NUS School of Computing - Graduate Certificates

Courses Offered for AY2025/2026

Course Code & Title	Sem 1	Sem 2
Graduate Certificate in Digital Business (DigiBiz)		
IS5007 Strategising for Global IT-enabled Business Success	✓	
IS5116 Digital Entrepreneurship	✓	
IS5117 Digital Government		
IS5151 Information Security Policy and Management		TBC
Graduate Certificate in Big Data Management & Analytics (BigDMA)		
CS5228 Knowledge Discovery and Data Mining	✓	TBC
CS5421 Database Applications Design and Tuning		TBC
CS5424 Distributed Database		
CS5425 Big Data Systems for Data Science	✓	TBC
IS5126 Hands-on with Applied Analytics	✓	TBC
Graduate Certificate in Principles and Practice of Secure Systems (SecureSys)		
CS5321 Network Security		TBC
CS5322 Database Security	✓	
CS5332 Biometric Authentication		TBC
CS5331 Web Security		
CS5439 Software Security	✓	
Graduate Certificate in Machine Learning and Applications (MLA)		
CS5242 Neural Networks and Deep Learning	✓	TBC
CS5260 Neural Networks and Deep Learning II		TBC
CS5339 Theory and Algorithms for Machine Learning		TBC
IS5006 Intelligent System Deployment		
IS5152 Data-Driven Decision Making		TBC

NUS School of Computing
Graduate Certificates – Course Description

Graduate Certificate in Digital Business (DigiBiz)

Course Code, Title & Description	Prerequisites (Course Code, Title & Description)
IS5007 Strategising for Global IT-enabled Business Success	***IS4204 IT Governance***
This course provides an understanding and practical tip on how companies could venture into the global markets. Students would learn how a typical High-tech multinational organises itself, conducts its R&D, formulate the global product launch, and build its business globally. This would be followed by how a Singapore/Asian company, could expand its business globally. Case studies would cover both high-tech and non-technology sectors with IT as enabler. Students can expect to gain an understanding on highly-matrix organisational structures, basics of global product launch, as well as practical tips on how their own future entrepreneurial start-ups could penetrate the global markets.	This course examines the governance in the use and deployment of Information Technology in an organisation. It covers the process of strategic planning to align IT strategies with business strategies. The elements of governance include Security Policy, Quality Management, Business Continuity Management, Risk Management, Project and Program Management, Returns on Investment of IT and Operational Management.
IS5116 Digital Entrepreneurship	***IS3103 Information Systems Leadership and Communication***
The key concepts of entrepreneurship are first covered, giving students the necessary background knowledge and an opportunity to develop a tech start-up venture as a team project. Following that, sessions are set aside for students to learn a wide range of issues about entrepreneurship by asking questions and hearing first hand from people who are active in the start-up eco-system as entrepreneurs or investors. The student would understand what is involved in building a high-tech start-up company and know how to develop an entrepreneurial venture. He would also be familiar with the entrepreneurship eco-system in Singapore.	Today's technology leaders need to have a deep understanding of business fundamentals, recognize the key drivers of innovation, and develop effective leadership to align and integrate novel technologies and business processes for successful products and services. The course will not only cover major topics relating strategic, tactical and operational facets of thought leadership in propelling IT implementations, adoptions and changes in organization but also equip students with industry-relevant communication skillsets. The strategic facet will explore the various contexts, complex issues and dynamic paths that evoke leadership in information systems, including technology championship, disruptive technology, and IT ecosystem. The tactical facet will strategize a culture to co-create value and nurture technological innovations. Students will be taught effective communication skills for influential communication, change management communication and directional communication. These skillsets will enable them to foster partnership between technology and business stakeholders such as vendors, IT professionals and functional users. The operational facet will include leadership areas in IT portfolio management, change management, and IT applications. Through a synthesis of critical knowledge areas required of technology leaders, students will examine the intersection of technology and business to drive IT-enabled changes in an organization. The course will prepare students for senior technology positions, and develop core communication skills that leaders need to be equipped with to be successful in leading technological transformations.
IS5117 Digital Government	
The goal of the course is to provide a deep understanding of key digital government concepts and issues such as: digital policies, integration and whole-of-government approach, management of digital government projects, public-private partnerships, public sector innovation, security and privacy, open government data, social media in government, digital democracy, and smart cities. The course also covers emerging trends in digital government such as the application of cloud, IoT, artificial intelligence, and blockchain technologies.	
IS5151 Information Security Policy and Management	***CS2107 Introduction to Information Security***
Advances in information technology (IT) are driving the transformation and success of modern organisations. Along with these advances, we see increasing cyber threats and risks that must be appropriately managed by the organisation. This course will prepare IT leaders to manage	This course serves as an introductory course on information security. It illustrates the fundamentals of how systems fail due to malicious activities and how they can be protected. The course also places emphasis on the practices of secure programming and

Course Code, Title & Description	Prerequisites (Course Code, Title & Description)
these challenges through understanding how to build a cybersecurity strategy and program that not only implements technical safeguards, but also employs effective policy, other controls and risk management practices to make the organisation resilient to threats and disruption.	implementation. Topics covered include classical/historical ciphers, introduction to modern ciphers and cryptosystems, ethical, legal and organisational aspects, classic examples of direct attacks on computer systems such as input validation vulnerability, examples of other forms of attack such as social engineering/phishing attacks, and the practice of secure programming.

Graduate Certificate in Big Data Management & Analytics (BigDMA)

Course Code, Title & Description	Prerequisites (Course Code, Title & Description)
CS5228 Knowledge Discovery and Data Mining	***CS2102 Database Systems***
This course introduces fundamental principles behind data mining and efficient techniques for mining large databases. It provides an overview of the algorithmic aspect of data mining: its efficiency (high-dimensional database indexing, OLAP, data reduction, compression techniques) and effectiveness (machine learning involving greedy search, branch and bound, stochastic search, parameter optimisation). Efficient techniques covered include association rules mining (Apriori algorithm, correlation search, constrained association rule discovery), classifier induction (decision trees, RainForest, SLIQ; Support vector machine; Naive Bayesian; classification based on association / visualisation), cluster analysis (k-means, k-mediods, DBSCAN, OPTICS, DENCLUE, STING, CLUSEQ, ROCK etc), and outliers/deviants detection (LOF, Distance-based outlier etc).	The aim of this course is to introduce the fundamental concepts and techniques necessary for the understanding and practice of design and implementation of database applications and of the management of data with relational database management systems. The course covers practical and theoretical aspects of design with entity-relationship model, theory of functional dependencies and normalisation by decomposition in second, third and Boyce-Codd normal forms. The course covers practical and theoretical aspects of programming with SQL data definition and manipulation sublanguages, relational tuple calculus, relational domain calculus and relational algebra.
	CS3243 Introduction to Artificial Intelligence
	The course introduces the basic concepts in search and knowledge representation as well as to a number of sub-areas of artificial intelligence. It focuses on covering the essential concepts in AI. The course covers Turing test, blind search, iterative deepening, production systems, heuristic search, A* algorithm, minimax and alpha-beta procedures, predicate and first-order logic, resolution refutation, non-monotonic reasoning, assumption-based truth maintenance systems, inheritance hierarchies, the frame problem, certainly factors, Bayes' rule, frames and semantic nets, planning, learning, natural language, vision, and expert systems and LISP.
CS5421 Database Applications Design and Tuning	***CS3223 Database Systems Implementation***
This course addresses the design and performance tuning of database applications. The syllabus focuses on relational database applications implemented with relational database management systems. Topics covered include normalisation theory (functional, multi-valued and join dependency, normal forms, decomposition and	This course provides an in-depth study of the concepts and implementation issues related to database management systems. It first covers the physical implementation of relational data model, which includes storage management, access methods, query processing, and optimisation. Then it covers issues and

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synthesis methods), entity relationship approach and SQL tuning (performance evaluation, execution plan verification, indexing, de-normalization, code level and transactions tuning). The syllabus optionally includes selected topics in the technologies, design and performance tuning of nonrelational database applications (for instance, network and hierarchical models and nested relational model for an historical perspective, as well as XML and NoSQL systems for a modern perspective).	techniques dealing with multi-user application environments, namely, transactions, concurrency control and recovery. The third part covers object-database systems that are useful extension of relational databases to deal with complex data types. The last part covers database technologies required for modern decision support systems, including data warehousing, data mining and knowledge discovery and on-line analytical processing.
CS5424 Distributed Database	
This course studies the management of data in a distributed environment. It covers the fundamental principles of distributed data management and includes distribution design, data integration, distributed query processing and optimization, distributed transaction management, and replication. It will also look at how these techniques can be adapted to support database management in emerging technologies (e.g., parallel systems, peer-to-peer systems, cloud computing).	
CS5425 Big Data Systems for Data Science	***CS2102 Database Systems***
Data science incorporates varying elements and builds on techniques and theories from many fields, including statistics, data engineering, data mining, visualization, data warehousing, and high-performance computing systems with the goal of extracting meaning from big data and creating data products. Data science needs advanced computing systems such as Apache Hadoop and Spark to address big data challenges. In this course, students will learn various computing systems and optimization techniques that are used in data science with emphasis on the system building and algorithmic optimizations of these techniques.	The aim of this course is to introduce the fundamental concepts and techniques necessary for the understanding and practice of design and implementation of database applications and of the management of data with relational database management systems. The course covers practical and theoretical aspects of design with entity-relationship model, theory of functional dependencies and normalisation by decomposition in second, third and Boyce-Codd normal forms. The course covers practical and theoretical aspects of programming with SQL data definition and manipulation sublanguages, relational tuple calculus, relational domain calculus and relational algebra.
IS5126 Hands-on with Applied Analytics	
The goal of the course is to bridge the divide between technical skills and business applications. Through learning-by-doing, students will engage in a series of guided group projects, and a final semester project of their own design. Lectures will cover practical skills using the latest tools and techniques, as well as discuss business cases and applications. The course will emphasize on the applied nature of data analytics by covering a breath of techniques including predictions, unsupervised, supervised, and semi-supervised learning, social media analytics, text mining, web mining, and image processing.	

Graduate Certificate in Principles and Practice of Secure Systems (SecureSys)

Course Code, Title & Description	Prerequisites (Course Code, Title & Description)
CS5321 Network Security	***CS3235 Computer Security***
The objective of this course is to introduce students to the various issues that arise in securing the networks, and study the state-of-the-art techniques for addressing these challenges. A number of most damaging attacks on computer systems involve the exploitation of network infrastructure. This course provides an in-depth study of network attack techniques and methods to defend against them. Topics include basic concepts in network security; firewalls and virtual private networks; network intrusion detection; denial of service (DoS); traffic analysis; secure routing protocols; protocol scrubbing; and advanced topics such as wireless network security.	The objective of this course is to provide a broad understanding of computer security with some in-depth discussions on selected topics in system and network security. This course covers the following topics: intrusion detection, DNS security, electronic mail security, authentication, access control, buffer overflow, memory and stack protection, selected topics in application security, for instance, web security, and well-known attacks.
CS5322 Database Security	***CS3223 Database Systems Implementation***
Database security has a great impact on the design of today's information systems. This course will provide an overview of database security concepts and techniques and discuss new directions of database security in the context of Internet information management. Topics covered include: Access control models for DBMSs, Inference controls, XML database security, Encrypted databases, Digital credentials and PKIs, Trust in open systems, and Peer-to-peer system security.	This course provides an in-depth study of the concepts and implementation issues related to database management systems. It first covers the physical implementation of relational data model, which includes storage management, access methods, query processing, and optimisation. Then it covers issues and techniques dealing with multi-user application environments, namely, transactions, concurrency control and recovery. The third part covers object-database systems that are useful extension of relational databases to deal with complex data types. The last part covers database technologies required for modern decision support systems, including data warehousing, data mining and knowledge discovery and on-line analytical processing.
CS5332 Biometric Authentication	***CS2040 Data Structures and Algorithms***
Biometrics (such as fingerprint, iris images) are commonly used for authentication. This course covers authentication methods, different types of biometrics, pattern recognition, performance measurement, spoofing attacks, as well as issues such as privacy, user acceptance, and standards compliance. Students will gain a solid understanding of the fundamentals of the technology underlying biometric authentication, and the key issues to be addressed for successful deployment. Both the theoretical and practical aspects of biometrics authentication will be discussed.	This course introduces students to the design and implementation of fundamental data structures and algorithms. The course covers basic data structures (linked lists, stacks, queues, hash tables, binary heaps, trees, and graphs), searching and sorting algorithms, and basic analysis of algorithms.
CS5331 Web Security	***CS3235 Computer Security***
This course aims to prepare graduate students for understanding the security of the latest web platform and its interplay with operating systems and the cloud infrastructure. The topics covered include the design of web browsers and web	The objective of this course is to provide a broad understanding of computer security with some indepth discussions on selected topics in system and network security. This course covers the following topics: intrusion detection, DNS security, electronic

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applications, vulnerabilities in web applications and web browsers, design of web scanners, authentication in web-based platforms, security policies and enforcement mechanisms. This course also covers security topics on the interface between the web platform and the backend systems, such as the underlying database systems and cloud infrastructure.	mail security, authentication, access control, buffer overflow, memory and stack protection, selected topics in application security, for instance, web security, and well-known attacks.
CS5439 Software Security	***CS3235 Computer Security***
Software engineering processes need to include security considerations in the modern world. This course familiarizes students to security issues in different stages of the software life-cycle. At the end of the course, the students are expected to understand secure programming practices, be able to analyse and check for impact of malicious inputs in programs, and employ specific testing techniques which can help detect software vulnerabilities.	The objective of this course is to provide a broad understanding of computer security with some indepth discussions on selected topics in system and network security. This course covers the following topics: intrusion detection, DNS security, electronic mail security, authentication, access control, buffer overflow, memory and stack protection, selected topics in application security, for instance, web security, and well-known attacks.
	CS2103 Software Engineering
	This course introduces the necessary conceptual and analytical tools for systematic and rigorous development of software systems. It covers four main areas of software development, namely object-oriented system analysis, object-oriented system modelling and design, implementation, and testing, with emphasis on system modelling and design and implementation of software modules that work cooperatively to fulfill the requirements of the system. Tools and techniques for software development, such as Unified Modelling Language (UML), program specification, and testing methods, will be taught. Major software engineering issues such as modularisation criteria, program correctness, and software quality will also be covered.

Graduate Certificate in Machine Learning and Applications (MLA)

Course Code, Title & Description	Prerequisites (Course Code, Title & Description)
CS5242 Neural Networks and Deep Learning	***CS3244 Machine Learning***
This course provides students with the knowledge of deep neural network and enables them to apply deep learning methods effectively on real world problems. The course emphasizes on the understanding of the principles of neural networks and deep learning; practical guidelines and techniques for deep learning; and their applications. Through assignments and projects, students will design, develop, and evaluate deep learning-based solutions to practical problems, such as those in the areas of computer vision, bioinformatics, fintech, cybersecurity, and games.	This course introduces basic concepts and algorithms in machine learning and neural networks. The main reason for studying computational learning is to make better use of powerful computers to learn knowledge (or regularities) from the raw data. The ultimate objective is to build self-learning systems to relieve human from some of already-too-many programming tasks. At the end of the course, students are expected to be familiar with the theories and paradigms of computational learning, and capable of implementing basic learning systems.
CS5260 Neural Networks and Deep Learning II	***CS5242 Neural Networks and Deep Learning***
This course is a follow-up to CS5242 and covers advanced topics in neural networks and deep learning. This course explores the underlying mechanism of a variety of different types of learning models: unsupervised, semi-supervised, and adversarial learning models, that are not covered in CS5242. Topics may include: generative adversarial networks, adversarial machine learning, zero-shot learning, geometric deep learning, neural architecture search.	This course provides students with the knowledge of deep neural network and enables them to apply deep learning methods effectively on real world problems. The course emphasizes on the understanding of the principles of neural networks and deep learning; practical guidelines and techniques for deep learning; and their applications. Through assignments and projects, students will design, develop, and evaluate deep learning-based solutions to practical problems, such as those in the areas of computer vision, bioinformatics, fintech, cybersecurity, and games.
CS5339 Theory and Application for Machine Learning	***CS3244 Machine Learning***
The course aims to provide a broad theoretical understanding of machine learning and how the theory guides the development of algorithms and applications. Topics covered include the approximation capabilities of common function classes used for machine learning, such as decision trees, neural networks, and support vector machines, the sample complexity of learning different function classes and methods of reducing the estimation error such as regularization and model selection, and computational methods used for learning such as convex optimization, greedy methods, and stochastic gradient descent.	This course introduces basic concepts and algorithms in machine learning and neural networks. The main reason for studying computational learning is to make better use of powerful computers to learn knowledge (or regularities) from the raw data. The ultimate objective is to build self-learning systems to relieve human from some of already-too-many programming tasks. At the end of the course, students are expected to be familiar with the theories and paradigms of computational learning, and capable of implementing basic learning systems.
IS5006 Intelligent System Deployment	***IS4242 Intelligent Systems and Techniques***
This course is an in-depth, hands-on, and practical application of the latest intelligence systems and the best-practice systems implementation methodology. The course describes the decision-making process in businesses today, including the hierarchy of decision-making responsibilities to address business problems and challenges. Intelligent systems have the capacity to gather and analyse data, learn from experience, and adapt according to external stimulus. The course includes problem	This course provides a broad coverage of intelligent systems in various industries (through examples of real-world applications) and the tools and techniques used to design such intelligent systems (e.g. data warehousing, data mining and optimization). Applications from several domains such as finance, healthcare, transportation, web and retail are discussed. The use of technology to solve business problems (such as real-time optimization, personalization, trend discovery and unstructured data

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assessment, intelligence techniques and models for decision making and expert systems. It will also cover how IT leaders enable business competitiveness with data-driven strategy.	analysis) are described. Software tools to apply these techniques are introduced. The emphasis of the course is on modelling, conceptual understanding of techniques, and applications to business problems. ***BT4014 Analytics Driven Design of Adaptive Systems*** To design technology that impacts people – in education, health, business – this course introduces methods for creating systems that use data intelligently to improve themselves. This requires combining human intelligence (using methods like crowdsourcing, collaborative design) with artificial intelligence (discovering which technology designs help which people) through designing randomized A/B experiments that are collaborative, dynamic, and personalized.
IS5152 Data-Driven Decision Making Data driven decision making improves productivity and profitability of businesses. This course teaches students decision making techniques based on data analysis. Various Machine Learning (ML) techniques for data analysis will be presented. The course also discusses aspects related to building an effective model for decision making such as: (i) methods for data preparation such as feature selection, data reduction and sample selection, (ii) metrics for determining a good model, (iii) visualization of model performance, (iv) overfitting and its avoidance. Examples of practical business decision making problems will be used to illustrate the merits of the ML techniques presented.	***ST2334 Probability and Statistics*** Basic concepts of probability, conditional probability, independence, random variables, joint and marginal distributions, mean and variance, some common probability distributions, sampling distributions, estimation and hypothesis testing based on a normal population. This course is targeted at students who are interested in Statistics and are able to meet the pre-requisites. Preclude ME students taking or have taken ME4273. ***ST1131 Introduction to Statistics*** This course introduces students to the basic concepts and the methods of statistics. A computer package is used to enhance learning and to enable students to analyse real life data. Topics include descriptive statistics, basic concepts of probability, sampling distribution, statistical estimation, hypothesis testing, linear regression. This course is targeted at students interested in Statistics who are able to meet the prerequisite. It is also an essential course for students in the following programmes: Industrial and Systems Engineering (FoE); E-Commerce (SoC); Project & Facilities Management and Real Estate (SDE).