smart
infrastructure facility

UNIVERSITY
OF WOLLONGONG
AUSTRALIA

Short Courses the SMART way

SMART Infrastructure Facility Short Courses

WHY SMART?

SMART Infrastructure Facility brings together leading academics, industry experts and professional staff from fields such as transport, water, energy, economics and modelling and simulation to address the infrastructure challenges of the future.

SMART partners with Schools and Faculties across campus so that members of the public have access to University-quality content outside of the regular degree programs.

The courses are high-quality educational experiences and delivered through a range of options, including interactive online classes, on-demand and face-to-face. Duration of a short course can vary. Please refer to website for more details.

SMART's VISION?

To be internationally recognised as a leading provider of research and learning for smart infrastructure solutions.

— Developing digital innovations for people-centric and sustainable infrastructure solutions.

— Contributing to cost-effective design and management of resilient infrastructure assets and networks.

— Informing the integrated planning of urban and regional infrastructure for more productive and adaptive development.

— Educating the next generation of infrastructure leaders, engineers and practitioners to foster innovation and progress.

WHEN YOU STUDY AT SMART...

You are learning from teachers who contribute to infrastructure planning in Australia through truly independent research coupled with deep academic rigour to ensure policy-makers and industry receives high quality and timely advice on major projects.

Career-Changing

Advance your career with SMART's rigorous short courses.

Skill-Boosting,

Stay competitive and relevant with focused, flexible learning and dedicated teachers.

Classes, Workshops, Events

Take part in a range of programs that showcase skills, innovations, and leaders.

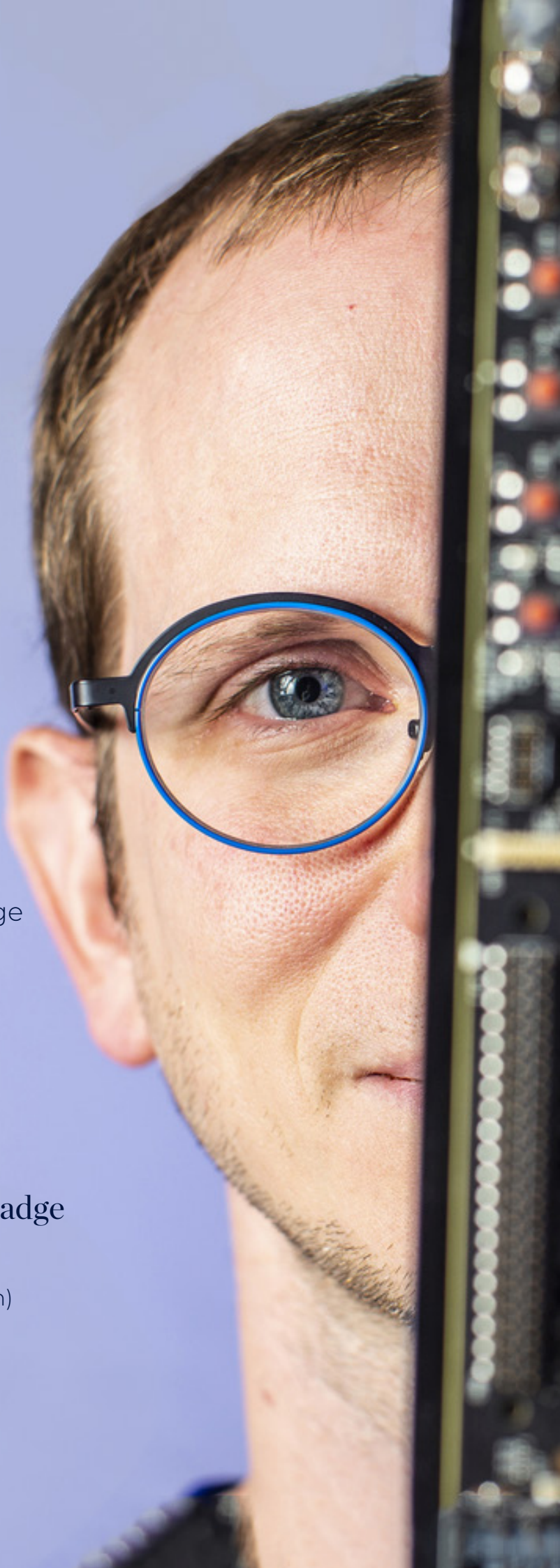
Learn On Campus & Online

Leverage robust learning tools, expert teachers and a supportive community.

FOR MORE INFORMATION ABOUT SHORT COURSE OFFERINGS PLEASE VISIT

uow.edu.au/smart/short-courses

Short courses, the SMART way



All successful participants will receive two UOW credit points

FEIS801
Big Data Analytics with Application

FEIS802
Infrastructure System of Systems Engineering

FEIS804
Introduction to Participatory Modelling

FEIS804
Introduction to Internet of Things

FEIS805
Advanced Computational Methods with Applications in Logistics

FEIS806
Urban Transport Planning for the Digital Age

FEIS807
Introduction to Agent-Based Modelling of Urban Systems

FEIS809
Introduction to MBSE and SysML

Courses with additional industry badge

FEIS808
AWS Academy Cloud Foundations (Amazon)

Big Data Analytics with Application

Course Overview

This introductory course on data science covers the following topics: data manipulation, data analysis with statistic and machine learning, data visualisation and how to work with large data sets.

These concepts will be illustrated using programming languages often used and freely available, namely R, Python and SQL.

The course presents in a practical way multivariate statistical analysis methods such as Regression, Clustering, Principal Component Analysis, Factor Analysis and ANOVA.

COURSE OUTLINE

This 21-hour (6 sessions, 3 days total) will include:

DAY 1 – DATA ANALYSIS PRINCIPLES, THEORY AND TOOLS

- Data analysis general principle and procedure
  - Requirement identification and data sourcing and gap analysis
  - Data profiling, cleansing and modelling, visualisation
  - Data model implementation and database/data warehouse design
- Basic statistics, data mining and machine learning overview
  - Univariate and multivariate statistics
  - Supervised and unsupervised learning techniques
  - Big data analysis techniques
- Data analysis tools
  - Element of Python and R, Jupyter notebook and R notebook
  - Data analysis packages: sklearn, pandas, numpy, R tastviews, matlibplot, ggplot2
  - Hadoop ecosystems
  - Deep learning

DAY 2 – BASIC STATISTICS, DATA MINING AND MACHINE LEARNING

- Descriptive statistics, ANOVA
- Feature selection and feature engineering
- Classification and regression methods
  - Linear regression, logistic regression, multivariate regression
  - Decision trees, classification and regression tree, random forest, support vector machine, K-nearest
  - Neural networks and deep learning
- Clustering methods
  - K-means and hierarchical clustering, Gaussian Mixture Model, DBSCAN, Latent Dirichlet allocation (LDA)
- Stochastic process and time series analysis briefing
- Natural language processing techniques
- Model evaluation techniques
  - ROC, AUC, AIC, BIC, Cross-Validation, etc

DAY 3 – CASE STUDIES

- Smart card data analysis
- Text mining
- Audio and video analysis

COURSE OUTCOMES

By the end of this course you will be able to:

- Understand the principle and theory of typical statistical, data mining and machine learning techniques
- Collect, transform and manage data efficiently and effectively to real-world applications
- Choose and apply appropriate methods and tools for data analysis
- Create impressive and meaningful visualization from data

COURSE PRE-REQUISITE

Basic knowledge of linear algebra and programming experience is required.

Infrastructure System of Systems Engineering

Course Overview

Infrastructure systems are socio-technical systems within an organisational environment. The presence of social and organisational aspects increases complexity and influences these systems throughout their life cycle, from conception and planning, engineering, operation, upgrades and final disposal. Infrastructure systems will be examined as 'System of Systems' (SoS). Various approaches for System of Systems Engineering (SoSE) will be presented and discussed.

'SystemsThinking', considered the most adequate approach to deal with the complexity of sociotechnical SoS, will be presented and illustrated with practical examples. Designing for Adaptability and evolution in System of Systems Engineering (DANSE) methodology will be introduced. The course will address the fundamentals of modelling and simulation considered to be of great importance for Infrastructure SoSE.

COURSE OUTLINE

This 21-hour (6 sessions, 3 days total) will include:

DAY 1 – SYSTEMS AND SYSTEM OF SYSTEMS CONCEPTS AND PRINCIPLES

- System of Systems (SoS): why do they matter?
- Understanding systems: core concepts, principles and characteristics
- Types of Systems (natural, social and man-made systems)
- Closed and Open Systems
- Sociotechnical and information-driven systems
- Complexity, Adaptation and Complex Adaptive Systems (CAS)
- Systemic structure: what is it?
- SoS core concepts, principles and characteristics
- SoS-ness classification: how of much a system is SoS?
- Hands-on examples: Airport, Multi-Mode Urban Transport, Emergency Services

DAY 2 – ENGINEERING SYSTEM OF SYSTEMS

- System Engineering: revisiting SE approach and processes
- SoS Engineering: what is the difference?
- Systems complexity: how to deal with it?
- Systems Thinking: how does it help? Methodologies and their practical use
- SoS lifecycle according to SoSE
- Architecting and managing SoS
- SoS specification, design, verification & validation
- Hands-on examples: Public Infrastructure Interdependency

DAY 3 – MODELLING FOR ENGINEERING SYSTEM OF SYSTEMS

- The Art & Science of Modelling
- Modelling, the language to talk about systems: from rich picture to SysML
- Introduction to SysML, Architecture Frameworks and UPDM
- System Modelling Tools
- SoS methodologies: an introduction to DANSE
- Model-Based Systems Engineering for System of Systems
- Urban Railway as SoS
- Hands-on examples: Urban Railway Infrastructure, Resilience and System Integrity

COURSE OUTCOMES

By the end of this course you will:

- Understand principles and concepts of systems and SoS, their commonalities and differences
- Understand infrastructure as sociotechnical SoS and factors that drive success or failure
- Apply SoS principles and concepts to analyse, specify and design Infrastructure SoS
- Understand how modelling can help to deal with the complexity of Infrastructure SoS

COURSE PRE-REQUISITE

There are no pre-requisites for this course

Participatory Design Techniques for Urban and Infrastructure Planning

Course Overview

This course will be co-delivered with our colleagues from arki_ lab (Copenhagen, Denmark), an urban design studio at the international forefront of participatory urban design.

Traditional urban and infrastructure planning increasingly faces opposition from local communities whose lifestyle or even livelihood might be affected by a planned development. Consultation periods, exhibition events or town hall forums are regularly used to address the asymmetry of information and gain local buy in. However, these approaches seldom deliver genuine appropriation of project outcomes by local communities or properly integrate local views in the planning process itself. Participatory Design applied to urban and infrastructure planning aims at addressing these shortcomings.

This course will provide participants with a progressive and in-depth understanding of Participatory Design principles, techniques and tools. After a short introduction, the course will start with an ice-breaking exercise demonstrating the cognitive biases associated with collaborative planning. Then, we will review examples of Participatory Design approaches applied to planning processes.

COURSE OUTLINE

This 24 hour (4 sessions, 4 days total) course will include:

DAY 1: THE NEED FOR PARTICIPATORY DESIGN

— Introduction to participatory design: as idea generator and tool for consensus building
— Ice-breaking exercise
— Mental models and cognitive biases in collaborative planning
— A brief history of participatory design theories and techniques
— Participation and social license to operate

DAY 2: GAMIFICATION AS A METHOD

— Participatory design principles
— Systems thinking in action: Mental Modeler
— Gaming as a mediating process for collective planning
— Gaming in action: arkinopoly for precinct design
— Applying stakeholder analysis: planning with people

DAY 3: PARTICIPATORY MODELLING

— Participatory modelling principles
— Companion modelling in action: AtollScape and AtollGame
— Ethics of community engagement
— Participatory modelling tools

DAY 4: NEXT GEN APPROACHES

— Next Gen approaches for participatory design
— Creative mobile app in action: arkicity – co-design your city
— Immersive virtual reality for social experiments
— Participatory design techniques handbook

COURSE OUTCOMES

By the end of this course you will be able to:

— By the end of this course, you will know:
— When to implement a Participatory Design approach?
— How to implement a Participatory Design approach?
— Which technique is most relevant to your context?
— What are the advantages and limitations of Participatory Design?
— How to evaluate the success of your Participatory Design process?

COURSE PRE-REQUISITE

Basic knowledge of urban or infrastructure planning is preferred but not a requirement.

Basic knowledge of computer or mobiles applications is preferred but not a requirement.

Introduction to Internet of Things

Course Overview

With more than 30 Billion connected devices expected by the end of 2020, the Internet of Things (IoT) is radically changing the technological landscapes. Applications opportunities are endless: home automation, healthcare, predictive maintenance, agriculture, energy management, or transportation are only some of those use cases. However, the Internet of Things is more than just sensors, it's a process ranging from remote data collection to data analytics in order to grasp the full potential of your data. This course offers an introduction to the IoT covering not only the theoretical background and current usages, but also providing practical knowledge through hands-on tutorials and workshops. Students will gain expertise on the whole IoT process.

COURSE TYPE

Introductory course: introducing concepts, methods or tools to relevant students or professionals

COURSE OUTLINE

This 21 hour (3 sessions, 6 days total) course will include:

DAY 1: WHAT IS THE INTERNET OF THINGS AND WHY SHOULD WE CARE?

- Introduction
- Defining the Internet of Things: history, technologies, trends, impacts, and business opportunities
- IoT networks, protocols and interoperability
- Introduction to sensors
- Introduction to IoT development kits: Arduino, LoPy, Raspberry Pi
- A first experiment: Building your first sensor and visualize data

DAY 2: LORAWAN AND THE THINGS NETWORK

- Achieving Long Range and Low Power data transmission
- LoRaWAN Architecture
- The Things Network – A free to use and open LoRaWAN network
- Tutorial/Workshop: Connecting your sensors to The Things Network
- Managing payloads: Encoding and decoding messages
- Tutorial: Connecting your sensor to the cloud and building your first dashboard with Cayenne

DAY 3: DASHBOARDS AND BUILDING ADVANCED APPLICATIONS

- Publishing data: MQTT
- Tutorial/Workshop: Graphically build your IoT Application with Node-Red
- Real-world applications (SMART Pedestrians, SMART Storm waterways management)
- Hackathon session

COURSE BENEFITS

By the end of this course you will be able to:

- Understand the Internet of Things and its applications
- Extend your knowledge of Python
- Discover hardware for the Internet of Things
- Know the different network protocols for the Internet of things
- Have extended knowledge on LoRaWAN
- Deploy and connect sensors to the Things Network
- Build IoT applications

COURSE PRE-REQUISITE

Basic knowledge of Computer Science and Python is preferred but not required.

Prior to the course, each student will have access to https://codecombat.com to get familiar with Python.

Advanced Computational Methods with Applications in Logistics

Course Overview

Today's world is producing an ever increasing amount of data. Businesses then need data analysis to provide forward-guidance that yields better, more-informed decisions. This subject introduces quantitative methods to optimise the decisions to be made in the context of supply chain and logistic systems. Each method will be illustrated with real world case studies. Participants will learn to verify and enhance existing operating models.

COURSE OUTLINE

This 21-hour (6 sessions, 3 days total) will include:

DAY 1: INTRODUCTION

— Introduction: Supply chain management – What and Why?

— Example of a real-life case study
  - ravelling Salesman Problem (TSP)
  - Vehicle Routing Problem (VRP)

— Introduction to basic VBA programming in Excel: Customise Excel macros (Basic data types, Arrays and matrices,

— Conditional and iterative statements, Functions and subroutines)

DAY 2: STANDARD METHODS

— Linear programming with applications to Manufacturing and Marketing

— Network models
  - Shortest path
  - Maximum flow
  - Transhipment

— Inventory control models

— Selecting the right business decisions

DAY 3: ADVANCED METHODS: EVOLUTIONARY ALGORITHMS

— A hard-to-solve problem: TSP or VRP

— Introduction to Metaheuristics
  - Constructive methods
  - Local searches
  - Evolutionary algorithms
  - Hybrids algorithms

— Tackling TSP or VRP using a metaheuristic.

COURSE OUTCOMES

By the end of this course you will be able to:

— Comprehend a large number of relevant quantitative supply chain/ logistics methods

— Select and apply appropriate quantitative methods to a given SCM/Logistics problem

— Manipulate data to optimise supply chain/ logistics performances using IT solutions

— Assess the relevance of methods, tools and techniques for the wider supply chain

COURSE PRE-REQUISITE

Basic knowledge of Supply Chain and Logistics, and familiarity with Excel is recommended.

Urban Transport Planning for the Digital Age

Course Overview

Traditional methods for transport planning have been widely used for the past age, however more and more transport researchers and planners have realized the shortcomings of classic methods in the digital age where historical and real-time data from various digital sources, such as GPS, smartphones, smart cards and Bluetooth sensors, are more readily available for better transport planning. Moreover, compared to traditional transport modes (e.g. bike, car, bus and train), more options (like autonomous vehicle, electric vehicles, connected vehicle, and scooter) are emerging to provide solutions to unsolved problems as well as to post new challenges in planning for their impacts on the demand for urban transport. It is however necessary to revisit the essentials of urban transport planning to understand the effective use of digital data and new technologies, and how they can be used for providing smarter mobility solutions. This short course will provide transport researchers and planners with basic knowledge of transport planning process, as well as major innovations and changes at the digital age. Multiple case studies will be shared with audiences as references for modern urban transport planning. The course will include a mixture of lectures and case studies throughout all three days planning.

COURSE OUTLINE

This 21-hour (6 sessions, 3 days total) will include:

DAY 1 : TRADITIONAL CONCEPTS OF TRANSPORT PLANNING

— Trip generation
— Trip distribution
— Mode choice
— Traffic assignment
— Advantages and disadvantages of the classic 4-step method
— Case Study 1 - A transport planning example using 4-step method

DAY 2 : RECENT INNOVATIONS AND CHANGES TO URBAN TRANSPORT PLANNING

— Trends in demand for urban mobility and choice preferences
— Urban transport technology and supply options
— Estimating cost of urban mobility and its impact on economic competiveness and environment.
— Framework for generating sustainable solutions for short, medium and long-term implementation
— Using digital data for urban transport innovations and improving urban liveability
— Case Study 2 - Vancouver Canada and Perth Australia: similarities and differences

DAY 3: SMART MOBILITY AND NEW TECHNOLOGIES

— Improved urban mobility, Internet of Things and digital technologies : CROW/ NACTO to Sidewalk Lab experiment in Toronto
— Traffic generation from land use – New South Wales transport demand guide and others. Compare contrast and discuss
— Case Study 3 – Rotterdam Netherlands and London UK: similarities and differences
— Big data in transport planning and operation
— Case Study 4 – Using opal card data to support public transport planning and operation
— Smart mobility – now and future

COURSE OUTCOMES

By the end of this course you will understand:

— Traditional methods are applied to transport planning
— Modern technology based developments have led to change in how transport planning has been done over the last several decades
— Trends in society, environment and technology are likely to impact mobility, transport demand changes and supply in future
— Transport estimates need to reflect above changes, how transport models need to be adapted
— Innovative approaches can improve urban mobility and reduce the overall cost

COURSE PRE-REQUISITE

Basic knowledge of Transport Planning and Data Analytics is preferred but not required.

Introduction to Agent-Based Modelling of Urban Systems

Course Overview

Societies, modern cities and urban infrastructure systems are becoming more complex, interconnected, and difficult to optimise, control and manage. Agent-based modelling (ABM) offers a new lens to understand and steer the functioning of these systems by conducting experiments on artificial societies of computer agents.

The course will begin by introducing fundamental principles of complexity and the dynamics of complex adaptive systems. A structured process to conceptualise, design, build, analyse and validate ABMs will then be explained and illustrated using real-world examples. The course will draw on applications in a wide variety of social, urban and infrastructure problems, to help illustrate the power of ABM as an effective and accessible tool to understand why systems don't always behave as expected and what can be done to improve them.

COURSE OUTLINE

This 26-hour (8 sessions, 4 days total) course will include

DAY 1: WHAT ARE ABMS?

- Motivation, concepts, and history
  - Growing artificial societies: Social science from the bottom-up
  - Fundamentals: Complex systems, interactions, adaptation, simple rules, randomness, and emergent behaviour
  - Why ABM is useful
  - ABM is and is nots
  - Comparison with other simulation methods
- Examples: Exploring the NetLogo models library

DAY 2: HOW TO BUILD ABMS

- Structuring an ABM project: ABM creation and design
- Agents, Environments, Interactions, User Interface/Observer, and Schedule
- Environmental topologies and agent interactions
- Agent types and behavioural models
- Putting everything together

DAY 3: HOW TO ANALYSE AND USE ABMS

- Exploring and describing model results: Examining the data to find meaningful relationships
- Sweeping the parameter space: The importance of multiple model runs
- Verification
- Validation
- Replication

DAY 4: TUTORIALS: BUILDING AGENT-BASED MODELS

- Building a model from scratch: incremental model
- A classic: the prey/predator model
- Simulating the spread of the flu in a population
- Traffic model

COURSE OUTCOMES

By the end of this course you will be able to:

- Understand what ABMs are and how that can be used
- Create an ABM from scratch and extend an ABM created by someone else
- Analyse and critically evaluate the results of an ABM
- Use ABMs to discover new ways to improve and optimise the behaviour of social, urban, and infrastructure systems
- Implement agent-based models using NetLogo

COURSE PRE-REQUISITE

Basic knowledge of modelling and simulation is preferred but not a requirement

Introduction to MBSE and SysML

Course Overview

The evolution of Systems Engineering into using model-based tools has resulted in a range of benefits from greater traceability of information within a project to better informed decisions. Model-based Systems Engineering (MBSE) is a refinement of the traditional Systems Engineering practice to bring the information into a common model. To support MBSE, the Object Management Group (OMG) and the International Council of Systems Engineers (INCOSE) collaborated to develop the Systems Modelling Language (SysML).

This course will introduce the MBSE concepts utilising SysML as the modelling paradigm. The course subsequently expands upon the understanding of SysML to see how broader and more complicated concepts are captured.

COURSE TYPE

Introductory course: introducing concepts, methods or tools to relevant students or professionals

COURSE OUTLINE

This 21-hour (6 sessions, 3 days total) will include:

DAY 1: INTRODUCTION AND PHYSICAL MODELLING

— Overview of MBSE and SysML

— Knowledge Management Support for Systems Engineering

— Physical Structure Modelling

DAY 2: BEHAVIOUR AND REQUIREMENTS

— Activity and State Modelling

— Dedicated Views and Model Usability

— Requirements Representations

— Allocation between the Pillars of SysML

DAY 3 : BROADENING THE SCOPE

— Introduction to Architecture Frameworks

— Risk and Safety Modelling

— Modelling Human Factors

COURSE BENEFITS

By the end of this course you will appreciate:

— What is MBSE and how it differs from traditional SE

— How to read SysML and the nuances inside the language

— How to utilise the tools to capture more complicated concepts such as risk and human factors

COURSE PRE-REQUISITE

A knowledge of Systems Engineering principles is preferred but not required.

Course with additional industry badge

AWS Academy Cloud Foundations

Course Overview

AWS Academy Cloud Foundations is intended for students who seek an overall understanding of cloud computing concepts, independent of specific technical roles. It provides a detailed overview of cloud concepts, AWS core services, security, architecture, pricing, and support.

COURSE TYPE

Introductory course: This is an introductory (level 100) course and is intended for AWS Academy member institutions.

COURSE OUTLINE

This 21-hour (6 sessions, 3 days total) course will include:

DAY 1: WELCOME AND AWS CLOUD OVERVIEW

- Module 0 - Welcome to AWS Academy
- Module 1.1 - Cloud Concepts Overview
- Module 1.2 - Cloud Economics
- Module 1.3 - AWS Infrastructure Overview

DAY 2: AWS CORE SERVICES

- Module 2.1 - AWS Core Services: Compute
- Module 2.2 - AWS Core Services: Storage
- Module 2.3 - AWS Core Services – Amazon Virtual Private Cloud
- Module 2.4 - AWS Core Services: Databases
- Module 2.5 - AWS Core Services: Elastic Load Balancing, Amazon CloudWatch, and Auto Scaling

DAY 3: CLOUD SECURITY AND ARCHITECTURE

- Module 3 - AWS Cloud Security
- Module 4 - Cloud Architecting
- Module 5 - Cloud Billing and Support

COURSE BENEFITS

By the end of this course you will be able to:

- Describe the six advantages of cloud computing
- Describe three cloud deployment models
- Use the AWS Cloud Adoption Framework to help organizations transform the way they work
- Understand the AWS pricing philosophy
- Review fundamental pricing characteristics
- Understand the elements of Total Cost of Ownership
- Understand the difference between AWS Regions, Availability Zones, and Edge Locations
- Understand the different AWS compute services
- Describe Amazon Elastic Compute Cloud
- Explain AWS Lambda, which is serverless computing
- Describe AWS Elastic Beanstalk
- Discuss storage services including Amazon EBS, Amazon S3, Amazon EFS, and Amazon Glacier
- Describe use cases for storage options, along with a demonstration of Amazon Glacier
- Understand storage pricing
- Understand virtual networking in the cloud with Amazon VPC
- Create virtual firewalls with security groups

— Secure delivery of data, videos, applications, and APIs with Amazon CloudFront
— Provide an overview of different database services in the cloud
— Highlight the differences between unmanaged and managed database solutions
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— Differentiate between Structured Query Language and NoSQL databases
— Review the availability differences of alternative database solutions
— Learn how to distribute traffic across Amazon EC2 instances using Elastic Load Balancing
— Discover the ability of Auto Scaling to launch servers in response to workload changes
— Use CloudWatch to monitor AWS resources and applications in real time
— Describe the AWS Shared Responsibility Model
— Examine IAM users, groups, and roles
— Describe different types of security credentials
— Review the AWS Trusted Advisor checks
— Discuss security compliance
— Understand best practices on day 1 with a new AWS account
— Explore the well-architected pillars and design principles
— Understand high availability and reliability
— Describe the business impact of design decisions
— Describe how to set up an organizational structure to simplify billing and account visibility
— Identify alternative support options and features

COURSE PRE-REQUISITE

This is an entry-level course, but students should possess:

— General IT technical knowledge
— General IT business knowledge

Course Coordinator

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