## **Lesson Plan for: Cybersecurity & Cryptography**

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

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| **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 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). | Computer Lab | 9:30-10:00 |
| 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 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. | Computer Lab | 12:15-12:45 |
| **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 supplement this workshop, we will use online modelling software. | Computer Lab | 8:30-10:00 |
| 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 themost importanttopics. 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 themost importanttopics. 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 Cyber Attacks*, initially beginning with an introduction, followed by analysing case studies for **Brute Force Attacks** and **DDoS Attacks.** | Computer Lab | 8:00-8:15 |
| 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) Assessment | Hacking and Cyber Attacks Assessment | This test will ask questions about different attacks and potential mitigations. **Open-book assessment worth 20%.** | Computer Lab | 8:15-8:45 |
| 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 was in the previous 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 | 8:45-9:30 |
| c) 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 | 9:30-10:30 |
| d) Hacking | Lecture: Hacking | Continue discussing cyber attacks and hacking. | Computer Lab | 11:00-12:30 |
| **11 July**  **Thursday** | 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 |
| **WEEK 3**  **14 July Sunday** | 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 |
| **15 July Monday** | **Field Trip** | **See the STEM Field Trip Proposal below.** | | | **All Day** |
| **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.

**STEM Field trip proposal:** **Cipher Company for Cybersecurity** (a Cybersecurity Firm): 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. Up to 45 minutes would be spent on the transportation (there and back). This would leave 30 minutes to split between the introduction and debrief. We will have roughly a 2 hour session (<https://maps.app.goo.gl/US5Zkzovm5EgVmDu7?g_st=ic> (Maps), <https://cipher.com.sa/> (Website). During the session, the students will split up into groups and will be given introduction to areas around the company. They will have an opportunity to do a hands on activity and have closing remakrs from a company executive.