic programming concepts, fundamental data structures, data science workflow and IDEs.	Computer Lab	11:00-11:30
	e) Specialist Topic	Python Programming: Operators	We will work through Python programming to reinforce information learnt in the previous lecture.	Computer Lab	11:30-12:30
15 July Monday	a) Specialist Topic	Python Programming: Conditional Statements	Lecture to discuss basic programming concepts, fundamental data structures, data science workflow and IDEs.	Computer Lab	8:30-9:00
	b) Specialist Topic	Python Programming: Conditional Statements	We will work through Python programming to reinforce information learnt in the previous lecture.	Computer Lab	9:00-10:00
	c) Specialist Topic	Python Programming: Loops	Lecture to discuss basic programming concepts, fundamental data structures, data science workflow and IDEs.	Computer Lab	10:00-10:30
	d) Specialist Topic	Python Programming: Loops	We will work through Python programming to reinforce information learnt in the previous lecture.	Computer Lab	11:00-12:00
	e) Specialist Topic	Python Programming: Final Challenge	Using all the previous information learnt, build a programming	Computer Lab	11:00-12:00
16 July Tuesday (half day)	a) Specialist Topic	Closing & Q&A	The final session will be set to give some final recaps and overview for the course and to give students the opportunity to ask questions and discuss areas beyond the course.	Computer Lab	8:30-10:15
	b) Final survey			Computer Lab	10:15-10:30

STEM group project: Designing a secure sustainable power grid. This project will involve two core aspects: designing a sustainable power grid using renewable energy sources and a relevant, robust cybersecurity framework. The cybersecurity aspect will consider secure

communication channels, encryption of data transmissions, and authentication protocols for grid access and control. The engineering aspect will focus on creating a sustainable energy source that could be developed within Saudi Arabia. It will consider the process of collecting, storing, and converting energy to electricity, but mainly transportation of the energy, thinking about the required physical infrastructure.

Certain aspects need to be considered, such as what happens in the case of an actual attack and what fail-safes are in place, energy-specific issues such as solar only working during clear day-time or safety and economic challenges for nuclear power plants, geographical locations, challenges with integration into any existing electrical grid and political challenges. Also, evaluate if a distributed power grid is better than a single large power plant (a grid generally has more redundancy, but the probability of a successful attack increases due to the increased connections in the notebooks and with a larger number of physical locations). This project will be interesting for the students as it combines both disciplines in an extremely relevant field, constituting various principles and ideas from both courses.

The main deliverables and forms of assessment will be a 4-page report (50%, based on application of technical knowledge, relevance to the real-world, novelty and innovation, organisation and clarity), a set of slides (25%, based on clarity, conciseness, use of media and diagrams) and the physical presentation (25%, based on delivery and communication skills, time-management and answering questions).

STEM Field trip proposal: 1. **Mishkat Interactive Centre**: This centre raises awareness of renewable energy sciences, which makes it a perfect option for inspiring students to do their group projects. They offer various programs we could do: The Wind Challenge (45 minutes), Inventor Zone (30 minutes) and Robotics Lab (45 minutes). 2. **Cybersecurity Firms**: The idea would be to visit a cybersecurity firm. The interest is clear - to give students a more practical experience and insight into the real world. If the company is happy to host for a longer time, including a tour, talks and a Q&A. This could take up to 2 hours in total. For both field trips, up to 1 hour would be spent on the transportation (there and back). This would leave 30 minutes to split between the introduction and debrief.

Mishkat Interactive Centre: https://maps.app.goo.gl/Nu1soQp8twR4GRWu8 (Maps), https://en.mishkat.org.sa/programs/ (Website)

Cybersecurity Forms:

1. **Wattlecorp Cybersecurity Labs**: https://maps.app.goo.gl/CYXStq1B1WaGT9MA7?g_st=ic (Maps), https://www.wattlecorp.com/sa/ (Website)

2. **Cipher Company for Cybersecurity**: (https://maps.app.goo.gl/US5Zkzovm5EgVmDu7?g_st=ic (Maps), https://cipher.com.sa/ (Website)
3. **Looptech**: https://maps.app.goo.gl/Bk2QQ38LvJ5LELhd6?g_st=ic (Maps), https://looptech.com.sa/ (Website)
4. **National Museum** (if issues with other options): https://maps.app.goo.gl/TZFkvTbkS9JB5Faf7?g_st=ic (Maps)