**For all Pillars**

**01.800 Research Attachment/Internship**
4 - 72 credits
This subject is intended to allow the PhD students to gain valuable industrial or research experience at relevant off campus industrial or research institutions.

**01.900 PhD Big D Project I and 01.901 PhD Big D Project II**
24 credits (12 credit for each course)
PhD Big D project is a student-driven group based project course that covers multidisciplinary research, design, innovation and entrepreneurship. It is a 2-semesters pass/fail course with 24 credits that can be used to substitute some course works component subjected to pillar's specification. There are no formal contact hours, except for compulsory workshops, progress sharing sessions, and term-end presentations. Each group is composed of 2 to 4 PhD students and the group members are expected to spend about 12 hours per week. The assessment will be judged by both internal and external panels.

**01.902 Intellectual Property (IP) Clinic**
3 credits
Intellectual Property (IP) management is an essential business growth strategy. Inventions, literary and artistic works, designs and symbols, names and images are examples of IPs and are protected by the law through patents, copyrights and trademarks. There are various IP infringement lawsuits between tech giants and institutions. Why are companies and institutions making such moves and how do all these IPs come into play? This IP Clinic covers the fundamentals of IP, what IP comprises, and how you can protect your ideas and inventions.

**01.903 Scientific and Grant Writing**
3 credits
The Scientific Writing component is based on the book Scientific Writing 2.0: a Reader and Writer's Guide. It helps to identify and articulate the differences between efficient and deficient scientific writing. Through many in-class exercises and the use of open-source assessment tools, the course identifies the role, content, and writing style of influential parts of a paper that contribute to the reviewer/editor's first impression - title, abstract, introduction, methodology, visuals and results, structure, conclusions and references. The course also promotes clarity, conciseness, and organization in writing. In addition, it covers publication ethics, publication process, and interaction with the editor (cover letter).
The Grant Writing component is an introductory course which covers typical and specific grant calls. Concerns of the grant reviewers and grant providers are highlighted through the systematic analysis of both the grant application document, in particular the grant title and abstract, and the written instructions given by the grantor to its grant reviewers. The course exposes the main reasons for grant rejection or grant award based on the study of past grant applications. It also covers the process of grant preparation, grant evaluation and grant writing

**01.904 SUTD Entrepreneurship**
3 credits
This course covers the essence of Entrepreneurship. The topics that will be covered are; Getting into the entrepreneur's mind-set, Assembling the team, Business Plan, Reality check, Fund raising and working with venture capital, Management & Execution and Exit Strategies. It is a practical oriented course taking into consideration on participants having business or product ideas, turning them into reality and the process of growing a business. Real-life cases will be used throughout the course and role plays will be conducted.

**01.905 SUTD Private Equity & Fund Raising for Businesses**
3 credits
This course aims to provide participants with the practical knowledge and competencies to carry out private equity investments. Module 1 on Sourcing Private Equity (PE) Deals and Fund Raising looks at a top-down approach to develop investment strategy for PF fund, starting with an overview of the PE industry and who's who in PE – the people, the companies and the deals. At the end of the highly interactive course, the participants will walk away with good insights into the PE industry, and practical tips on what is needed to start the first PE fund.

**01.907 Leadership, Teamwork and Personal Branding**
The Leadership, Teamwork and Personal Branding course cover two days of powerful and practical leadership & teamwork learning for workplace application. Students will visit key learning milestones through creative learning approaches designed for enhanced engagement and retention. The Personal Branding component is designed to increase self-awareness and position themselves confidently during business settings or potential employers. Students will learn how to enhance their professional image, develop personal resilience, adapt to technology, network effectively and gain techniques on resume writing and interview skills, to secure job and assignment opportunities.

**01.910 Speaking Focus in the Academic Environment**
3 credits
The purpose of this course is to provide new PhD students opportunities to learn about speaking and presentation skills in order for them to communicate optimally in the university teaching and learning and research environment with students, peers and faculty.

**01.911 Teaching at SUTD: Engaging the Learners**
3 credits
The purpose of this course is to provide new PhD students opportunities to learn about the way university students learn and approaches to teaching and learning in the university in order for them to be able to be more effective at assisting or teaching in the university teaching and learning environment.

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

Established in collaboration with MIT

## Architecture and Sustainable Design (ASD) Courses

**20.502 Design Computation in Architecture**
12 credits
This course includes Advanced Topics in Design Optimization and Design Information Modeling.

**20.503 Advanced Topics in Performative Design: Daylight and Electric Lighting**
12 credits
This seminar course teaches natural and electric lighting in an architectural context. Students will learn the scientific basis of light and visual perception in order to apply them to the design of two course projects: the design and construction of an electric light fixture (luminaire) and the comprehensive lighting design of a large communal gathering space with integrated electric and daylight systems. Individual activities and lectures focus on calibrated high dynamic range photography, daylight simulations, material properties, visual comfort / perception, electric lighting design, lighting energy consumption, solar heat gains, scale model building and human behaviour.

**20.504 Material Computation: Advanced Topics in Geometry and Matter**
12 credits
Computation enables architects to integrate and design with multifaceted information including that of engineering and manufacturing nature. The course, Material Computation: Advanced topics in Geometry and Matter, introduces concepts and approaches towards synthetic design computation. We conceptualise architecture as material distribution in space and explore computational analysis and form finding methods which enable a high-level of control over material/structural behaviour. Simultaneously, we look into existing and future multi-material fabrication methods to realize “effective” material distribution that balances the notion of qualitative and quantitative parameters in design.

**20.505 Urban Housing Typologies**
12 credits
The 'Urban Housing Typology' seminar will discuss the complex nature of urban contexts as places to formulate human habitation. Investigating the interdependencies evolving between a building's entity and its urban territory students will speculate how strategies for urban building types have contributed in the past and can contribute in the future to urban development.

**20.590 PhD Pro-Seminar**
12 credits
This course introduces Research Design Methods and provides a Forum for Dialogue.

**20.620 Independent Study (Building Technology)**
12 credits
In this course study, students will learn the scientific basis of natural/light and the methodology to characterize the quality of light through different varieties of tropical trees. The activities in the course will include using high dynamic range photography with fish eye lens to estimate the leaf area index of trees and measuring illuminance, luminance and temperature under canopies of selected species of trees. In line with the activities a pilot study will be undertaken to test the resulting methodology developed for the characterisation.

**20.621 Independent Study (Design)**
12 credits
The subject concerns theories of the design process from the perspectives of architecture and engineering design. The subject will pay special attention to the question of how, where, and when in the design process it is appropriate and fruitful to apply quantitative problem solving methods (such as computational tools or mathematical optimization).

**20.650 Research Project I and 20.651 Research Project II**
24 credits (12 credit for each course)
This is a cross-disciplinary research project that spans two-terms. Students either have to work with a faculty from another pillar and their own ASD supervisor, or to work with another PhD student from another pillar with their ASD supervisor on a research project. The project subject must be mutually agreed by the ASD and/or faculty from another pillar and approved by the ASD PhD Committee.

**20.801 Future Cities**
12 credits
Understanding a city as a whole, its people, components, functions, scales and dynamics, is crucial for the appropriate design and management of the urban system. While the development of cities in different parts of the world is moving in diverse directions, all estimations show that cities worldwide will change and grow strongly in the coming years.
Especially in the tropics over the next 3 decades, it is expected that the number of new urban residents will increase by 3 times the population of Europe today. Yet already now, there is an extreme shortage of designers and urban planners able to understand the functioning of a city as a system, and to plan a sustainable and resilient city. To answer questions like: Which methods can contribute to the sustainable performance of a city, and how can we teach this to the next generations, the ETH Future Cities Laboratory in Singapore has produced over the last 3 years many necessary research results. "Future Cities" aims to bring these latest results to the places where they are needed most.

**20.802 Methods in the Study of Architecture**
12 credits

**20.803 Advanced Topics in Digital Design and Fabrication**
12 credits

**20.804 Advanced Topics in Performative Design: Urban Sustainability**
12 credits

**20.805 Conservation Theories and Approaches of Built Heritage**
12 credits
This seminar elective course teaches conservation theories and approaches in an architectural context. This course is to acquaint participants with an overview of the discipline of architectural conservation, its origins, developments, as well as inherent contradictions. The course will cover the range of scales of conservation, the smallest denominator being artifact conservation to urban conservation. Case-studies in Singapore and the region will be introduced.

**20.806 Integrated Building Design**
12 credits
The course is intended to give students enrolled a working understanding of integrated design in principle and practice. To enable students to lead and develop a performance vision for a building's design, as architects and coordinators as well as collaborate effectively in important design team meetings with consultants.

Through a series of lectures that focus on different aspects such as structure, services, envelope and transportation, appreciation of 'good' and 'bad' integration will be developed. By use of case-studies and examples to provide students with design-strategies and approximation approaches to understand and undertake integration activities themselves. This will be supported analytically by an introduction to the relevant first-principal and codified assessment methods.

To broaden understanding the course will be supplemented by guest presentations from engineering professionals in associated topics to give their insight into these issues.

**20.807 Toward Carbon-Neutral Architecture and Urban Design**
12 credits
The course is intended to give students enrolled a working understanding of how to design, construct, and operate sustainable architecture and urban design developments and projects toward achieving carbon neutral on all aspects. Students will develop an understanding of a building's relationship to its site's natural systems; the building enclosure's ability to mitigate outdoor conditions; passive systems for conditioning and lighting; mechanical heating, cooling and ventilation strategies; lighting and daylighting opportunities; site and building water cycles; and health and well-being, and advanced building and environmental system simulation through a series of lectures and workshops.

Case studies will be introduced based on the lecture themes. Topics are discussed based on the physical laws that govern the exchange of energy between building and environment and how they relate to human comfort. The ability and confidence in making both quantitative and qualitative statements about building performance will help students in integrating these

considerations into their future architecture and urban design work. Ultimately students will be able to understand the impact of their design decisions on building performance in order to mitigate the carbon footprint.

Workshops throughout the semester will be a series of design exercise and environmental design studies as well as calculations, which will serve as supporting documents for the final carbon-neutral project at the end of the semester.

**20.808 Scientific Approaches to Green Design in Urban and Natural Environment**
12 credits
This subject is to acquaint participants with an overview of sustainability, its origins, developments, as well as various contemporary green and liveability issues. The students will have the opportunity to explore the multi-dimensional issues of urban and natural environmental sustainability through scientific lenses and at diverse temporal and spatial scales.

Existing patterns of anthropogenic development are unsustainable in the long run. Current development practices consume enormous amounts of resources, damage local natural ecosystems, produce pollutants, and lower the quality of life.

Green designs underpin the current worldwide sustainability drive towards achieving better liveability. Essentially, green infrastructure is the network of natural and designed vegetation elements within our cities and towns, in both public and private domains. Green infrastructure includes traditional green elements such as urban parks, gardens and trees, as well as newer green roofs, green walls, water sensitive urban design, and rain garden technologies.

Students will also be asked to assess how the concepts of sustainability is influencing contemporary green design and planning via the theories of ecology. Some contribution to the lectures and case studies as well as potential for real-world engagement will be provided by outdoor site visits/fieldtrips and enlisting practitioners, urban thinkers, key real estate leaders and others in outlining the challenges and opportunities for a variety of sustainable urban and natural developments.

**20.809 Social Architecture: Theory and Practice**
12 credits
This course aims to equip the students with theoretical/historical knowledge of 'Social Architecture' as well as practical skills for practicing it. Students will be exposed to key concepts, methods and goals developed in social architecture, an umbrella term that includes community architecture and planning, community design, social design, democratic design, community development, etc. which share a common approach of environmental design that encourages social behaviors leading towards certain public benefits, such as livability, safety, and sustainability. Through case studies, fieldworks and hands-on workshops, students will learn the various design processes that often involve the members of community, and how these strategies could be applied in their own design projects. The first half of the course will

introduce students to theories and methods; while the second half will explore various topics under which social architecture is currently being practiced.

**20.900 PhD Research Pre-Candidacy**
1-48 credits
PhD research work by doctoral students before passing the Qualifying examination.

**20.910 PhD Research Post-Candidacy**
1-48 credits
PhD research work by doctoral students after passing the Qualifying examination.

## Engineering Product Development (EPD) Courses

### 30.500 Applied Mathematics for Engineering

12 credits

The applied mathematics module will cover several mathematical topics that are useful for research and analysis across different engineering discipline. Topics may vary with the instructor but often with a focus of methods in solving mathematical problems in engineering instead of rigorous mathematical proof.

### 30.501 Modeling Multi-Energy Systems

12 credits

This course will introduce modern techniques for modeling multi-domain energy systems, selecting several key methods for deeper exploration. Bond-graph models, optimization using dynamic programming, and statistical parameter estimation techniques will be covered in detail. The emphasis of this course will be on sensing to obtain accurate signals, inferring using appropriately designed and validated models, and acting with stable and optimal control. Throughout this course, concepts will be presented an analyzed from the critical point viewpoint epitomized by George E. P. Box's insight that: "Essentially, all models are wrong, but some are useful." A project will be a component of the course.

Students are required to have solid undergraduate foundations in advanced calculus and linear algebra.

### 30.502 Research Methods

12 credits

The provision of essential tools for the analysis of empirical data is the focal of this course where you will learn to use statistics to design experiments, analyse errors and uncertainties, use probability distributions to describe uncertainties in data, and evaluate the statistical significance of experimental results. The course will also teach methods to smooth, fit, and filter data. In the final part of the course, the honest presentation of data, and ethics in research will be discussed.

### 30.504 Computational Science & Engineering

12 credits

Computation and simulation now pervades most fields of science and are essential to the design and development of most engineering applications. This course is aimed at covering a wide range of topics—both theoretical and practical—related to numerical methods and programming. However, this course is not aimed at covering an exhaustive compendium of numerical methods, or teaching one or more programming languages. Instead, it will be focused on learning enough to feel comfortable starting to use them in your everyday research work.

**30.505 Design Science**
12 credits
This class will introduce students to design science. Many design principles and methods are reviewed, applied and analyzed. Students will learn to make connections between design science and other fields in e.g. engineering and how principles in design science can be used to advance these fields. The class will cover a broad set of design methods such as customer needs analysis, methods in creativity, functional modeling, design for X, design for testing & verification.

**30.506 Data Structure and Algorithms**
12 credits
This course introduces data structure and algorithms for engineering research. Students will learn to design and select suitable data structure that is most efficient to represent a problem and to implement and understand efficient algorithms that solve engineering problems effectively. The students will understand the operation, implementation and performance of fundamental algorithms and data structures, and the relative merits and suitability of each for various applications. In addition, the students will develop the ability to model and implement efficient solutions for various engineering problems using appropriately selected algorithms and data structures, and analyze the complexity and compare among various techniques, in order to make the most appropriate design choices when solving real-world problems.

**30.507 Functional Materials**
12 credits
This course covers the basics of materials science and engineering by focusing on specific technological themes. It is design to benefit students of diverse backgrounds. It will begin with a review on classical materials and then focus on 1) modern classes of functional materials and their properties, specifically materials for energy, advanced displays, and biomedical devices 2) nanoscale materials: quantum dots, carbon nanotubes, graphene and nanocomposites. We will study the properties of modern materials used in the various technologies, which entails the understanding of the chemistry, physics, engineering and design aspects of these materials. The course materials are designed to be relevant to both material users and material engineers.

**30.508 Optimization and Control**
12 credits
This course will introduce students to mathematical optimization and its application to engineering problems. The course will cover static and dynamics optimization under algebraic, differential and integral constraints. The topics include: non-linear programing, calculus of variations, Pontryagin's Maximum Principle, Bellman's Dynamic Programming as well as number of numerical methods for solving non-linear optimization and optimal control problems. During this course, students will learn to formalize and solve optimization problems in practical scenarios.

**30.509 Applied Thermodynamics**
12 credits
No single event in the universe is proven violating thermodynamic laws; therefore, this course aims to connect principles, concepts and thermodynamic laws to solutions of engineering problems. It covers classical and statistical thermodynamics, principles and concepts of multicomponent and multi-phase equilibria, diffusion and nucleation. Furthermore, hands-on and practical design studies are demonstrated for nanotechnology, thermal and energy applications.

**30.510 Quantum Computation and Quantum Information**
12 credits
This subject will introduce students to the emerging field of quantum information processing, The course will introduce the basic theory underlying quantum computation and quantum cryptography and their implementation. The course will cover quantum models of information and computation, quantum algorithms, quantum information theory and the physics of systems capable of supporting quantum information processing. The course will begin with a self-contained introduction to quantum mechanics and so no prior knowledge of quantum mechanics is assumed.

**30.511 Design Management**
12 credits
This course is aimed at PhD students interested in the relationship between design theory and theories of business management (such as theories of the firm), and in particular, addresses how and why design methods could be applied to innovating business models (i.e., how firms are organized to provide value). We will cover some of the design-relevant management theory base, along with selected theories from the design traditions, with the idea that this provides students with the means to think about firms and other organizations as “design problems”, and possible design frameworks and solutions for those problems.

**30.512 Advanced Topics in Biomedical Engineering**
12 credits
This course is intended to provide PhD students broad yet detailed understanding on emerging topics in Biomedical Engineering and Sciences. Experts from the fields of human pathophysiology, cell & molecular biology, chemical biology, drug discovery, bio-imaging, tissue engineering and diagnostics development will share latest information from their fields of expertise and discuss the cutting-edge technologies used in the respective research fields.

**30.513 Understanding the Interaction between Human Behaviour, Technology and Design**
12 credits
Human beings have limited cognitive abilities and limited will power. Because of this, human behavior and decision are often marked by systematic departure from logical, rational ‘norms’. This course examines how technology and design interacts with and change human behavior, and how human behavior with all its proclivities redefines the status quo of technology and design. The influence of the dynamics of human interactions in cyber social networks is an

example of topics to be explored in this course. Techniques for prediction and forecasting from users' perspectives also will be included in the course.

**30.514 Optics and Photonics**
12 credits
This is an introductory optics course that will cover the theory and design principles of optics and photonics with an emphasis on applications. Optical communication systems, lightwave system components, multichannel systems, fiber optics will be covered. Methods for analyzing the propagation of light waves in different media will be covered. Design principles for photonics devices including filters, optical resonators, eigenmodes of optical fibers and waveguides, various types of lasers and amplifiers, photo-detectors will also be covered. Techniques for device fabrication, future manufacturing approaches, and real-world applications of optics and photonics such as internet data communications will also be covered.

**30.580 Research Project I**
6 credits
Students will learn and practice research design, defining, proposing, and forming a research topic. Through a short project, students will practice the attributes and characteristics of a good research project such as critical review, creativity thinking, inter and intra-disciplinary collaboration and effective communication on the research findings.

**30.590 Research Seminar I**
3 credits
The PhD research seminar series is intended to broaden the students' research perspectives by learning beyond individual research areas, and to effectively communicate scientific research to a wider audience. To this end, local and external speakers are invited to speak at this platform, while students get the opportunity to prepare and present conference-style talks on topics of their interest. Taken together, the course intends to foster a strong research culture at SUTD while inviting active participation to spark new research ideas.

**30.591 Research Seminar II**
3 credits
PhD research seminar series is intended to give PhD students the opportunity to prepare and present conference-style talks on the topics of their research. External speakers and faculty will also be invited to speak at this platform. These seminars are intended to foster a strong research culture at SUTD where the latest and greatest results are brought from the lab and communicated clearly to a broad audience. Held in a relaxed setting, these seminars are designed to invite active participation from all to spark new ideas and learn beyond your individual research areas.

**30.600 Special Topics in Psychology**
12 credits
Introduction to key psychological concepts and research methods; special topics may include language and bilingualism, developmental and cognitive psychology, human-machine interaction, etc.; hands-on experience in designing and conducting a research project that include literature search, research hypothesis formation, data collection, statistical analysis, report writing and project presentation.

**30.601 Independent Study (Physics, Optics and Photonics)**
12 credits

**30.621 Independent Study (Robotics)**
12 credits

**30.622 Independent Study (Material Science)**
12 credits

**30.623 Independent Study (Applied Statistics)**
12 credits

**30.624 Independent Study (Materials Fabrication and Processing)**
12 credits

**30.625 Independent Study (Electronic Devices)**
12 credits

**30.801 Industry Design Project**
12, 24, or 36 credits
Industrial Project is project-based module, which may have a research, development or design focus, is investigative in nature and provides an opportunity for students to go to local industries/research institutes and apply their knowledge gained in SUTD in real life. We will also focus on training them to prepare industrial proposals, create industrial collaborations and develop the leadership in managing their projects. Moreover, this course will also provide a regular opportunity for industrial interaction for our PhD students.

**30.901 Graduate Project Seminar I**
3 credits
Graduate Project Seminar I course is a mandatory module for all EPD PhD students. The main objective of this course is to enable graduate students to improve and optimize their research planning, organisation and presentation skills – oral and writing. As part of this module, students are required to attend seminars/ invited talks (both internal and external when possible) and also present individual research projects and plans.

**30.900 PhD Research Pre-Candidacy**
1-48 credits
PhD research work by doctoral students before passing the Qualifying examination.

**30.910 PhD Research Post-Candidacy**
1-48 credits
PhD research work by doctoral students after passing the Qualifying examination.

## Engineering Systems and Design (ESD) Courses

**40.510 Linear Optimization**
12 credits
This course provides an advanced treatment of the area of mathematical optimization known as linear programming. The course starts from fundamentals of linear algebra and then covers the formulation, solution and analysis of linear programs. It also discusses several topics related to linear optimization, such as network algorithms and the network simplex, and integer programming. Equipped with the tools discussed in class, students should be able to write mathematical optimization models for real-world optimal decision making problems, choose an appropriate methodology to solve such models, and analyze their solution.

**40.520 Stochastic Modeling**
12 credits
A good knowledge of uncertainty is a key tool in analyzing environmental systems, telecommunication systems, financial systems and overall large scale complex systems. The aim of this course is to acquaint students with the basic tools for modeling stochastic phenomena. The course does not require knowledge of measure theoretic probability, but knowledge of elementary probability and advanced calculus will be assumed.

**40.530 Statistics**
12 credits
This graduate-level course aims to acquaint students with classical concepts in Probability, Statistics and Learning that are important to many applications in the mathematical sciences and in engineering. A basic understanding of elementary probability will be assumed, and a quick review will be conducted during the first week to start everyone on the same page. The course will focus on fundamental paradigms in statistics – their motivations, their differences, and how they influence various methodologies used in learning (also known as statistical inference).

**40.590 Research Seminar**
0 credits
Students attend the ESD Seminar Series and learn about the current research activities in the field.

**40.671 Dynamic Programming**
6 credits
The course covers the basic models and solution techniques for problems of sequential decision making under uncertainty (dynamic programming). We will study optimal control of a dynamical system over both a finite and an infinite number of (discretized) stages. The course will cover fundamental methods to solve dynamic programs, including backward induction, value iteration, and policy iteration. We will also discuss approximation methods for problems involving large state spaces.

**40.752 Economics of Communication Networks**
12 credits
This course aims at providing the basic microeconomic models for communication networks, investigate the role of pricing both as an incentive and control mechanism for sharing resources and providing services at the various layers of the Internet architecture, define and analyze competition issues in the current Internet. Topics covered include key microeconomic concepts, externalities, pricing theory, economic models of queues, cost sharing, economics of transport protocols and wireless, bandwidth auctions, interconnection models, network neutrality.

**40.840 Special Topics (Operations Management)**
6 credits
This course will provide an introduction to the emerging topics in Operations Management. Topics will include supply chain management, service management, healthcare operations management, and sustainable operations. Special emphasis will be given to mathematical modeling techniques, which integrate tools from optimization theory, dynamic programming, queuing theory, game theory, microeconomics and statistics, for analyzing operations of these systems and guiding their strategic/operational decisions.

**40.811 Independent Study (Randomized Algorithms)**
6 credits
This course will provide fundamentals concepts for design and analysis of efficient algorithms using randomization as a tool. Some special research topics in the area of randomized Algorithms will be considered.

**40.900 PhD Research Pre-Candidacy**
1-48 credits
PhD research work by doctoral students before passing the Qualifying examination

**40.910 PhD Research Post-Candidacy**
1-48 credits
PhD research work by doctoral students after passing the Qualifying examination

**40.911 Research Project I and 40.912 Research Project II**
0 credits
Directed research project

**45.842 Special Topics (Logistics and Supply Chain)**
12 credits
The objective of this course is to expose students to the issues that need to be considered in designing and operating logistics and supply chains. We will start with an introduction including definition of logistics and supply chain management, key supply chain costs and metrics, and fundamental issues and trade-offs in supply chain management.

We will then discuss the interactions between stages in a supply chain, double marginalization and contracts for supply chain coordination, strategic alliances and incentive alignment, channels of distribution, coordinating distribution strategies, pricing/promotions. We will also discuss supply chain planning, facility location models, and vehicle routing models.

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN

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## Information Systems Technology and Design (ISTD) Courses

### 50.500 Analysis of Algorithms

12 credits

This course will cover the techniques for algorithm analysis, with examples from various sorting and search algorithms. Then the course will introduce advanced design and analysis techniques including randomizing algorithms, dynamic programming, greedy algorithms, amortized analysis. Finally, some graph algorithms such as minimum spanning trees, shortest path algorithms and maximum flow will be discussed. The course will be based on instructors-lead lectures, student-lead discussions, quizzes in the form of mock technical interviews, midterm and final exam.

### 50.510 Computer Networks

12 credits

Introductory graduate-level course in computer networking. The course covers core concepts and major design and implementation techniques for large-scale computer networks at the application, transport, network, and data link layers, as well as network security across these layers. It emphasizes the Internet as an open, decentralized, and interoperable infrastructure. The course may also cover selected current and advanced topics in computer network design and research.

### 50.511 Wireless Communications and Networking

12 credits

This is a graduate-level introduction to the fundamentals of wireless communications and networking. The focus is on design, analysis, and fundamental limits of wireless transmission systems, wireless networks, and development of foundations for research in this field. To provide long-term value, the emphasis basic principles with a broad applicability in wireless communications and networking.

### 50.530 Software Engineering

12 credits

This course is an introduction to a range of fundamental problems in building reliable and correct software, including but not limited to software design, software testing, debugging and verification. Students will be exposed to recent research on tackling these problems and through project work learn how to develop research ideas on solving real-world problems of software systems.

### 50.571 Digital Signal Processing

12 credits

Provide an understanding of the fundamentals of digital signal processing suitable for a range of signal processing applications. Topics include discrete-time signal representation and analysis, Fourier transform, z-transform, comparing discrete-time and continuous-time signals and systems, and digital filter design for recursive and non-recursive filters.

**50.572 Graphics & Visualization**
12 credits
Introduction to computer graphics algorithms, software and hardware. Topics include ray tracing, the graphics pipeline, transformations, texture mapping, shadows, sampling, global illumination, splines, animation and color. Advanced topics and recent research works will be covered.

**50.580 Project**
12 credits
The objective of the project is for the student to learn a research area other than those within the pillar. The aim is to promote inter-disciplinary research. Students taking this course are required to finish a one or two-term project advised by a faculty member in any pillar other than ISTD, possibly with a co-advisor from ISTD. The project can also be an industrial project which may have a research, development or design focus, to be investigative in nature and provides an opportunity for students to go to local industries/research institutes and apply their knowledge gained in SUTD in real life. Training will include preparing industrial proposals, creating industrial collaborations and developing the leadership in managing their projects.

**50.590 Research Seminar**
0 credits
Preparation and delivery of seminars on research topics.

**50.900 PhD Research Pre-candidacy**
1-48 credits
PhD research work by doctoral students before passing the Qualifying examination.

**50.910 PhD Research Post-Candidacy**
1-48 credits
PhD research work by doctoral students after passing the Qualifying examination.

## General Track Courses

**99.900 PhD Research Pre-candidacy**
1-48 credits
PhD research work by doctoral students before passing the Qualifying examination.