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| **Getting to know one another** | **Unit** | **0** |
| Welcome to the Cloud Computing course “Unit 0” activity.This first activity aims at cultivating a sense of community among the students taking the course. The topic sets the stage for successful and interesting encounters with the course instructor and your classmates and offers opportunities to create an environment that will foster achievement of overall learning outcomes.To start off the course, you will introduce yourself and get to know your fellow students and instructor by posting, reading and commenting on the posts of others in the online forum. As your instructor, I am excited about meeting you and will accompany you as you learn this course. My expectation is that through this course, you will gain the requisite masterly of concepts and skills in cloud computing. I also look forward to a cordial and collaborative learning environment. It is now my turn to know you. As part of the activity for this week, click on the 'forum' tab. On the 'Getting to know You' forum, introduce yourself and tell us about your experience with cloud computing. In addition to that, indicate your expectations of this course. You can set up threads and/or leave comments on the forum. I wish you all the best as you explore the world of cloud computing. |
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| **Unit-level overview** | **Unit** | **1** |
| Unit name or title: | Introduction to Cloud Computing: Computing Paradigms *(NB. Unit 1 and 2 will be completed together in the same week)* |
| Aim of the unit: | This unit aims at helping you understand various computing paradigms and their challenges and how new computing paradigms have been conceptualized to address those challenges. You will then relate those developments and challenges to the emergence of cloud computing.  |
| This topic covers: | This unit introduces you to the various paradigms of computing, namely: 1. Parallel computing
2. Bio computing
3. Quantum computing
4. Grid computing
5. Cloud computing
6. Utility computing
7. Distributed computing
8. Ubiquitous computing
9. Centralized computing

Synergetic human-machine computing |
| Intended learning outcomes: | *At the end of this unit, you will be able to:*1. Identify and describe the major computing paradigms
2. Explain why cloud computing has become a compelling paradigm for managing and delivering resources
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| Overview of student activity: | A pre-topic video R1.0 will give you an overview of this unit, and after that the main video explains to you the need to be familiar with two articles (R1.2 and R1.3) and another video (R1.1). You will discuss various ideas regarding paradigms with your classmates and with the tutor and finally determine the most influential paradigm using an online poll |
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| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| Identify and describe the major computing paradigms. | 1 | E1.1, E1.2, E1.3 | A1.1 |
| Explain why cloud computing has become a compelling paradigm for managing and delivering resources. | 1 | E1.4 | A1.2 |
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| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| Unit 1 addresses Module-level outcome 1 which requires you to demonstrate an understanding of the concepts and principles of cloud computing. |
| Purpose of the unit/week/section: |
| This unit will help you understand various computing paradigms and their related challenges. It will also help you appreciate why cloud computing has become a compelling paradigm for managing and delivering resources over the Internet. |
|  Over to you: *(a description of the process of the section)*  |
| In this first unit you will be introduced to the wider context of computing paradigms within which Cloud Computing is contained. Beginning with the pre-topic activity and then to the unit activities you will need to watch the two videos [R1.0 and R1.1 then read articles R1.2 and R1.3](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing). These which will help you name the paradigms and discuss their meanings with your classmates. |
| Pre-topic activity: |  Number of hours | 15 mins |
| E1.1 Watch the videos [R1.0 Cloud Computing](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing) and [R1.1 Computing Paradigms](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing) and use what you learn to draw a concept map for computing paradigms. (What is a concept map? See [R1.2 Concept Map Example](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)). Draw a concept map for computing paradigms with at least five branches of paradigms. |
| Face to face time: *(if applicable)* | Number of hours | 30 mins |
| E1.2 Discuss face-to-face with classmates and tutor on computing paradigms and the challenges they attempt to resolve. Make appropriate notes. You will need these notes to complete the last part of online activity E1.3. |
| Online activity | Number of hours | 75 mins |
| What should students do? | E1.3: * Read the short article R1.3 Computing Paradigms.
* Choose any one of the conventional paradigms and draw a simple diagram of a possible system architecture that fits that paradigm. Post your diagram, without naming the paradigm on the class group on the VLE. Draw a simple diagram and do not spend more than 15 mins on this part.
* Select the diagram of one of your classmates that you identify as representing a different paradigm, name it and explain why you identified it as such. Also suggest improvements to the diagram, if any.
* Comment appropriately on at least one classmate who attempted to identify your diagram. If necessary, post an improved version of your diagram.
* Using what you have learned from the entire class group, and from the face-to-face discussions in class, add appropriate diagrams in the word document R1.3. This activity helps you achieve unit level learning outcome 1.

Using notes that you made during activity E1.2, add a brief description of each paradigm below the diagram you have inserted in R1.3. Save you revised document, adding your name for submission as assessment A1.1. |
|  | E1.4: Discuss briefly within your group at least 2 reason why Cloud Computing is a compelling paradigm for managing and delivering services over the Internet. Be careful that your discussions appear in your online group to show the detailed contributions of each member up to and until arriving at the two reasons. This will be your assessment A1.2.*Your group will be assigned by the e-moderator and this group will be used in all subsequent units in this module. The group will as far as possible balance different abilities, gender, backgrounds and other relevant characteristics.* |
| Where do they do it? | After face-to-face discussions in class, you will do E1.3 and E1.4 on the Virtual Learning Environment (VLE) using any connected personal computer. |
| By when should they do it? | You should complete each online activity within seven days from the time the activity is given. |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours |  |
| *(The number of hours is already included within the time for learning activities)* Learning outcome 1 will be assessed through A1.1: You will submit the revised R1.3 after completing the activity E1.3. You will be scored for each diagrammatical concept that matches the paradigms and a brief description given. You are expected to provide at least six paradigms.Learning outcome 2 will be assessed through A1.2: Your online group discussion will be scored for each individual member’s valuable contribution towards the final group output. |
| How does this section link to other sections of the module? |
| This unit sets the stage for the rest of the units in this module by giving you the over-arching concepts and challenges which cloud computing seeks to resolve. |
|  |
| = Total number of hours  | 2 Hours |
|  |
| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | [R1.0 - Video:](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)  *[Cloud Computing](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)*[R1.1 – Video:](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)  *[Computing Paradigms](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)*[R1.2 – Article:](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing) *[Concept Map Example](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)*[R1.3 - Article:](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing) *[Conventional and Emergent Computing Paradigms](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)* |
| How are students enabled to access the resources? | Resources are shared on the VLE that students have access to using a shared enrolment key. |
| Where in this unit are students expected to work collaboratively? | Commenting on your peers’ work in the class group as well as online discussion in your smaller group are the bases of collaboration in this unit |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All resources are downloadable for use offline. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |

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| **Unit-level overview** | **Unit** | 2 |
| Unit name or title: | Fundamentals of Cloud Computing *(NB. Unit 1 and 2 will be completed together in the same week)* |
| Aim of the unit: | In this unit, you will learn about the fundamental principles underlying cloud computing. You will also be able to justify the need for cloud computing and use a cloud application.  |
| This topic covers: | The basic concepts of cloud computing and the motivation behind cloud computing. It also introduces basic user skills of cloud computing |
| Intended learning outcomes: | *At the end of this* ***unit****, you will be able to:*1. Define Cloud Computing and its basic concepts.
2. Justify the need for cloud computing.

Use a cloud application |
|  |
| Overview of student activity: | You will watch two videos and practice using a cloud application. You will discuss concepts of cloud computing and related practical ideas with your classmates and with the tutor |
|  |
| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| Define Cloud Computing and its basic concepts.  | 1 | E2.1, E2.2, E2.3 | A2.1 |
| Justify the need for cloud computing.  | 1 | E2.2, E2.3, E2.4 | A2.2 |
| Use a cloud application | 1 | E2.5 | A2.2 |
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| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| This Unit addresses Module-level Outcome 1 which requires you to demonstrate an understanding of concepts and principles of cloud computing. |
| Purpose of the unit/week/section: |
| The purpose of this unit is to help you review the basic principles related to cloud computing.  |
| Over to you: *(a description of the process of the section)* |
| This unit will give you an understanding of the basic concepts of cloud computing. You will learn how to use basic cloud applications. You will read the given article and watch the video clips which will help you justify the need for cloud computing. You will then practice using common cloud applications. |
| Pre-topic activity: |  Number of hours | 10 mins |
| E2.1 Watch the video [R2.1 Cloud Computing Fundamentals](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing) and in one sentence write down in your own words why cloud computing is needed in the world of today. Keep this sentence for E2.2 |
| Face to face time: *(if applicable)* | Number of hours | 40 mins |
| E2.2 Discuss face-to-face with classmates and tutor on the essential characteristics, service models, and deployment models of cloud computing. Discuss what circumstances would lead to an individual or institution making use of SaaS, PaaS and IaaS. Under your basic sentence from E2.1, expand your write-up with short notes referring to the characteristics, service models and deployment models. Keep this for reference for E2.3 |
| Online activity | Number of hours | 70 mins |
| What should students do? | E2.3 Read R2.2 NIST *Definitions for Cloud Computing.* Using this and the notes you made for E2.2, make a concept map that correctly links cloud computing to its characteristics, service models and deployment models. Keep this for submission as assessment A2.1. |
| E2.4 Watch the video on R2.3 *Mr Ford’s Class - Cloud Computing* <https://www.oercommons.org/courses/the-internet-04-05-cloud-computing/view>. Using your online group mention and explain to your fellow group members which use of cloud computing he mentions that you find most interesting and why. |
| E2.5 Explore the google apps environment and briefly use at least four of the applications. Capture screen shots of each and paste in a Word document with a brief caption of each. At the end of the document write a paragraph explaining which of these applications could have an impact in your life or career. Keep this document ready for submission for assessment as A2.2 |
| Where do they do it? | After face-to-face discussions in class, you will do this activity on the Virtual Learning Environment (VLE) using any connected personal computer.  |
| By when should they do it? | You should complete this activity within seven days from the time the activity is given |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours |  |
| Assessment A2.1 assesses unit-level outcome 1: define cloud computing and its basic concepts. The assessment will be scored for its accuracy in aligning to the basic concepts as they appear in R2.2Assessment A2.2 assesses both unit-level outcome 2 – justify the need for cloud computing - and outcome 3, use a cloud application. You will score maximum points if the need is stated correctly and logically justified. Your practice of the application will score if you used each application for its right purpose. |
| How does this section link to other sections of the module? |
| This unit helps you gain insights into the fundamental concepts of cloud computing and it will be useful for unit 4. |
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| = Total number of hours  | 2 Hours |
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| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | [R2.1 - Video: Cloud Computing Fundamentals](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing) [R2.2 - Article: Definitions for Cloud Computing](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)[R2.3 – Video: Mr Ford’s Class - Cloud Computing](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)   |
| How are students enabled to access the resources? | Resources are shared on the VLE that students have access to using a shared enrolment key. |
| Where in this unit are students expected to work collaboratively? | Commenting on your peers’ work in the class group as well as online discussion in your smaller group are the bases of collaboration in this unit |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All resources are downloadable for use offline. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |

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| **Unit-level overview** | **Unit** | 3 |
| Unit name or title: | Cloud Computing Architecture & Management |
| Aim of the unit: | This unit aims at equipping you with skills to identify the layers of cloud computing architecture, their purpose and how they are interrelated. |
| This topic covers: | * The different layers of cloud architecture.
* The functions of these layers.
* The relationships amongst these layers.

The special case of IBM cloud reference architecture. |
| Intended learning outcomes: | *At the end of this* ***unit****, you will be able to:*1. Describe cloud architecture & anatomy
2. Explain how to manage cloud infrastructure
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| Overview of student activity: | You will watch a video and read an article and then perform the describedassessments and e-tivities. |
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| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| 1. Describe cloud architecture & anatomy | 1 | E3.1 | A3.1 |
| 2. Explain how to manage cloud infrastructure | 1 | E3.2 | A3.2 |
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| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| Unit 3 addresses Module-level Outcome 1 which requires you to demonstrate an understanding of concepts and principles of cloud computing. |
| Purpose of the unit/week/section: |
| The purpose of this unit is to help you to comprehend the essential components of the cloud, what their functionsare and how they are interrelated. It gives you an understanding of the underlying infrastructure, both hardwareand software and the management issues surrounding cloud in computing. |
|  Over to you: *(a description of the process of the section)*  |
| In this unit you will learn about the various layers of the cloud architecture, their components and how they areinterrelated. You will also learn about the managerial issues related to cloud computing. This will enable you toappreciate the role of each component and why it exists. You will also gain an appreciation of the various criticalroles in cloud management. This will help you to understand what hardware, software and managerial roles youwill require to setup and manage a cloud infrastructure. |
| Pre-topic activity: |  Number of hours | 20 mins |
| E3.1 Read the article [“cloud computing architecture” (R3.1)](https://www.w3schools.in/cloud-computing/cloud-computing-architecture/), by w3 schools, followed by the article [IBM cloud](https://www.w3schools.in/cloud-computing/cloud-computing-architecture/)[computing reference architecture” (R3.2),](https://www.w3schools.in/cloud-computing/cloud-computing-architecture/) by Ghantasala. Additionally watch the video on [“overview of](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)[cloud computing architecture” by IBM from minute 27.00 to 43.00 (R3.3)](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing).Write down the major components of cloud architecture and explain their functions.Write done the major management issues related to cloud computing and why they are important. |
| Face to face time: *(if applicable)* | Number of hours | 60 mins |
| E3.2: E-moderator subdivides the students in groups of 3. In the groups, the students discuss the relationshipbetween cloud architecture and the IBM cloud reference architecture. They will then place the components of thereference architecture where they fit in the general architecture. Finally, there will be a class discussion in plenarythat will agree on the outcome of the discussion. |
| Online activity | Number of hours | 2 hours |
| What should students do? | E3.3: refer to the managerial issues that you read about in e-tivity 3.2. Draw a possible organogram depicting new roles and responsibilities for a hypothetical organization that must manage a cloud infrastructure. |
| Where do they do it? | After face-to-face discussions in class, you will do this activity in a computer laboratory or using personal computer. |
| By when should they do it? | You should complete this activity within seven days from the time the activity is given. |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours | 40 mins |
| You will be scored if you correctly list the various components of cloud architecture and their importance. Learning outcome 1 will be assessed through A3.1 (Describe Cloud Architecture &amp; Anatomy). Identify the major components of cloud architecture and their functions. Post it on the VLE.A3.2 (Explain how to manage cloud infrastructure).Learning outcome 2 will be assessed through A3.2 (Share your organogram of a possible set of roles and responsibilities for a hypothetical business that runs a cloud service, post it on the VLE.) |
| How does this section link to other sections of the module? |
| An understanding of cloud anatomy and infrastructure gives you an idea of how the various hardware andsoftware components work together to achieve delivery of cloud solutions. |
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| = Total number of hours  | 4 Hours |
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| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | [R3.1 – Article- Cloud Architecture](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)[R3.2 – Article – IBM Cloud Reference Model](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing)[R3.3 – Video – overview of cloud architecture](https://drive.google.com/drive/folders/1xAgk9DoFcPj2J7z3s_yUG_nJQ22GJIB5?usp=sharing) |
| How are students enabled to access the resources? | Resources are shared on the VLE that students have access to using a sharedenrolment key. |
| Where in this unit are students expected to work collaboratively? | During the class session where they discuss and relate the cloud architecture with IBM reference architecture. |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All resources are downloadable for use offline. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |

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| **Unit-level overview** | **Unit** | 4 |
| Unit name or title: | Technological Drivers for Cloud Computing |
| Aim of the unit: | This unit will help you illustrate how the technological components contributes to the success of cloud computing |
| This topic covers: | 1. Technological drivers of cloud computing2. Tools and techniques used to deliver cloud solution |
| Intended learning outcomes: | *At the end of this* ***unit****, you will be able to*1. Describe the characteristics of each underlying technology in detail (Lo1)2. Demonstrate how each of these technological components contributes to the success of cloud computing  |
|  |
| Overview of student activity: | You will read a write-up proposed for this unit and reflect on the mentioned technological drivers of cloud computing. |
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| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| 1. Describe the characteristics of each underlying technology in detail | 1 | E4.1 | A4.1 |
| 2. Demonstrate how each of these technological components contributes to the success of cloud computing | 1 | E4.1 | A4.1 |
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| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| Unit 4 addresses Module-level Outcome 1 which requires you to demonstrate an understanding of concepts and principles of cloud computing. |
| Purpose of the unit/week/section: |
| The purpose of this unit is to help student demonstrate how technological components contributes to the success of cloud computing before they deploy a virtual machine in unit 5. |
| Over to you: *(a description of the process of the section)* |
| In this unit you will identify technological drivers of cloud computing and discusses each technological component in detail. As recent advancements in each of these technologies are highlighted with their advantages and characteristic features, this prepares you to select the best tools to use in a practical deployment phase in Unit 5. |
| Pre-topic activity: |  Number of hours | 1 hour |
| Read (R4.1) which provides you with a brief description on Service-Oriented Architecture (SOA) and the Service-Oriented Computing (SOC).E4.1: Explain the purpose of each of the 3 entities shown in the figure enclosed and platforms they use to communicate to each other. |
| Face to face time: *(if applicable)* | Number of hours | - |
|  |
| Online activity | Number of hours | 2 hrs 20 min |
| What should students do? | * Read (R4.1) which provides you with a brief description on Service-Oriented Architecture (SOA) and the Service-Oriented Computing (SOC).
* Explain the purpose of each of the 3 entities shown in the figure enclosed and platforms they use to communicate to each other.
* Describe any 4 benefits of using Service-Oriented Architecture (SOA)
 |
| Where do they do it? | You will do this activity in a computer laboratory or using personal computer |
| By when should they do it? | You should complete this activity within seven days from the time the activity is given |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours | 40 mins |
| Learning outcome 1 will be assessed through E4.1  |
| How does this section link to other sections of the module? |
| This unit focuses on identifying those technological drivers of cloud computing and discusses each technological component in detail. This unit helps you identify ideal tools used to deploy a virtual machine in unit 5. |
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| = Total number of hours  | 4 Hours |
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| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | (R4.1) [SOA (Service Oriented Architecture) and Cloud Computing](https://drive.google.com/open?id=1iZAejjzHpWLIBPpP_WQLQX8bQo_YQD0p)  |
| How are students enabled to access the resources? | Resources are shared on the Virtual Learning Environment that students have access to using a shared enrolment key. |
| Where in this unit are students expected to work collaboratively? | You will read the notes made by at least 3 of your classmates and add any point you could have left out to your notes. And re-post the newer version.You will comment on the work of at least 2 of your classmates |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All study resources are downloadable for off-line use. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit 4 by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |

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| **Unit-level overview** | **Unit** | 5 |
| Unit name or title: | Virtualisation |
| Aim of the unit: | This unit will help you describe virtualization, explain its benefits and apply that knowledge in creating a virtual machine. |
| This topic covers: | 1. The concept of virtualization2. Components of a virtual machine 3. Types of hypervisors4. Creating and configure a virtual machine. |
| Intended learning outcomes: | *At the end of this* ***unit****, you will be able to:*1. Identify and describe the various types of virtualization and approaches2. Create and configure a virtual machine |
|  |
| Overview of student activity: | You will watch a video, read an article and practically learn how to deploy a virtual machine. |
|  |
| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| 1. Identify and describe the various types of virtualization and hypervisors | 1 | E5.1 | A5.1 |
| 2. Create and configure a virtual machine | 2, 3 | E5.2, E5.3 | A5.2 |
|  |
| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| Unit 5 addresses Module-level Outcome 1 which requires you to demonstrate an understanding of concepts and principles of cloud computing; Module-level Outcome 2 which requires you to deploy (install, programme and configure) a secure cloud-based application and Module-level Outcome 3, which requires you to solving a real-life challenge through provision resources using open-source tools |
| Purpose of the unit/week/section: |
| The purpose of this unit is to demonstrate different approaches used to deploy a Virtual Machine in while solving a real-life challenge. |
|  Over to you: *(a description of the process of the section)*  |
| In this unit you will deploy a virtual machine, install an operating system and install an open source application used to provide a real-life service – an eLearning application. |
| Pre-topic activity: |  Number of hours | 30 mins |
| E5.1 Watch this video clip (R5.1). Take note of the name of the software that lets you run multiple operating systems on one physical server. List at least 3 open-source software that lets you run multiple operating systems on one physical server. |
| Face to face time: *(if applicable)* | Number of hours | 50 mins |
| E5.2 Read the first page of this article (R5.2). Take notes on benefits that virtualization has over traditional systems. In your respective groups describe virtualization benefits that your department can consider using and explain why. |
| Online activity | Number of hours | 2 hours |
| What should students do? | * E5.3 Watch the following video clips (R5.3) and (R5.4)
* Set up at least 2 virtual machines using one of the hypervisors discussed under this topic (e.g.: [VMWare](https://www.vmware.com/products/workstation-pro/workstation-pro-evaluation.html), [Oracle VirtualBox](https://www.virtualbox.org/wiki/Downloads)).
* Install an operating system (e.g.: [Debian](https://www.debian.org/CD/netinst/), [Ubuntu](https://help.ubuntu.com/community/Installation/MinimalCD#A64-bit_PC_.28amd64.2C_x86_64.29_.28Recommended.29)) on each virtual machine.
* Set up ONLY ONE specific open source information system (e.g.: [Moodle](https://docs.moodle.org/37/en/Step-by-step_Installation_Guide_for_Ubuntu), [Koha](http://kohageek.blogspot.com/2017/06/install-koha-on-debian.html), [UniTime](http://help.unitime.org/Timetabling_Installation), [DSpace](http://libtechnophile.blogspot.com/2019/01/installing-dspace-63-in-ubuntu-18041-lts.html)) on each virtual machine.
* Make notes of all steps you took to set up ONE virtual machine in point/bulleted form to the discussion forum and comment on the notes posted by 2 of your colleagues.
 |
| Where do they do it? | You will do this activity in a computer laboratory or using personal computer |
| By when should they do it? | You should complete this activity within seven days from the time the activity is given |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours | 40 min |
| Learning outcome 1 will be assessed through A5.1 [E5.1 and E5.2]Learning outcome 2 will be assessed through A5.2 [ E5.3] using an [assessment rubric](https://drive.google.com/a/strathmore.edu/file/d/1QFNLo8-qspkjXJm3DTKkswGXUV5x6Thy/view?usp=sharing) |
| How does this section link to other sections of the module? |
| This unit helps you to practically apply concepts learnt in Unit 3 on Cloud Deployment and Service Models and Unit 4 on Technological Drivers for cloud computing. This unit paves the way for you for Unit 10 on Security in Cloud Computing |
|  |
| = Total number of hours  | 4 Hours |
|  |
| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | (R5.1) [Virtualization and Cloud Computing](https://www.youtube.com/watch?v=JpdnMnRXigY) (R5.2) [Cloud computing virtualization challenges](https://www.journalijar.com/article/18464/cloud-computing-virtualization-challenges/)(R5.3) [Install VM Debian](https://drive.google.com/open?id=1ZK04arRFQNBQFudraLZTCoQVNKpviV11)(R5.4) [Apache2 php MariaDB](https://drive.google.com/open?id=1ScF3e2Z2RPMbRCibskUkQWVYcKFfCjO6) |
| How are students enabled to access the resources? | Resources are shared on the Virtual Learning Environment that students have access to using a shared enrolment key. |
| Where in this unit are students expected to work collaboratively? | You will read the notes made by at least 3 of your classmates and add any point you could have left out to your notes. And re-post the newer version.You will comment on the work of at least 2 of your classmates |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All study resources are downloadable for off-line use. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |

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| **Unit-level overview** | **Unit** | 6 |
| Unit name or title: | Programming models for Cloud Computing  |
| Aim of the unit: | This unit helps you to differentiate between the different types of cloud computing models and the rationale or reason for their creation and their key features. These different models are specifically used to create cloud –based programs that address the needs of concurrency, fault-tolerance, multi-tenancy and parallelization. However, the different models do not address all these features exhaustively. |
| This topic covers: | 1. The characteristics of cloud-based applications
2. The reasons why new programming models are necessary.
3. The key features of the models and the characteristics they support.
 |
| Intended learning outcomes: | *At the end of this* ***unit****, you will be able to:*1. Discuss the rationale behind the need for new programming models.
2. Describe the key features of cloud programming models.
3. Write a basic MAPReduce program in a cloud environment.
 |
|  |
| Overview of student activity: | You will read notes and references that will help you to understand the core concepts of the topic as stated in the outcomes. You will then read a tutorial that gives more details of one of the programming models (MAPReduce). You will then log onto Heroku cloud platform and write a basic MAPReduce program. This will demonstrate to you how the model differs from traditional programming.  |
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| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| 1. Discuss the rationale behind the need for new programming models.  | 1 | E6.1, E6.2 | A6.1 |
| 2. Describe the key features of cloud programming models.  | 1 | E6.2 | A6.1 |
| 3. Write a basic MAPReduce program on the Heroku cloud platform.  | 3 | E6.3 | A6.2 |
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| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| Unit 6 addresses Module level outcome 1 that requires you to demonstrate understanding of concepts and principles of cloud computing and Module level outcome 3 on solving a real-life challenge by provision resources using open-source tools. |
| Purpose of the unit/week/section: |
| The purpose of this unit is to assist you to comprehend why cloud applications require different programming models, what these models are and their key features and the characteristics of cloud programs that they support. Cloud applications should have certain characteristics like multi tenancy, fault tolerance, parallelism and scalability among others. These programming models are unique in that they allow programmers to create applications with these characteristics.  |
| Over to you: *(a description of the process of the section)* |
| In this Unit, you will learn about the different cloud programming models that have been devised to create cloud applications that are compliant with the characteristics of multi tenancy, scalability, parallelized and fault tolerance. This Unit links to Unit 3 where you learn about cloud models and services and Unit 5 where you learn about the different technologies used in cloud computing. You should be able to relate the concepts in this unit with those from those units.You should be able to create a program on the cloud using one of the models and describe the difference between the model and traditional programming.  |
| Pre-topic activity: |  Number of hours | 20 mins |
| E6.1 read the notes provided on “Programming Models for Cloud Computing” (R7.1), provided on the VLE. What are the some of the reasons that new models are needed? Make a brief write-up of one paragraph and post this on the VLE.  |
| Face to face time: *(if applicable)* | Number of hours | 1 hour |
| E6.2: a face to face lecture on cloud computing models will precede the e-tivity. This will be followed by a multiple-choice quiz (A6.1) that summarizes knowledge gained from the lecture.  |
| Online activity | Number of hours | 2 hours |
| What should students do? | E6.3: Read the tutorial on MAPReduce programming (R7.2). It contains instructions on how to log onto the Heroku cloud platform, an optional link to python tutorial in case you are not familiar with python. You will then write a python program in the map reduce model to demonstrate how it works (A6.2)You will share the link to your work with the instructor in the VLE forum.  |
| Where do they do it? | After face-to-face class lecture, you will do this activity in a computer laboratory or using personal computer. |
| By when should they do it? | You should complete this activity within seven days from the time the activity is given. |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours | 40 mins |
| You will be scored if you correctly identify at least three reasons why new programming models are required. You will be scored correctly if you provide a link to your work on Heroku and the moderators is able to run the program successfully. Learning Outcomes 1 & 2 will be assessed via the multiple-choice quiz A6.1.Learning outcome 3 will be assessed from proper completion of the e-tivity on Heroku A6.2.  |
| How does this section link to other sections of the module? |
| This unit links to the units on cloud computing services and models and the one on cloud computing technologies. In services and models, you have learnt about different models like PaaS and SaaS. E-tivity 6.3 gives you a chance to work on a real-world PaaS. In ‘cloud computing technologies” you learn about the main technologies used in cloud computing including different programming models briefly mentioned therein. This unit is a further elaboration of those concepts.  |
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| = Total number of hours  | 4 Hours |
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| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | R6.1 – Article- Cloud computing programming models. R6.2 – Tutorial- MAPReduce model in python on Heroku. |
| How are students enabled to access the resources? | Resources are shared on the VLE that students have access to using a shared enrolment key. |
| Where in this unit are students expected to work collaboratively? | While working on the tutorial, the students are allowed to work collaboratively.  |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All study resources are downloadable for off-line use. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |

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| **Unit-level overview** | **Unit** | 7 |
| Unit name or title: | Software Development in the Cloud  |
| Aim of the unit: | The aim of this unit is to help you gain knowledge of how SaaS applications are developed on a PaaS environment.  |
| This topic covers: | 1. Differentiating SaaS from traditional applications. 2. The benefits of SaaS applications to users & service providers. 3. The challenges of using SaaS applications. 4. Developing SaaS applications using PaaS |
| Intended learning outcomes: | *At the end of this* ***unit****, you will be able to:*1. Differentiae traditional applications from SaaS applications.2. Describe the benefits of using SaaS applications. 3. Discuss the challenges of using and developing SaaS applications. 4. Develop a SaaS application in a PaaS environment.  |
|  |
| Overview of student activity: | You will read notes that have been prepared on the VLE. You will then go through a tutorial on how to develop and deploy a SaaS application on Red Hat Open shift PaaS environment. You will share your application with the instructor/ moderator. You will also discuss with your classmates what you think are the merits, demerits and challenges involved in such a deployment once you are done with your task. |
|  |
| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| 1. Differentiate traditional applications from SaaS applications. | 1 | E7.1, E7.2 | A7.1 |
| 2. Describe the benefits of using SaaS applications.  | 1 | E7.2 | A7.2 |
| 3. Discuss the challenges of using and developing SaaS applications.  | 1 | E7.2 | A7.2 |
| 4. Develop a SaaS application in a PaaS environment. | 3 | E7.3 | A7.3 |
|  |
| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| Unit 7 addresses Module level outcome 1, demonstrating an understanding of concepts and principles of cloud computing, and 3, solving a real-life challenge by provision resources using open-source tools. |
| Purpose of the unit/week/section: |
| The purpose of this unit is to help you gain knowledge of the characteristics of SaaS applications and how to develop and deploy a SaaS application in a PaaS environment. Platform as a Service (PaaS) allows developers to deploy cloud applications on infrastructure that does not belong to the organization, rather is being leased. This comes with different benefits and challenges both to the user and to the organization. Deploying a SaaS application is also different from traditional applications and this unit aims to give you a chance to practically deploy a SaaS application while at the same time imparting the theoretical knowledge to you.  |
| Over to you: *(a description of the process of the section)* |
| In this unit you will learn about the characteristics of SaaS applications including their challenges and benefits. You will learn how to deploy a SaaS application in a PaaS environment. This unit links to unit 3 that gave an overview of cloud deployment models and mentions SaaS & PaaS. This unit gives a practical implementation of the two. It also links to unit 9 “open Source Support for Cloud”. You will deploy a SaaS application on Red hat open shift which is an open source platform. it also links to unit 4 “Cloud Computing Technologies”. Being able to deploy a SaaS on a PaaS is an important cloud skill.  |
| Pre-topic activity: |  Number of hours | 20 mins |
| E7.1 read the notes on “Software Development on the Cloud” that have been posted on the VLE. What do you think are additional challenges and advantages of deploying a SaaS application rather than traditional applications? Post your reflections on the VLE in a brief essay not exceeding 100 words |
| Face to face time: *(if applicable)* | Number of hours | 1 hour |
| E7.2: E-moderator subdivides the students in groups of 3. Listen to the lecture on “Software Development in the Cloud” and discuss with your colleagues the difference between cloud SaaS and traditional applications. Find more material from the internet to supplement the notes given by the lecturer. Find at least five differences. Rank the differences according to what you think Is the most significant (5) to least significant difference (1). Share your ranking in class plenary session.  |
| Online activity | Number of hours | 2 hours |
| What should students do? | E7.3: go through the tutorial on “how to deploy a SaaS application in Red Hat open shift. Follow through the steps of the tutorial and deploy the application as instructed in the tutorial. Share the URL/ link of your deployed application with the moderator on the VLE.Write a brief paragraph relating the differences between traditional applications and SaaS applications based on your experience (not from the theoretical concepts).  |
| Where do they do it? | After face-to-face discussions in class, you will do this activity in a computer laboratory or using personal computer. |
| By when should they do it? | You should complete this activity within seven days from the time the activity is given. |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours | 40 mins |
| You will be scored if you correctly complete the tree e-tivities. Marks will be given for an attempt to complete the e—tivities. Learning outcomes 1 will be assessed through A7.1 - Listen to the lecture on “Software Development in the Cloud” and discuss with your colleagues the difference between cloud SaaS and traditional applications. Find more material from the internet to supplement the notes given by the lecturer. Find at least five differences. Rank the differences according to what you think Is the most significant (5) to least significant difference (1). Share your ranking in class plenary session.Learning outcome 2 & 3 will be assessed through A7.2 - read the notes on “Software Development on the Cloud” that have been posted on the VLE. What do you think are additional challenges and advantages of deploying a SaaS application rather than traditional applications? Post your reflections on the VLE in a brief essay not exceeding 100 words.Learning outcome 4 will be assessed through A7.3 - go through the tutorial on “how to deploy a SaaS application in Red Hat open shift. Follow through the steps of the tutorial and deploy the application as instructed in the tutorial. Share the URL/ link of your deployed application with the moderator on the VLE.Write a brief paragraph relating the differences between traditional applications and SaaS applications based on your experience (not from the theoretical concepts) |
| How does this section link to other sections of the module? |
| Having looked at Unit 3 (Cloud Computing Architecture and Management), Unit 6 (Technological Drivers for Cloud Computing) and Unit 7 (Virtualization), this unit exposes you to security concerns when deploying a Cloud Computing environment. It also helps you to apply this knowledge to design and deploy a secure virtual environment. |
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| = Total number of hours  | 4 Hours |
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| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | R7.1 - notes: “software development on the cloud”R7.2 – tutorial- “deploying a cloud application on red hat open shift”.  |
| How are students enabled to access the resources? | Resources are shared on the VLE that students have access to using a shared enrolment key. |
| Where in this unit are students expected to work collaboratively? | In E7.2 where you will make comparison of traditional s SaaS applications and rank them.  |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All study resources are downloadable for off-line use. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |

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| **Unit-level overview** | **Unit** | 8 |
| Unit name or title: | Cloud Service Providers |
| Aim of the unit: | The aim of this unit is to give an overview of different cloud service providers as well as the services each provider offers. |
| This topic covers: | * Different companies offering cloud services
* Tools offered by these companies
* Cloud services offered by each of the companies
* Features and architectures of different tools.
 |
| Intended learning outcomes: | *At the end of this* ***unit****, you will be able to:*1. Identify cloud service providers and list the services they offer.2. Identify and describe the features of open source/proprietary tools offered by the companies. |
|  |
| Overview of student activity: | You will identify different cloud services which you use and list the companies which offer the services. You will perform an online search to identify local cloud service companies and list their services. Finally, you will draw a comparison between open source tools and proprietary tools. |
|  |
| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| 1. Identify cloud service providers and list the services they offer. | 1 | E8.1, E8.2, E8.3 | A8.1  |
| 2. Identify and describe the features of open source/proprietary tools offered by the companies. | 1 | E8.4 | A8.2  |
|  |
| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| Unit 8 addresses module outcome 1 which requires you to demonstrate an understanding of concepts and principles of Cloud Computing. |
| Purpose of the unit/week/section: |
| Cloud computing represents the disruptive shift which has shaken up the enterprise software ecosystem. It is important to be conversant with several cloud service providers who offer a variety of services based on a company’s direct needs. This unit will prompt you to discover such services offered by different providers as well as be able to differentiate between open source and proprietary tools. |
| Over to you: *(a description of the process of the section)* |
| In this unit you will learn about different cloud service providers, services offered by these companies and tools which they offer their users ranging from free tools to paid for tools. |
| Pre-topic activity: |  Number of hours | 0.5 hours |
| E8.1 Before you perform other activities in this unit, reflect on your previous and current use of cloud services. Do this through identifying the cloud services that you use, or you have used before and list the service as well as the company offering the service. Post this on the VLE forum and read the list posted by each of your group members. Expand your original list by adding the service providers listed by your group members which you had not listed.  |
| Face to face time: *(if applicable)* | Number of hours | 2 hours |
| E8.2 Interact with your tutor and classmates to discover cloud service providers and the services they offer. After this, perform an online search on local cloud service providers and their offerings. |
| Online activity | Number of hours | 1 hour |
| What should students do? | E8.3 Perform an online search on local cloud service providers and summarise your findings by listing at least 2 providers and the services they offer companies. Post your summary on the VLE (A8.1). |
| E8.4 Compare and contrast between open source and proprietary tools and give motivations for use of each of the categories. R8.1, R8.2 |
| Where do they do it? | After face-to-face discussions in class, you will do this activity on the VLE using any connected personal computer. |
| By when should they do it? | You should complete this activity within seven days from the time the activity is given. |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours | 0.5 hours |
| Learning outcome 1 will be assessed through A8.1 and A8.2A8.1: Compile a summary of 2 local cloud service providers and list the services they offer. Post this summary on the VLE.A8.2: Compare and contrast between open source and proprietary tools offered by different cloud service providers. With your study buddy, give motivations for the use of each category of tools in less than 200 words. Post this on the forum discussion on the VLE and compare your response to that of your classmates.  |
| How does this section link to other sections of the module? |
| With the knowledge of what cloud services are provided by different companies as well as being able to differentiate between open source and proprietary tools, you will be able to transition to unit 10 in which Open Source Support for Cloud is discussed. |
|  |
| = Total number of hours  | 4 Hours |
|  |
| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | R8.1: [TechBeacon](https://techbeacon.com/enterprise-it/how-choose-open-source-vs-commercial-cloud-management-tools) Article - How to choose: Open-source vs. commercial cloud management toolsR8.2: [The New Stack](https://thenewstack.io/context-how-to-choose-proprietary-vs-open-source-tools/) article - Context: How to Choose Proprietary vs. Open Source Tools |
| How are students enabled to access the resources? | Resources are shared on the VLE that students have access to using a shared enrolment key. |
| Where in this unit are students expected to work collaboratively? | Activity in which students will be required to make a group presentation on a sales pitch of a fictional company’s cloud services. |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All study resources are downloadable for off-line use. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |

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| **Unit-level overview** | **Unit** | 9 |
| Unit name or title: | Open Source Support for Cloud |
| Aim of the unit: | The aim of the unit is s to give an overview of open source support for cloud |
| This topic covers: | 1. Comparison between open source and closed source tools2. Differentiation of the advantages of open source tools over closed source |
| Intended learning outcomes: | At the end of this **unit**, you will be able to:1. Differentiate between open source and closed source tools2. Describe advantages of open source tools over closed source tools |
|  |
| Overview of student activity: | You will be required to engage in class discussions with your tutor and classmates as well as two articles provided for a reading exercise. After this you will need to give motivations for the use of one open source tool of your choice, make a summary of the article you will read and finally write a summary of the topic based on your reading and upload the document to the VLE. |
|  |
| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| 1. Differentiate between open source and closed source tools | 1 | E9.1, E9.2 | A9.1 |
| 2. Describe advantages of open source tools over closed source tools | 1 | E9.3 | A9.2 |
|  |
| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| Unit 9 addresses Introduction to Cloud Computing outcome 1. |
| Purpose of the unit/week/section: |
| The unit sheds light on open source tools which support cloud computing as well as providing information on the architecture of both open source and closed source tools. Open source software has been popularised by the capability it offers software developers to extend features of existing software. Features of open source software can be built on by a wide community of engineers. Proprietary software on the other hand has restrictions on the extent to which the software can be altered by users. With the knowledge gained in this unit, you should be able to critique these two categories of tools, giving pros and cons of each. |
| Over to you: *(a description of the process of the section)* |
| In this unit you will be exposed to open source tools which different providers offer. |
| Pre-topic activity: |  Number of hours |  |
|  |
| Face to face time: *(if applicable)* | Number of hours | 2 hours |
| E9.1 Interact with your tutor and classmates to discuss the impact of Open Source cloud tools on the developer community. In your groups, identify one such tool and give a summary on what the tool is used for as well as its advantages. |
| Online activity | Number of hours | 1 hour  |
| What should students do? | E9.2 Read [Open Source For U](https://opensourceforu.com/2018/11/the-best-open-source-tools-for-cloud-infrastructure-management/) (R9.1) and [TechBeacon](https://techbeacon.com/enterprise-it/4-essential-open-source-tools-cloud-management) (R9.2) articles on open source tools for cloud infrastructure management. |
| E9.3 Write a one-page summary of unit 10 and submit on the VLE. |
| Where do they do it? | After face-to-face discussions in class, you will do this activity on the VirtualLearning Environment (VLE) using any connected personal computer. |
| By when should they do it? | You should complete this activity within seven days from the time the activity is given |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours | 1 hour |
| Learning outcome 1 will be assessed through A9.1 and A9.2.A9.1: In one paragraph, summarise your findings based on R9.1 and R9.2 and post on the VLE.A9.2: Write a one-page summary of Unit 10 and post on the VLE. |
| How does this section link to other sections of the module? |
| An understanding of open source tools versus closed source tools will allow the learner to understand security aspects associated with both open source and closed source tools. |
|  |
| = Total number of hours  | 4 Hours |
|  |
| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | R9.1 - Open Source 4 U articleR9.2 - TechBeacon article |
| How are students enabled to access the resources? | Resources are shared on the VLE that students have access to using a shared enrolment key. |
| Where in this unit are students expected to work collaboratively? | Making a comparison between open source tools versus closed source tools on the eLearning forum. |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All study resources are downloadable for off-line use. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |

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| **Unit-level overview** | **Unit** | 10 |
| Unit name or title: | Security in Cloud Computing |
| Aim of the unit: | This unit helps you acquire knowledge and skills on security aspects in Cloud Computing and apply that knowledge and skills to configure a secure virtual environment. |
| This topic covers: | * Security issues in Cloud Computing
* Solutions to Cloud Computing security issues
* Configure a secure virtual machine/environment
 |
| Intended learning outcomes: | At the end of this unit, you will be able to:1. Describe different security aspects in Cloud Computing.2. Configure an existing virtual machine to secure it. |
|  |
| Overview of student activity: | You will watch a video and read articles which will help you describe terms related to security aspects in Cloud Computing. The knowledge you acquire from the video and the articles will also help you configure an existing virtual machine (deployed in Unit 5) to make it secure. |
|  |
| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| 1. Describe different security aspects in Cloud Computing | 1 | E10.1, E10.2 | A10.1, A10.2 |
| 2. Configure an existing virtual machine to secure it | 3 | E10.3 | A10.3 |
|  |
| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| Unit 10 addresses Module level outcome 1 and 3 which require you to demonstrate understanding of concepts and principles of cloud computing and solve a real-life challenge by provisioning resources using open-source tools respectively. |
| Purpose of the unit/week/section: |
| The purpose of this unit is to assist you comprehend security issues affecting Cloud Computing environments. The importance of migrating to a cloud environment cannot be over emphasised. You need to perform due diligence of cloud service provider to ensure you keep your data and that of your client protected from any security threats. |
| Over to you: *(a description of the process of the section)* |
| In this unit, you will learn about various security issues in Cloud Computing and how to handle them. Having looked at how cloud environment works and the benefits one would accrue by migrating to the cloud, it’s paramount to recognize the security implications of such a move. Understanding possible areas of security lapses is also a pointer on the responsibility each stakeholder ought to take. The concepts you learn in this unit will help you secure a virtual environment. |
| Pre-topic activity: |  Number of hours | 1 hour |
| E10.1 Watch the video on ‘CEH18-2 Introduction to Cloud Computing Security’ (R10.1). As you watch this video, take notes on security concerns in Cloud Computing that are highlighted. Explain why security is a shared responsibility and list security issues faced by cloud providers and those faced by customers. Provide a probable solution to each of those issues. Post your notes on the VLE. Comment on the work of your class buddy and point out to them any security issue they could have missed out. Post your comments to your buddy on the VLE forum. |
| Face to face time: *(if applicable)* | Number of hours | - |
|  |
| Online activity | Number of hours | 3 hours |
| What should students do? | E10.2: Read the article on ‘Survey of Security Issues in Cloud Computing’ (R10.2). Review the seven cloud-computing security risks and do a brief description of each. In addition, develop a simple Cloud provider due diligence checklist with at least four items you would look out for to ensure your cloud is secure. Post on the VLE. |
|  | E10.3: Read the article on ‘The Research Cloud lifecycle’ (R10.3) paying attention to the mitigation tasks involved in securing a virtual machine and protect it against hacking attempts. Based on the Virtual Machine you configured in Unit 5 (Virtualisation), implement at least 3 mitigation measures to secure your virtual machine. Post the host address of your virtual machine on the VLE forum. Also, post brief notes on the mitigation measures you applied, highlighting the steps you used to achieve each of those measures on the VLE. Click on the host address provided by your study buddy. Critique the security status of the virtual machine of your class buddy and comment on it on the VLE. Consider the feedback from your class buddy and improve security of your virtual machine. Post the final host address with the improved security on the VLE and indicate it as (FINAL) at the beginning of the address. |
| Where do they do it? | You will do this activity in a computer laboratory or using personal computer. |
| By when should they do it? | You should complete this activity within seven days from the time the activity is given. |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours |  |
| Learning outcome 1 will be assessed through A10.1 (You will be scored correctly for clearly defining why cloud security is a shared responsibility and identifying security issues faced by cloud providers and customers. You will receive maximum score for clearly elaborating the solutions to security issues identified) and A10.2 (You will be scored correctly for identifying and describing seven Cloud Computing security risks. Maximum score will be given for coming up with a checklist with at least 4 four items).Learning outcome 2 will be assessed through A10.3 (You will be scored for identifying three mitigations and highlighting the steps involved. Maximum scores will be awarded for clearly elaborated steps). |
| How does this section link to other sections of the module? |
| Having deployed a virtual machine in Unit 5 (Virtualisation), this unit exposes you to security concerns when deploying such an environment. It will also help you apply that knowledge to secure the virtual machine you deployed. |
|  |
| = Total number of hours  | 4 Hours |
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| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | R10.1 – [Video](https://www.youtube.com/watch?v=k-hBrGuPxb8): CEH18-2 Introduction to Cloud Computing SecurityR10.2 – [Article](https://www.ijert.org/survey-of-security-issues-in-cloud-computing): Survey of Security Issues in Cloud ComputingR10.3 – [Article](http://training.nectar.org.au/package05/sections/mitigating.html): The Research Cloud lifecycle |
| How are students enabled to access the resources? | Resources are shared on the VLE that students have access to using a sharedenrolment key. |
| Where in this unit are students expected to work collaboratively? | You will be required to comment on the work of your class buddy in E10.1 (securityissues faced by cloud providers and customers) and E10.3 (security status of virtualmachine). |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All study resources are downloadable for off-line use. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |

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| **Unit-level overview** | **Unit** | 11 |
| Unit name or title: | Advanced Concepts in Cloud Computing |
| Aim of the unit: | This unit helps you to comprehend the research openings and applications of cloud and its appropriateness to solve general challenges in the society. |
| This topic covers: | * Mobile cloud computing
* Green cloud computing
* Intercloud
* Media cloud

Cloud analytics and computational intelligence in cloud |
| Intended learning outcomes: | *At the end of this* ***unit****, you will be able to:*1. Briefly describe Mobile cloud computing, Green cloud computing and Multimedia cloud computing.2. Examine how cloud analytics and computational intelligence in cloud are beneficial? |
|  |
| Overview of student activity: | You will read the articles provided and apply the knowledge gained to expound various advanced concepts in Cloud Computing. You are also expected to collaborate in a wiki with your class buddy. |
|  |
| **Constructive alignment of unit level outcomes with module level outcomes, learning activities and assessment** |
| Intended unit learning outcomes:***At the end of this unit, you will be able to:*** | Module-level outcome | Activity where students engage with this outcome | Where and how is this outcome assessed? |
| 1. Briefly describe mobile cloud computing, green cloud computing and multimedia cloud computing | 1 | E11.2 | A11.1, A11.2 |
| 2. Examine how cloud analytics and computational intelligence in cloud are beneficial? | 1 | E11.3 | A11.2, A11.3 |
|  |
| **Detailed explanation of ALL student and teacher engagement with the unit:***(This should be presented in the order that the activities take place. So, if students do work online before coming to the lecture, that should be shown ahead of what happens in class. If there is more than one opportunity for face-to-face contact, or more than one online task, there should be a separate section for each instance, and they should be presented in the template in the same order that students encounter them.)**Content – such as lecture material – can EITHER be shown here OR added as clearly identifiable addenda to the document. If you plan to use addenda, you should ensure that this are cross-referenced in this section.)* |
| Module-level outcomes addressed: |
| Unit 11 addresses Introduction to Cloud Computing outcome 1 which require you to demonstrate understanding of concepts and principles of cloud computing. |
| Purpose of the unit/week/section: |
| The purpose of this Unit is to make you conversant with the research work and applications of cloud. Cloud Computing is developing at a rapid pace hence the need to keep abreast of such developments. |
| Over to you: *(a description of the process of the section)* |
| This far in this module you have gained knowledge and skills on cloud computing hence you can provision computing services over the Internet to offer faster, innovative and flexible resources. In this Unit you will familiarize yourself with research work and applications of cloud to tackle various challenges in the society. |
| Pre-topic activity: |  Number of hours | 30 mins |
| E11.1 This Unit will be looking at various advanced concepts in Cloud Computing which include mobile cloud computing, green cloud computing, multimedia cloud computing, cloud analytics and computational intelligence. Identify one of these concepts that you know little or nothing about, but you are looking forward to learning more about it. Post it on the VLE forum indicating your inspiration for it. At the end of this Unit, you will be required to come back and describe what you have learned about the concept you raised earlier. |
| Face to face time: *(if applicable)* | Number of hours | - |
|  |
| Online activity | Number of hours | 2.5 hours |
| What should students do? | E11.2: Read the articles provided ‘[Study of Mobile Cloud Computing (MCC) and Research Challenges](https://www.ijert.org/study-of-mobile-cloud-computing-mcc-and-research-challenges)’ (R11.1), ‘I[ncentives to Apply Green Cloud Computing](https://scielo.conicyt.cl/scielo.php?script=sci_arttext&amp;pid=S0718-18762013000300006)’ (R11.2) and ‘[Mobile Applications: Delivery Technologies in Multimedia Cloud Computing](https://www.ijert.org/mobile-applications-delivery-technologies-in-multimedia-cloud-computing-2)’ (R11.3). Briefly describe mobile cloud computing, green cloud computing and multimedia cloud computing. Post your work on the VLE. Critique the work of your class buddy by replying to it on the VLE. Reflect on the replies by your class buddy and improve your work accordingly and post the improved work on the VLE. |
|  | E11.3: Read the article ‘[Big Data and Cloud Computing: Trends and Challenges](https://online-journals.org/index.php/i-jim/article/view/6561/4356)’ (R11.4). Collaborate on a wiki on cloud analytics and computational intelligence in Cloud with your class group. Include other references, you have used to come up with your answer. Each member should make some contributions on the two concepts on the group wiki. |
| Where do they do it? | You will do this activity in a computer laboratory or using personal computer. |
| By when should they do it? | You should complete this activity within seven days from the time the activity is given. |
| E-moderator/tutor role |
| The e-moderator will provide guidance, read and comment on students’ work and grade assessment |
| How are the learning outcomes in this unit assessed? | Number of hours | 1 hour |
| Learning outcome 1 will be assessed through A11.1 (You will be scored correctly for clearly defining mobile cloud computing, green cloud computing and multimedia cloud computing. Maximum score will be given for critiquing the work of your class buddy) and A11.2 (Each question has an indicated maximum score). Learning outcome 2 will be assessed through A11.2 (Each question has an indicated maximum score) and A11.3 (The group wiki will be scored correctly for demonstrating collaboration in drafting the wiki. Maximum scores will be awarded for clearly incorporating more research references). |
| How does this section link to other sections of the module? |
| Having explored the various concepts of Cloud Computing, this section seeks to introduce you to the research areas where Cloud Computing in being applied in various sectors of the economy. It further highlights the benefits emerging from that research and development. |
|  |
| = Total number of hours  | 4 Hours |
|  |
| **Some important questions** |
| Which learning resources/ references will scaffold the students’ learning? | R11.1 – [Article](https://www.ijert.org/study-of-mobile-cloud-computing-mcc-and-research-challenges): Study of Mobile Cloud Computing (MCC) and Research ChallengesR11.2 – [Article](https://scielo.conicyt.cl/scielo.php?script=sci_arttext&amp;pid=S0718-18762013000300006): Incentives to Apply Green Cloud ComputingR11.3 – [Article](https://www.ijert.org/mobile-applications-delivery-technologies-in-multimedia-cloud-computing-2): Mobile Applications: Delivery Technologies in Multimedia CloudComputingR11.4 – [Article](https://online-journals.org/index.php/i-jim/article/view/6561/4356): Big Data and Cloud Computing: Trends and Challenges |
| How are students enabled to access the resources? | Resources are shared on the VLE that students have access to using a sharedenrolment key. |
| Where in this unit are students expected to work collaboratively? | You will be required to comment on the work of your class buddy in E11.2 (mobilecloud computing, green cloud computing and multimedia cloud computing) andcollaborate in a group wiki in E11.3 (cloud analytics and computational intelligencein cloud). |
| How has an inclusive approach been incorporated in this unit? | You will obtain access to computers in the laboratory in case you do not have a personal computer. All study resources are downloadable for off-line use. |
| How will feedback on unit be obtained from students? | You will provide a one paragraph reflection on the unit by completing the online evaluation form. |
| How will student feedback be used to improve unit? | You are required to provide feedback quarterly (every three weeks) as the module progresses. Your feedback will be incorporated in improving the current and subsequent cohorts. |
| At which point(s) will students receive formative feedback on the work they have done in the unit? | You will get feedback within 72 hours after submission to help you improve. |