



**Bachelor of Engineering Program in
Software Engineering
(International Program)
(2017 Revision)**

**International College
King Mongkut's Institute of Technology
Ladkrabang**

Bachelor of Engineering Program in Software Engineering (International Program) 2017 Revision

Name of Institution	King Mongkut's Institute of Technology Ladkrabang (KMITL)
Faculty/Campus/College	International College
Program Code	136001

Part 1 General Information

1. Program title

Title (Thai) : หลักสูตรวิศวกรรมศาสตรบัณฑิต สาขาวิชาวิศวกรรมซอฟต์แวร์
(หลักสูตรนานาชาติ)

Title (English) : Bachelor of Engineering Program in Software Engineering
(International Program)

2. Degree title

Full Title (Thai) : วิศวกรรมศาสตรบัณฑิต (วิศวกรรมซอฟต์แวร์)

(English) : Bachelor of Engineering (Software Engineering)

Abbreviation (Thai) : วศ.บ. (วิศวกรรมซอฟต์แวร์)

(English) : B.Eng. (Software Engineering)

3. Major or minor subjects (if any)

None

4. Total number of credits

– Track 1: Total number of credits no less than 144 CP¹

– Track 2:

– Number of credits for courses taken at KMITL no less than 80 CP

¹ In this document, CP stands for Credit Point, which refers to the credit point in the KMITL credit system.

- Number of credits for courses taken at the University of Glasgow no less than the equivalent of 75 CP
- Total number of credits no less than 155 CP

5. Program characteristics

5.1 Program type

4-year full-time undergraduate program

5.2 Language of instruction

English

5.3 Admission

Both Thai and non-Thai students

5.4 Cooperation with other institutions

- Track 1: Solely run by International College, KMITL
- Track 2: Cooperation between International College, KMITL, and School of Computing Science, University of Glasgow (UK) under the Memorandum of Agreement between the University Court of the University of Glasgow and International College, King Mongkut's Institute of Technology Ladkrabang (Appendix C)

5.5 Degree conferment

- Track 1: One degree, Bachelor of Engineering in Software Engineering conferred by KMITL.
- Track 2: Two degrees, Bachelor of Engineering in Software Engineering conferred by KMITL and BSc (Honours) in Software Engineering conferred by the University of Glasgow.

6. Program status and approval

This revision of the program is expected to take effect in Semester 1/2017 (August 2017).

Deliberated and endorsed by the University Academic Committee in the/..... meeting on

Approved by the University Council in the/..... meeting on

7. Expected year that the program be published by the Commission of Higher Education

Academic Year 2019

8. Possible careers for the graduates

- Software engineers, software architects, software developers
- IT system analysts and designers
- Lecturers, researchers, and experts in software engineering or a related field
- Entrepreneurs

3. Curriculum and Lecturers

3.1 Curriculum

There are 2 study tracks in the program:

- Track 1 (Ordinary track): Study the entire program at International College, KMITL
- Track 2 (KMITL – University of Glasgow track): Study the first two years at International College, KMITL, and the remaining years at the School of Computing Science, University of Glasgow. To join Track 2, the student must be qualified according to the requirements set out in the Memorandum of Agreement between the University Court of the University of Glasgow and International College, King Mongkut’s Institute of Technology Ladkrabang (Appendix C).

In order to successfully graduate from the program, the student must satisfy all of the requirements of the curriculum as set out below for one of these two tracks.

3.1.1 Total credit points

- Track 1: Total number of credits no less than 144 CP
- Track 2:
 - Number of credits for courses taken at KMITL no less than 80 CP
 - Number of credits for courses taken at the University of Glasgow no less than the equivalent of 75 CP
 - Total number of credits no less than 155 CP

3.1.2 Curriculum structure

Course Group	Track 1	Track 2
A. General Education Courses	31	31
A1. Science and Mathematics	7	7
A2. Languages	12	12
A3. Humanity	6	6
A4. Social Science	6	6
B. Specific Courses	107	118
B1. Core Courses	15	15
B2. Major Compulsory Courses	74	85
B2.1 Organizational Issues and Information Systems	10	25
B2.2 Technology for Applications	15	12
B2.3 Software Technology and Methodologies	28	27
B2.4 Computing Fundamentals	13	13
B2.5 Computer Hardware and Architectures	8	8
B3. Major Electives	18	18
C. Free Electives	6	6
Total	144	155

3.1.3 Courses

The courses listed in this section are the courses in the registration system at KMITL. If a course is required for the student in Track 2, the student can either study that course at KMITL or study a course at the University of Glasgow that the Administrative Board of the International College Committee has approved to be equivalent.

Meaning of the Digits in a Course Code

A course code consists of 8 numerical digits, which have the following meaning:

Digit No.	Meaning
1 st , 2 nd	Faculty/College offering the course <ul style="list-style-type: none"> • 13 = International College
3 rd , 4 th	Program to which the course belongs and place of instruction <ul style="list-style-type: none"> • 00 = Shared courses • 01 = Bachelor of Engineering Program in Software Engineering, Courses held at the International College, KMITL • 91 = Bachelor of Engineering Program in Software Engineering, Courses held at the University of Glasgow
5 th	Course level <ul style="list-style-type: none"> • 6 = Undergraduate
6 th	Course group <ul style="list-style-type: none"> • 0 = Field-experience courses • 1 = Core courses • 2 = Major compulsory courses • 3, 4 = Major Electives
7 th , 8 th	Running number

A. General Education Courses **31 CP**

A1. Science and Mathematics **7 CP**

For both tracks, take the following course:

Code	Title	Credit
13006107	Introduction to Computers and Programming	4 (3-2-7)
13006108	Basic Electricity and Electronics	3 (2-2-5)

A2. Languages **12 CP**

For both tracks, take the following four courses:

Code	Title	Credit
13006208	Academic English 1	3 (3-0-6)
13006209	Academic English 2	3 (3-0-6)
13006210	Technical Writing	3 (3-0-6)
13006211	Technical Communication and Presentation	3 (3-0-6)

The student whose level of English language proficiency is not sufficient for “13006208 Academic English 1” will be required to take and pass “13006200 Preparatory English” before being permitted to take any of the above English language courses.

Code	Title	Credit
13006200	Preparatory English	0 (3-0-6)

A3. Humanity

6 CP

For both tracks, take the following course:

Code	Title	Credit
13006301	Introduction to Logic	3 (3-0-6)

and take at least one course (at least 3 CP) in the following list:

Code	Title	Credit
13006302	Philosophy of Science	3 (3-0-6)
13006303	Cultural Studies	3 (3-0-6)
13006304	Thai Society and Culture	3 (3-0-6)
13006305	Introduction to Humanities	3 (3-0-6)
13006306	Introduction to Philosophy	3 (3-0-6)
13006307	Introduction to Ethics	3 (3-0-6)
13006308	Introduction to Information Literacy	3 (3-0-6)

A4. Social Science

6 CP

For Track 1, take the following course:

Code	Title	Credit
13006401	Computer Ethics and Law	3 (3-0-6)

For Track 2, take the following course:

Code	Title	Credit
13906401	Professional Skills and Issues	3 (3-0-6)

Additionally, for both tracks, take at least one course (at least 3 CP) in the following list:

Code	Title	Credit
13006402	Introduction to Economics	3 (3-0-6)
13006403	Business Administration	3 (3-0-6)
13006404	Industrial Management	3 (3-0-6)
13006405	Business and Commercial Laws	3 (3-0-6)
13006406	International Trade and Finance	3 (3-0-6)
13006407	Introduction to Psychology	3 (3-0-6)
13006408	Introduction to Environmental Studies	3 (3-0-6)

B. Specific Courses**107 CP (Track 1), 118 CP (Track 2)****B1. Core Courses****15 CP**

For both tracks, take all of the following courses:

Code	Title	Credit
13006006	Linear Algebra	3 (3-0-6)
13006007	Calculus 1	3 (3-0-6)
13006008	Calculus 2	3 (3-0-6)
13006009	Probability and Statistics	3 (3-0-6)
13016105	Discrete Mathematics	3 (3-0-6)

B2. Major Compulsory Courses**74 CP (Track 1), 85 CP (Track 2)****B2.1 Organizational Issues and Information Systems****10 CP (Track 1), 25 CP (Track 2)**

Required courses for Track 1:

Code	Title	Credits
13016004	Software Industrial Internship in Summer	0 (0-45-0)
13016237	Information Systems and Databases	3 (3-0-6)
13016241	Computer Networks and Communications	3 (3-0-6)
13016242	Computer Networks and Communications Laboratory	1 (0-3-2)
13016294	Team Software Project	3 (0-9-5)

Required courses for Track 2:

Code	Title	Credits
13016237	Information Systems and Databases	3 (3-0-6)
13016241	Computer Networks and Communications	3 (3-0-6)
13016242	Computer Networks and Communications Laboratory	1 (0-3-2)
13916001	Software Engineering Summer Placement	3 (0-45-0)
13916205	Database Systems	3 (3-0-6)
13916206	Networked Systems	3 (3-0-6)
13916291	Team Project	9 (0-18-9)

B2.2 Technology for Applications**15 CP (Track 1), 12 CP (Track 2)**

For Track 1 Normal Study Option, take the following courses:

Code	Title	Credits
13016223	Artificial Intelligence	3 (3-0-6)
13016224	Software Verification and Validation	3 (3-0-6)
13016243	Human-Computer Interaction	3 (3-0-6)
13016291	Software Project 1	3 (0-9-5)
13016292	Software Project 2	3 (0-9-5)

For Track 1 Cooperative Education Option, take the following courses:

Code	Title	Credits
13016005	Pre-Cooperative Education	0 (0-2-0)
13016006	Cooperative Education	6 (0-45-0)

Code	Title	Credits
13016223	Artificial Intelligence	3 (3-0-6)
13016293	Software Project	6 (0-18-9)

For Track 2, take the following course:

Code	Title	Credits
13916292	Individual Project	12 (0-24-12)

B2.3 Software Technology and Methodologies **28 CP (Track 1), 27 CP (Track 2)**

Required courses for Track 1:

Code	Title	Credits
13016209	Object-Oriented Concepts and Programming	3 (3-0-6)
13016210	Object-Oriented Programming Laboratory	1 (0-3-2)
13016214	Software Engineering Principles	3 (3-0-6)
13016215	Software Engineering Principles Laboratory	1 (0-3-2)
13016219	Object-Oriented Analysis and Design	3 (3-0-6)
13016220	Object-Oriented Analysis and Design Laboratory	1 (0-3-2)
13016226	Compiler Construction	3 (3-0-6)
13016228	Software Design and Architecture	3 (3-0-6)
13016230	Software Development Process	3 (3-0-6)
13016235	C Programming	3 (3-0-6)
13016236	C Programming Laboratory	1 (0-3-2)
13016248	Seminar in Software Engineering	0 (0-3-0)
13016249	Advanced Object-Oriented Programming	3 (2-2-5)

Required courses for Track 2:

Code	Title	Credits
13016209	Object-Oriented Concepts and Programming	3 (3-0-6)
13016210	Object-Oriented Programming Laboratory	1 (0-3-2)
13016214	Software Engineering Principles	3 (3-0-6)
13016215	Software Engineering Principles Laboratory	1 (0-3-2)
13016235	C Programming	3 (3-0-6)
13016236	C Programming Laboratory	1 (0-3-2)
13016248	Seminar in Software Engineering	0 (0-3-0)
13016249	Advanced Object-Oriented Programming	3 (2-2-5)
13916201	Advanced Programming	3 (3-0-6)
13916203	Interactive Systems	3 (3-0-6)
13916204	Programming Languages	3 (3-0-6)
13916208	Professional Software Development	3 (2-2-5)

B2.4 Computing Foundations **13 CP**

Required courses for Track 1:

Code	Title	Credits
13016212	Data Structures and Algorithms	3 (3-0-6)

Code	Title	Credits
13016213	Data Structures and Algorithms Laboratory	1 (0-3-2)
13016216	Operating Systems	3 (3-0-6)
13016239	Algorithm Design and Analysis	3 (3-0-6)
13016240	Theory of Computation	3 (3-0-6)

Required courses for Track 2:

Code	Title	Credits
13016212	Data Structures and Algorithms	3 (3-0-6)
13016213	Data Structures and Algorithms Laboratory	1 (0-3-2)
13016239	Algorithm Design and Analysis	3 (3-0-6)
13916202	Algorithmics I	3 (3-0-6)
13916207	Operating Systems	3 (3-0-6)

B2.5 Computer Hardware and Architectures

8 CP

Required courses for both tracks:

Code	Title	Credits
13016204	Digital Circuit and Logic Design	3 (3-0-6)
13016205	Digital Circuit Laboratory	1 (0-3-2)
13016207	Computer Organization and Assembly Language	3 (3-0-6)
13016208	Computer Organization and Assembly Language Laboratory	1 (0-3-2)

B3 Major Electives

18 CP

B3.1 Major Electives for Track 1

For Track 1, choose one of the following specializations and take at least 6 major electives (18 CP) that satisfies the stated requirement.

Specialization	Requirements
a) Enterprise Software Engineering	Take all of the following courses <ul style="list-style-type: none"> • 13016384 Database Systems 3 (3-0-6) • 13016344 Web Programming 3 (3-0-6) • 13016385 Distributed Computing 3 (3-0-6) • 13016386 Enterprise Software Development 3 (3-0-6) plus at least two other major electives for Track 1.
b) Internet of Things	Take all of the following courses <ul style="list-style-type: none"> • 13016389 Microprocessors and Interfacing 3 (2-2-5) • 13016344 Web Programming 3 (3-0-6) • 13016390 Embedded System Software 3 (2-2-5) • 13016391 Computer Networking for the Internet of Things 3 (3-0-6) plus at least two other major electives for Track 1.
c) Intelligent Systems	Take all of the following courses <ul style="list-style-type: none"> • 13016394 Big Data 3 (3-0-6) • 13016364 Machine Learning 3 (3-0-6) • 13016395 Computational Intelligence 3 (3-0-6) • 13016396 Knowledge Representation and Reasoning 3 (3-0-6)

	plus at least two other major electives for Track 1.
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List of Major Electives for Track 1

Code	Title	Credits
13016301	Programming Languages	3 (3-0-6)
13016306	Software Metrics	3 (3-0-6)
13016308	Service Oriented Architecture	3 (3-0-6)
13016318	Operations Research	3 (3-0-6)
13016320	Computer Graphics	3 (3-0-6)
13016321	Game Development	3 (3-0-6)
13016322	Introduction to Parallel Computing	3 (3-0-6)
13016323	Advanced Topics in Software Engineering	3 (3-0-6)
13016324	Advanced Topics in Software Architecture	3 (3-0-6)
13016325	Software Quality Assurance	3 (3-0-6)
13016332	Geographic Information Systems	3 (3-0-6)
13016336	Information Retrieval	3 (3-0-6)
13016337	Advanced Topics in Database Systems	3 (3-0-6)
13016341	TCP/IP Networks	3 (3-0-6)
13016343	Network Programming	3 (3-0-6)
13016344	Web Programming	3 (3-0-6)
13016346	Mobile Computing and Wireless Communications	3 (3-0-6)
13016347	Computer and Network Security	3 (3-0-6)
13016348	Advanced Topics in Computer Networks	3 (3-0-6)
13016362	Applied Artificial Intelligence	3 (3-0-6)
13016364	Machine Learning	3 (3-0-6)
13016366	Data Mining	3 (3-0-6)
13016367	Semantic Web	3 (3-0-6)
13016368	Intelligent Agents	3 (3-0-6)
13016369	Introduction to Robotics	3 (3-0-6)
13016371	Pattern Recognition	3 (3-0-6)
13016380	Software Development for Mobile Devices	3 (3-0-6)
13016381	Embedded Control Systems	3 (3-0-6)
13016382	Digital Signal Processing and Applications	3 (3-0-6)
13016383	Digital Signal Processor Architectures and Programming	3 (3-0-6)
13016384	Database Systems	3 (3-0-6)
13016385	Distributed Computing	3 (3-0-6)
13016386	Enterprise Software Development	3 (3-0-6)
13016387	Business Intelligence	3 (3-0-6)
13016388	Selected Topics in Enterprise Software Engineering	3 (3-0-6)
13016389	Microprocessors and Interfacing	3 (2-2-5)
13016390	Embedded System Software	3 (2-2-5)
13016391	Computer Networking for the Internet of Things	3 (3-0-6)
13016392	Wireless Sensor Networks	3 (3-0-6)
13016393	Selected Topics in the Internet of Things	3 (3-0-6)
13016394	Big Data	3 (3-0-6)
13016395	Computational Intelligence	3 (3-0-6)

Code	Title	Credits
13016396	Knowledge Representation and Reasoning	3 (3-0-6)
13016397	Natural Language Processing	3 (3-0-6)
13016398	Selected Topics in Intelligent Systems	3 (3-0-6)
13016399	Software Entrepreneurship	3 (3-0-6)
13016400	Digital Image Processing	3 (3-0-6)
13016401	Computer Vision	3 (3-0-6)

B3.2 Major Electives for Track 2

For Track 2, take at least 6 major electives (18 CP) from the list below.

List of Major Electives for Track 2

Code	Title	Credits
13916301	Advanced Topics in Software Engineering	3 (3-0-6)
13916302	Advanced Topics in Database Systems	3 (3-0-6)
13916303	Selected Topics in Enterprise Software Engineering	3 (3-0-6)
13916304	Selected Topics in the Internet of Things	3 (3-0-6)
13916305	Selected Topics in Intelligent Systems	3 (3-0-6)
13916306	Advanced Networking and Communications	3 (3-0-6)
13916307	Advanced Operating Systems	3 (3-0-6)
13916308	Advanced Software Engineering Practices	3 (2-2-5)
13916309	Algorithmics II	3 (3-0-6)
13916310	Artificial Intelligence	3 (3-0-6)
13916311	Big Data: Systems, Programming, and Management	3 (3-0-6)
13916312	Computer Architecture	3 (3-0-6)
13916313	Computer Vision Methods and Applications	3 (3-0-6)
13916314	Computing Science in the Classroom	3 (3-0-6)
13916315	Cyber Security Fundamentals	3 (3-0-6)
13916316	Database Theory and Application	3 (3-0-6)
13916317	Distributed Algorithms and Systems	3 (3-0-6)
13916318	Embedded Systems	3 (3-0-6)
13916319	Enterprise Cyber Security	3 (3-0-6)
13916320	Functional Programming	3 (3-0-6)
13916321	Human-Centred Security	3 (3-0-6)
13916322	Human-Computer Interaction	3 (3-0-6)
13916323	Information Retrieval	3 (3-0-6)
13916324	Internet Technology	3 (3-0-6)
13916325	IT Architecture	3 (3-0-6)
13916326	Machine Learning	3 (3-0-6)
13916327	Mobile Human-Computer Interaction	3 (3-0-6)
13916328	Modelling Reactive Systems	3 (3-0-6)
13916329	Multimedia Systems and Applications	3 (3-0-6)
13916330	Research Methods and Techniques	3 (3-0-6)
13916331	Safety-Critical Systems Development	3 (3-0-6)
13916332	Software Project Management	3 (3-0-6)

C. Free Electives**6 CP**

Students can take any undergraduate course as a free elective. All students in the program are required to take at least 6 CP of free electives in total.

3.1.4 Recommended study plans

Year 1 Semester 1

Track 1 and Track 2, Courses held at KMITL

Code	Course Title	Credits
13006007	Calculus 1	3 (3-0-6)
13006107	Introduction to Computers and Programming	4 (3-2-7)
13006108	Basic Electricity and Electronics	3 (2-2-5)
13006208	Academic English 1	3 (3-0-6)
13006301	Introduction to Logic	3 (3-0-6)
13016235	C Programming	3 (3-0-6)
13016236	C Programming Laboratory	1 (0-3-2)
	Total	20

Year 1 Semester 2

Track 1 and Track 2, Courses held at KMITL

Code	Course Title	Credits
13006008	Calculus 2	3 (3-0-6)
13006209	Academic English 2	3 (3-0-6)
130063__	Elective in Humanity	3 (x-x-x)
13016105	Discrete Mathematics	3 (3-0-6)
13016204	Digital Circuit and Logic Design	3 (3-0-6)
13016205	Digital Circuit Laboratory	1 (0-3-2)
13016209	Object-Oriented Concepts and Programming	3 (3-0-6)
13016210	Object-Oriented Programming Laboratory	1 (0-3-2)
	Total	20

Year 2 Semester 1

Track 1 and Track 2, Courses held at KMITL

Code	Course Title	Credits
13006006	Linear Algebra	3 (3-0-6)
13006210	Technical Writing	3 (3-0-6)
130063__	Elective in Social Study	3 (x-x-x)
13016207	Computer Organization and Assembly Language	3 (3-0-6)
13016208	Computer Organization and Assembly Language Laboratory	1 (0-3-2)
13016212	Data Structures and Algorithms	3 (3-0-6)
13016213	Data Structures and Algorithms Laboratory	1 (0-3-2)
13016249	Advanced Object-Oriented Programming	3 (2-2-5)
	Total	20

Year 2 Semester 2

Track 1 and Track 2, Courses held at KMITL

Code	Course Title	Credits
13006009	Probability and Statistics	3 (3-0-6)
13006211	Technical Communication and Presentation	3 (3-0-6)
13016214	Software Engineering Principles	3 (3-0-6)
13016215	Software Engineering Principles Laboratory	1 (0-3-2)
13016237	Information Systems and Databases	3 (3-0-6)
13016239	Algorithm Design and Analysis	3 (3-0-6)
13016241	Computer Networks and Communications	3 (3-0-6)
13016242	Computer Networks and Communications Laboratory	1 (0-3-2)
13016248	Seminar in Software Engineering	0 (0-3-0)
	Total	20

Year 2 Special Semester

Track 1, Courses held at KMITL

Code	Course Title	Credits
13016004	Software Industrial Internship in Summer	0 (0-45-0)
	Total	0

Year 3 Semester 1
Track 1, Courses held at KMITL

Code	Course Title	Credits
13016219	Object-Oriented Analysis and Design	3 (3-0-6)
13016220	Object-Oriented Analysis and Design Laboratory	1 (0-3-2)
13016216	Operating Systems	3 (3-0-6)
13016223	Artificial Intelligence	3 (3-0-6)
13016240	Theory of Computation	3 (3-0-6)
	[For Enterprise Software Engineering Specialization]	
13016344	Web Programming	3 (3-0-6)
13016384	Database Systems	3 (3-0-6)
	[For Internet of Things Specialization]	
13016344	Web Programming	3 (3-0-6)
13016389	Microprocessors and Interfacing	3 (2-2-5)
	[For Intelligent System Specialization]	
13016364	Machine Learning	3 (3-0-6)
13016394	Big Data	3 (3-0-6)
	Total	19

Year 3 Semester 2

Track 1 with Normal Study Option, Courses held at KMITL

Code	Course Title	Credits
13016226	Compiler Construction	3 (3-0-6)
13016228	Software Design and Architecture	3 (3-0-6)
13016230	Software Development Process	3 (3-0-6)
13016294	Team Software Project	3 (0-9-5)
	[For Enterprise Software Engineering Specialization]	
13016385	Distributed Computing	3 (3-0-6)
13016386	Enterprise Software Development	3 (3-0-6)
	[For Internet of Things Specialization]	
13016390	Embedded System Software	3 (2-2-5)
13016391	Computer Networking for the Internet of Things	3 (3-0-6)
	[For Intelligent System Specialization]	
13016395	Computational Intelligence	3 (3-0-6)
13016396	Knowledge Representation and Reasoning	3 (3-0-6)
	Total	18

Year 4 Semester 1

Track 1 with Normal Study Option, Courses held at KMITL

Code	Course Title	Credits
13016224	Software Verification and Validation	3 (3-0-6)
13016243	Human-Computer Interaction	3 (3-0-6)
13016291	Software Project 1	3 (0-9-5)
130163__	Major Elective 1	3 (x-x-x)
____6__	Free Elective 1	3 (x-x-x)
	Total	15

Year 4 Semester 2

Track 1 with Normal Study Option, Courses held at KMITL

Code	Course Title	Credits
13006401	Computer Ethics and Law	3 (3-0-6)
13016292	Software Project 2	3 (0-9-5)
130163__	Major Elective 2	3 (x-x-x)
____6__	Free Elective 2	3 (x-x-x)
	Total	12

Year 3 Semester 2

Track 1 with Cooperative Education Option, Courses held at KMITL

Code	Course Title	Credits
13016005	Pre-Cooperative Education	0 (0-2-0)
13016226	Compiler Construction	3 (3-0-6)
13016228	Software Design and Architecture	3 (3-0-6)
13016230	Software Development Process	3 (3-0-6)
13016294	Team Software Project	3 (0-9-5)
	[For Enterprise Software Engineering Specialization]	
13016385	Distributed Computing	3 (3-0-6)
13016386	Enterprise Software Development	3 (3-0-6)
	[For Internet of Things Specialization]	
13016390	Embedded System Software	3 (2-2-5)
13016391	Computer Networking for the Internet of Things	3 (3-0-6)
	[For Intelligent System Specialization]	
13016395	Computational Intelligence	3 (3-0-6)
13016396	Knowledge Representation and Reasoning	3 (3-0-6)
	Total	18

Year 4 Semester 1Track 1 with Cooperative Education Option,
Course held in industry or a research lab in partnership with KMITL

Code	Course Title	Credits
13016006	Cooperative Education	6 (0-45-0)
	Total	6

Year 4 Semester 2

Track 1 with Cooperative Education Option, Courses held at KMITL

Code	Course Title	Credits
13006401	Computer Ethics and Law	3 (3-0-6)
13016293	Software Project	6 (0-18-9)
130163__	Major Elective 1	3 (x-x-x)
130163__	Major Elective 2	3 (x-x-x)
___6__	Free Elective 1	3 (x-x-x)
___6__	Free Elective 2	3 (x-x-x)
	Total	21

Course Descriptions

13006006 Linear Algebra 3 (3-0-6)

Prerequisite: None

Matrices and systems of linear equations; Hermitian matrices and unitary matrices; LU factorizations; Determinant; Cramer's rule; Vector spaces; Linear independence; Bases; Dimension and rank of matrices; Orthogonality; Eigenvalues and eigenvector; Reduction of matrices to diagonal forms.

13006007 Calculus 1 3 (3-0-6)

Prerequisite: None

Limits and continuity; Differentiation and its applications; Integration and its applications; Transcendental functions; Techniques of integration; Improper integrals.

13006008 Calculus 2 3 (3-0-6)

Prerequisite: 13006007 Calculus 1

Sequences and series of real numbers; Power series; Three-dimensional space; Vector-valued functions of one variables; Functions of several variables; Partial derivatives; Polar coordinate system; Double integrals; Introduction to Differential Equations.

13006009 Probability and Statistics 3 (3-0-6)

Prerequisite: 13006007 Calculus 1

This course provides an elementary introduction to probability and statistics with applications. The topics of study include elementary probability theory, discrete random variables and probability distributions, continuous random variables and probability distributions, joint probability distributions, expected values, random sampling, parameter estimation, and hypothesis testing.

13006107 Introduction to Computers and Programming 4 (3-2-7)

Prerequisite: None

This course provides an introduction to basic components of a computer and computer operation, the history and the evolution of computers, an introduction to a programming language, basics of computer programming using structured and object-oriented approaches, and some examples of computer programming to serve various purposes.

13006108 Basic Electricity and Electronics 3 (2-2-5)

Prerequisite: None

This course teaches the students to understand basic principles of electricity and electronics. Topics studied include basic concepts of electric circuits, resistors, capacitors, inductors, solid-state devices, diode and rectifiers, and transistors.

13006200 Preparatory English 0 (3-0-6)**Prerequisite:** None

This course is designed for the freshman undergraduate students who need to develop their English language skills to be at a suitable level for university study and for their life at university. By the end of the course, they are expected to be at the level equivalent to IELTS (Academic) score of 5.5 or higher.

13006208 Academic English 1 3 (3-0-6)**Prerequisite:** None

This course trains the students' skills of English language for academic purposes, covering all essential skills for studying at university (reading, writing, listening, and speaking). The students taking this course are expected to have their English language proficiency at the level equivalent to the IELTS (Academic) score of 5.5. By the end of the course, they are expected to be at the level equivalent to IELTS (Academic) score of 6.0 or higher.

13006209 Academic English 2 3 (3-0-6)**Prerequisite:** 13006208 Academic English 1

This course trains the students' skills of English language for academic purposes, covering all essential skills for studying at university (reading, writing, listening, and speaking). The students taking this course are expected to have their English language proficiency at the level equivalent to the IELTS (Academic) score of 6.0. By the end of the course, they are expected to be at the level equivalent to IELTS (Academic) score of 6.5 or higher.

13006210 Technical Writing 3 (3-0-6)**Prerequisite:** 13006209 Academic English 2

This course provides a study and practice of academic writing skills in English language. By the end of the course, the students are expected to be able to compose clear and effective technical writings, including technical essays, reports, and articles, with correct and appropriate usage of the language.

13006211 Technical Communication and Presentation 3 (3-0-6)**Prerequisite:** 13006209 Academic English 2

This course provides a study and practice of technical communication and presentation skills in English. The course studies how to communicate and make a presentation clearly and effectively, with correct and appropriate usage of the language. The students are trained to communicate on technical topics through conversations and written correspondence (such as letters or emails), give public speeches and lectures on technical topics, and discuss in a seminar. The course will also study techniques in creating and delivering effective presentations.

13006301 Introduction to Logic 3 (3-0-6)**Prerequisite:** None

This course provides a study of the nature of logic and logical reasoning, covering the following topics: arguments, syntax and semantics of propositional logic, validity and equivalence in propositional logic, truth tables, basic proof theory for propositional logic, syntax and semantics of first-order logic, validity and equivalence in first-order logic, basic proof theory for first-order logic, limitations of first-order logic, and applications of logic for problem solving.

13006302 Philosophy of Science 3 (3-0-6)

Prerequisite: None

The course provides a study of the thing we call “science”, together with its nature and methodology. The topics cover the meaning of science, reality, the nature of scientific observations, scientific theories and their discovery and formation, scientific explanations and predictions, the problem of induction, scientific rationality, the nature of scientific knowledge, concepts of truth, hypothesis testing, hypothesis confirmation, hypothesis falsification, logic of scientific method, and scientific progress.

13006303 Cultural Studies 3 (3-0-6)

Prerequisite: None

This course covers basic theory and concepts of cultural studies, evolution and relations of world cultures, and study in detail of selected cultures in present days.

13006304 Thai Society and Culture 3 (3-0-6)

Prerequisite: None

This course covers a study of Thai social identity and culture, development and inheritance of Thai culture, evolution of Thai society, as well as relation of Thai society and culture to societies and cultures of other countries.

13006305 Introduction to Humanities 3 (3-0-6)

Prerequisite: None

Basic introduction to humanities. Focuses on central concepts, historical development and fundamental nature of philosophy, architecture, music, religion and art.

13006306 Introduction to Philosophy 3 (3-0-6)

Prerequisite: None

An introduction to philosophy through ancient, medieval, modern, and contemporary sources. The course includes main areas such as ethics, metaphysics, epistemology, aesthetics, and philosophy of religion.

13006307 Introduction to Ethics 3 (3-0-6)

Prerequisite: None

A philosophical study of “the good life”: What constitutes a good life: “How ought one to live?” Examination and critical analysis of a variety of ethical theories from classical through the present and their practical application to contemporary issues.

13006308 Introduction to Information Literacy 3 (3-0-6)**Prerequisite:** None

Information literacy concept, Information needs and sources, Access of information, Evaluation of information, Communication and presentation of information

13006401 Computer Ethics and Law 3 (3-0-6)**Prerequisite:** None

This course provides a study of social, legal and moral issues raised by the development of information technology. The course examines the relationship between law, policy and technology related to current issues, including intellectual property, privacy, computer crime and various risks which may cause damages associated with computer usage.

13006402 Introduction to Economics 3 (3-0-6)**Prerequisite:** None

This course gives an overview of economics, covering basic concepts and theories of microeconomics and macroeconomics. Topics in microeconomics studied include demand and supply, price elasticities, consumer behavior theory, production and cost theory, and perfect and imperfect competitions. Macroeconomics topics studied include aggregate demand and supply, macroeconomic data (e.g. gross domestic product, national income, etc.), management of economic growth, inflation problems, unemployment problems, money and banking systems, fiscal and monetary policy, taxation, international trades, and exchange rates.

13006403 Business Administration 3 (3-0-6)**Prerequisite:** None

This course introduces concepts, principles, and processes in business administration. The topics of study include objectives and types of business organizations, planning, organization structures, motivation, leadership, communication, controlling of operations, marketing, and personnel management.

13006404 Industrial Management 3 (3-0-6)**Prerequisite:** None

This course provides a study of production management, the scope and various activities of production management, organization structures, planning and development of new products, forecasting of production, production planning, production layouts and operation standards, production scheduling, factory location, purchasing and inventory control, quality control, industrial finance, personnel management, labor relations, personnel motivation, production maintenance, and safety management.

13006405 Business and Commercial Laws 3 (3-0-6)**Prerequisite:** None

A study of laws and regulations relating to business, namely: juristic acts and contracts; specific contracts e.g. sale exchange, rent, hire-purchase, pledge, mortgage, agent and brokerage; laws and regulations relating to the establishment and registration of commercial and trade entities; companies and partnerships, labor and factory laws; copyright; patent; trademark; personal and corporate income taxes and cheques and offences of using cheques.

13006406 International Trade and Finance 3 (3-0-6)

Prerequisite: None

A study of fundamental economic principles, economic systems, mechanism of macro economic systems, the roles of international trade affecting an economy of the country, international factor movement, trade policies, economic integration, international financial policies, exchange rates, balance of payment, international financial systems, the relationship between domestic and international economy as well as interesting events about international trade and finance.

13006407 Introduction to Psychology 3 (3-0-6)

Prerequisite: None

An eclectic approach to a social and behavioral survey of major topics in psychology, including learning, motivation, intelligence, personality, mental illness, and social relations.

13006408 Introduction to Environmental Studies 3 (3-0-6)

Prerequisite: None

Survey of environmental studies examining ecological, socioeconomic, aesthetic, and technological influences determining quality of life on earth.

13016004 Software Industrial Internship in Summer 0 (0-45-0)

Prerequisite: None

This course demands the student to complete a full-time software industrial training in a software company for one summer semester. The objectives of software industrial training are for the students to gain work experience in the software industry and to understand the role of a software engineer. Each student is required to submit a report and present an official statement from the employer confirming their satisfactory in the software industrial training. Each student is required to formally enroll in this course in a summer semester.

13016005 Pre-Cooperative Education 0 (0-2-0)

Prerequisite: None

This course intends to prepare to the students who will be taking cooperative education in the industry in the subsequent semester. Covered in this course include the principles and concepts of cooperative education, rules, regulations, and procedures related to cooperative education, guide to finding a company for cooperative education, resume writing and interview, time management, basic project management, workplace etiquettes, corporate cultures, participating and conducting an effective meeting, effective communications in workplace (e.g. emails, memos, and telephone conversation), report writing, and preparing and delivering a good presentation.

13016006 Cooperative Education 6 (0-45-0)**Prerequisite:** 13016005 Pre-Cooperative Education

The course demands the student to work in a software company or a government/private organization, which is approved by the International College, for software development or research for one normal semester. The work of the student is under supervision of a faculty member, who is regarded as his/her “supervisor”. The student must report progress to his/her supervisor regularly. At the end of the semester, the student is required to submit a report and present their work to the evaluation committee.

13016105 Discrete Mathematics 3 (3-0-6)**Prerequisite:** None

This is an introductory course in discrete mathematics, covering the following topics: basic set theory, theory and techniques of counting, properties of integers, mathematical induction, recursive definitions, recurrent equations, sequences and summations, relations, graphs, and trees.

13016204 Digital Circuit and Logic Design 3 (3-0-6)**Prerequisite:** None

This course covers the following topics: basic theory of switching circuit, Boolean algebra, truth table, Boolean equation reduction by Karnaugh mapping and Quine–McCluskey method, Venn diagram, logic gates, flip-flops, counters, shift registers, and combinational and sequential circuit design.

13016205 Digital Circuit Laboratory 1 (0-3-2)**Prerequisite:** None

Laboratory exercises supplementing 13016204 Digital Circuit and Logic Design

13016207 Computer Organization and Assembly Language 3 (3-0-6)**Prerequisite:** 13016204 Digital Circuit and Logic Design

This course studies the basics of microcomputer architectures and instruction execution. The topics covered include microprocessor structures, registers, bus technology, memory hierarchy, main memory, cache memory, storage devices, and peripheral devices. The course also covers assembly language programming, including instruction sets, addressing modes, and instruction decoding.

13016208 Computer Organization and Assembly Language Laboratory 1 (0-3-2)**Prerequisite:** 13016204 Digital Circuit and Logic Design

Laboratory exercises supplementing 13016207 Computer Organization and Assembly Language

13016209 Object-Oriented Concepts and Programming 3 (3-0-6)**Prerequisite:** 13016235 C Programming

This course introduces object-oriented concepts and methodology and studies object-oriented programming using C++. Topics covered include objects, classes, encapsulation, inheritance, multiple inheritance, polymorphism, abstract classes, static class members, object construction and destruction, namespaces, function overloading, function overriding, exception handling, template classes, and container classes. This course also covers basic techniques for testing and debugging object-oriented programs.

13016210 Object-Oriented Programming Laboratory 1 (0-3-2)

Prerequisite: 13016235 C Programming

Laboratory exercises supplementing 13016209 Object-Oriented Concepts and Programming

13016212 Data Structures and Algorithms 3 (3-0-6)

Prerequisite: 13016209 Object-Oriented Concepts and Programming

The course studies basic data structures and their related operations as well as an introduction to the analysis of algorithms. Topics include arrays, stacks, queues, lists, hash tables, trees, heaps, graphs, time and space complexity analysis of algorithms, asymptotic notations, iterative and recursive algorithms, and algorithms for sorting and searching and their complexity.

13016213 Data Structures and Algorithms Laboratory 1 (0-3-2)

Prerequisite: 13016209 Object-Oriented Concepts and Programming

Laboratory exercises supplementing 13016212 Data Structures and Algorithms

13016214 Software Engineering Principles 3 (3-0-6)

Prerequisite: 13016212 Data Structures and Algorithms

This course is the study of important principles and concepts of software engineering, as well as an overview of software development processes. The topics include software development processes, requirement and specification of software, introduction to business process analysis and modelling, structured and object-oriented software analysis, design, and modelling, software verification and validation, software project management, software evolution and maintenance, and computer-aided software engineering (CASE) tools.

13016215 Software Engineering Principles Laboratory 1 (0-3-2)

Prerequisite: 13016212 Data Structures and Algorithms

Laboratory exercises supplementing 13016214 Software Engineering Principle

13016216 Operating Systems 3 (3-0-6)

Prerequisite: 13016212 Data Structures and Algorithms

This course studies basic principles and concepts of operating systems. Topics include structures of operating systems, process management, processor scheduling, process synchronization, inter-process communication, semaphores and monitors, mutual exclusion, deadlock detection and prevention, memory management, virtual memory, file systems, I/O systems, secondary storage

management, user account management, and operating system security. The course also studies and compares among important operating systems.

13016219 Object-Oriented Analysis and Design 3 (3-0-6)

Prerequisite: 13016214 Software Engineering Principles

This course covers the principles and methodology of object-oriented analysis and design, with emphasis on the use of the Unified Modeling Language (UML), and also the object-oriented development methodology under the unified process. Students will study how to utilize various UML diagrams as well as several design patterns in software analysis and design processes.

13016220 Object-Oriented Analysis and Design Laboratory 1 (0-3-2)

Prerequisite: 13016214 Software Engineering Principles

Laboratory exercises supplementing 13016219 Object-Oriented Analysis and Design

13016223 Artificial Intelligence 3 (3-0-6)

Prerequisite: 13016212 Data Structures and Algorithms

The course covers the following topics: meanings of artificial intelligence, various knowledge representations (including semantic networks, frames, rules, logic, etc.), problem solving by search (including uninformed search and heuristic search), playing games using search, elementary logic, logical reasoning, knowledge-based systems, rule-based systems, expert systems, machine learning, planning, intelligent agents, and programming languages for artificial intelligence.

13016224 Software Verification and Validation 3 (3-0-6)

Prerequisite: 13016214 Software Engineering Principles

This course studies three important methods for software verification and validation: testing, peer reviews, and formal verification, with emphasis on testing. Topics on testing include the necessity and limitations of testing, an overview of test processes, testing throughout the software development life cycle, unit testing, test design techniques, test automation, tool support for testing, and test management. The course will study how software peer reviews, which can help detect and prevent software defects, are carried out in practice and study the inspection processes throughout the software development life cycle, including the inspection of requirement documents, design documents, code, and test plans. The course will also provide a basic understanding of formal verification techniques, such as Hoare Logic and model checking.

13016226 Compiler Construction 3 (3-0-6)

Prerequisite: 13016212 Data Structures and Algorithms AND
13016240 Theory of Computation

This course studies theories and concepts for constructing computer language translators. The topics include lexical analysis, syntax analysis, parser construction, syntax-directed translation, type checking, run-time environment handling, intermediate and machine code generation and code optimization, interpreter construction, together with case studies of compiler design and construction for some computer languages.

13016228 Software Design and Architecture 3 (3-0-6)**Prerequisite:** 13016214 Software Engineering Principles

This course introduces basic concepts and principles of software design and software architecture. It starts with discussion on design issues, followed by coverage on design patterns. It then gives an overview of architectural structures and styles. Practical approaches and methods for creating and analyzing software architecture are presented. The emphasis is on the interaction between quality attributes and software architecture. Students will also gain experiences with examples in design pattern application and case studies in software architecture.

13016230 Software Development Process 3 (3-0-6)**Prerequisite:** 13016214 Software Engineering Principles

A software development process is a set of activities, methods, and practices that are used in the production and maintenance process of software. This course is concerned with improving the processes used to develop and maintain high-quality software in a timely and economical manner. It covers the evolutions of different software development models and the currently popular and successful process models, for example, iterative software development (e.g. spiral models and the Rational Unified Process (RUP)), agile software development (e.g. Extreme Programming (XP), Agile Modeling (AM), Scrum, Crystal, Feature-Driven Development (FDD), and Incremental Funding Method (IFM)), Test-Driven Development (TDD), Personal Software Process (PSP), Team Software Process (TSP), and software maturity frameworks, such as the Capability Maturity Model (CMM).

13016235 C Programming 3 (3-0-6)**Prerequisite:** None

This is an introductory course in computer programming using the C language. Emphasis is placed on developing the students' abilities in the design and implementation of algorithms. The course describes the fundamentals of program design and implementation in C, variables and data types, input and output statements, conditional statements, loop statements, modularity, parameter passing, pointers, arrays and complex arrays, strings, user-defined types, file processing, and program testing and debugging techniques.

13016236 C Programming Laboratory 1 (0-3-2)**Prerequisite:** None

Laboratory exercises supplementing 13016235 C Programming

13016237 Information Systems and Databases 3 (3-0-6)**Prerequisite:** 13016212 Data Structures and Algorithms

This course studies basic concepts of information systems and database systems, with emphasis on the study of relational database systems. Topics include basic concepts of information systems and database systems, types of data models, relational database design, entity-relationship models, normal forms of relational databases, and database query languages. Some important non-relational data models are also introduced in this course.

topics on the design of interactive software: requirement analysis for interactive software, principles and techniques of user interface design, types of input devices, choosing appropriate input devices, and validation and usability evaluation of interactive software.

13016248 Seminar in Software Engineering 0 (0-3-0)

Prerequisite: None

This course requires the students to attend seminars, lectures, and/or talks, given by invited speakers who are well-known in the software industry or in research and development in computing-related areas. The students are required to submit a written report summarizing what they have learned from each seminar.

13016249 Advanced Object-Oriented Programming 3 (2-2-5)

Prerequisite: 13016209 Object-Oriented Concepts and Programming

This course covers advanced concepts of object-oriented programming and the Java programming language, with emphasis on principles and practices for the design and implementation of large and complex programs. The course covers the following topics: design and implementation principles to support software reuse, basic design patterns, exception handling, event-driven programming, development of programs with graphical user interface, multithread programming, and the use of tools to assist debugging and testing programs. Students are encouraged to learn to utilize classes from standard or third-party libraries by studying from the documentation of those libraries.

13016291 Software Project 1 3 (0-9-5)

Prerequisite: 13016214 Software Engineering Principles

This course is the first half of the senior project. In this course, the students will conduct their independent study, research and development of computer software using software engineering methodology. The students will be guided by their project advisor(s) to conduct research and software development with the aim that they can develop their own original work with their creativity and problem solving skills. The required project progress report must be submitted and presented to the examination committee at the end of the semester.

13016292 Software Project 2 3 (0-9-5)

Prerequisite: 13016291 Software Project 1

This course is the continuation of 13016291 Software Project 1. In this course, the students will conduct their independent study, research and development of computer software using software engineering methodology. The students will be guided by their project advisor(s) to conduct research and software development with the aim that they can develop their own original work with their creativity and problem solving skills. The required thesis must be submitted together with the developed software and presented to the examination committee at the end of the semester.

13016293 Software Project 6 (0-18-9)

Prerequisite: 13016214 Software Engineering Principles

This is the senior project course for the student who takes the cooperative education option. Ideally, the project topic in this course should have arisen from the student's work experience during their cooperative education. In this course, the students will conduct their independent study, research and development of computer software using software engineering methodology. The students will be guided by their project advisor(s) to conduct research and software development with the aim that they can develop their own original work with their creativity and problem solving skills. The required thesis must be submitted together with the developed software and presented to the examination committee at the end of the semester.

13016294 Team Software Project 3 (0-9-5)

Prerequisite: 13016214 Software Engineering Principles

This is a software project course in which the students work in group to develop software according to the requirements provided by the users. The students will learn to integrate their knowledge and skills to perform each phase of software development, including requirement analysis, modeling, design, implementation, and testing, in order to obtain the required software, whose topic is decided by the advisor(s) or by the students themselves.

13016301 Programming Languages 3 (3-0-6)

Prerequisite: 13016209 Object-Oriented Concepts and Programming

This course studies the evolution of programming languages and their relationship. It covers important concepts and issues in programming language design, including syntax and semantics of programming languages, data types, abstraction, polymorphism, and program decomposition. The course also studies important programming language paradigms, such as object-oriented programming, functional programming, and logic programming, by referring to case studies of contemporary programming languages, such as C, C++, Java, Lisp, Prolog, ML, and Python.

13016306 Software Metrics 3 (3-0-6)

Prerequisite: 13016214 Software Engineering Principles

This course covers a step-by-step study of software metrics. It includes an introduction to foundations of measurement theory, models of software engineering measurement, software product metrics, software process metrics and measuring management. The course comprises of the following basic modules: measurement theory (overview of software metrics, basics of measurement theory, goal-based framework for software measurement, empirical investigation in software engineering), software product and process measurements (measuring internal product attributes: size and structure, measuring external product attributes: quality, measuring cost and effort, measuring software reliability, software test metrics, and object-oriented metrics), and measurement management.

13016308 Service Oriented Architecture 3 (3-0-6)

Prerequisite: 13016219 Object-Oriented Analysis and Design

Service-Oriented Architecture (SOA) is a way to organize and use distributed services that may be controlled by different owners. SOA provides a uniform means to offer, discover, interact with, and use services to produce desired effects consistent with the specified preconditions and

requirements. This course describes SOA concepts and design principles, interoperability standards, security considerations, runtime infrastructure and web services for the implementation of SOA.

13016318 Operations Research 3 (3-0-6)

Prerequisite: 13006002 Mathematics 2

The course provides an introduction to operation research methods, including linear programming, dynamic programming, game theory, queuing theory, CPM and PERT, and operation research techniques applied to industrial control planning and management.

13016320 Computer Graphics 3 (3-0-6)

Prerequisite: 13006006 Linear Algebra AND

13016212 Data Structures and Algorithms

The course provides an overview of graphic systems, including input-output devices, scan conversion, two-dimensional transformations, translation, scaling, rotation, reflection, shearing, windowing concepts, clipping algorithms, window-to-viewport transformation, three-dimensional concepts, three-dimensional representations, three-dimensional transformations, three-dimensional viewing, hidden-surface and hidden-line removal, shading and color models, and applications of computer graphics to the development of graphical user interface and output display for computer software.

13016321 Game Development 3 (3-0-6)

Prerequisite: 13016212 Data Structures and Algorithms

This course provides a study of technology, science, and art involved in the development of computer games. Students will study a variety of software technologies relevant to computer game design and development, including programming languages, scripting languages, operating systems, file systems, networks, simulation engines, and multimedia design systems. Lectures and discussion topics will be taken from several areas of computer science: simulation and modeling, computer graphics, artificial intelligence, real-time processing, game theory, software engineering, human-computer interaction, graphic design, and game aesthetics.

13016322 Introduction to Parallel Computing 3 (3-0-6)

Prerequisite: 13016216 Operating Systems

The course introduces parallel computing and parallel programming, covering the following topics: concepts of parallel computing, architectures of parallel computing systems, SIMD and MIMD, shared-memory and distributed-memory systems, parallel algorithms, data dependencies and parallelism, synchronization, performance analysis of parallel programs, and programming in parallel programming languages.

13016323 Advanced Topics in Software Engineering 3 (3-0-6)

Prerequisite: 13016214 Software Engineering Principles

Study of selected advanced topics in software engineering which are important at present

13016324 Advanced Topics in Software Architecture 3 (3-0-6)**Prerequisite:** 13016228 Software Design and Architecture

Study of selected advanced topics in software architecture which are important at present

13016325 Software Quality Assurance 3 (3-0-6)**Prerequisite:** 13016214 Software Engineering Principles

This course introduces concepts, metrics, and models in software quality assurance. The course covers components of software quality assurance systems before, during, and after software development. It also discusses metrics and models for software quality as a product, in process, and in maintenance. The Capability Maturity Model (CMM) will be introduced, as well as related ISO and IEEE standards. Students will gain an understanding of software quality and approaches to assure software quality.

13016332 Geographic Information Systems 3 (3-0-6)**Prerequisite:** 13016237 Information Systems and Databases

This course provides a foundation of geographic information systems (GIS). The topics include meaning and applications of GIS, digital representation, map projection, coordinate systems, spatial data modeling, spatial databases, geometry functions, data input and editing, remote sensing, GPS, GIS data quality, GIS data visualization, GIS requirement analysis, design, and development, GIS applications, Web-based GIS, Mobile GIS, software tools for GIS development, and GIS technology and its future.

13016336 Information Retrieval 3 (3-0-6)**Prerequisite:** 13006009 Probability and Statistics AND
13016212 Data Structures and Algorithms

This course studies fundamental theory and techniques of information retrieval, focusing on text-based information and the Web. The main components of the course include models for information retrieval (including Boolean models, vector space models, and probabilistic models), retrieval evaluation, query languages and processing, indexing and searching, classification, clustering, link analysis, and web crawling and searching.

13016337 Advanced Topics in Database Systems 3 (3-0-6)**Prerequisite:** 13016237 Information Systems and Databases

Study of selected advanced topics in database systems which are important at present

13016341 TCP/IP Networks 3 (3-0-6)**Prerequisite:** 13016241 Computer Networks and Communications

This course describes TCP/IP networks, the topics of study are TCP/IP layers, Internet addresses, domain name systems, TCP/IP protocol suites: IPv4, IPv6, ARP, ICMP, TCP and UDP, Internet routing and routing protocols. It also describes various application protocols, including IGMP,

13016348 Advanced Topics in Computer Networks 3 (3-0-6)**Prerequisite:** 13016241 Computer Networks and Communications

Study of selected advanced topics in computer networks which are important at present

13016362 Applied Artificial Intelligence 3 (3-0-6)**Prerequisite:** 13016223 Artificial Intelligence

This course covers applications of logic in artificial intelligence, communication of multi-agents, intelligent search, advanced planning, advanced learning, natural language understanding, applications of artificial neural networks and genetic algorithms, and recent techniques in artificial intelligence. The course also studies applications of artificial intelligence in related computing areas.

13016364 Machine Learning 3 (3-0-6)**Prerequisite:** 13006009 Probability and Statistics AND
13016212 Data Structures and Algorithms

Study fundamental concepts of learning and well-known machine learning algorithms. The subject covers the following topics: fundamental probability theory; learning theory; bias/variance trade-off; Vapnik-Chervonenkis theory; supervised/unsupervised learning; generative/discriminative learning; parametric/non-parametric learning; reinforcement learning; applications of machine learning.

13016366 Data Mining 3 (3-0-6)**Prerequisite:** 13006004 Probability and Statistics AND
13016237 Information Systems and Databases

This course provides an introduction to data mining. Students will learn the basics of data mining algorithms with an emphasis on their real-world applications. Students will learn user data types, data mining methodology, measuring the effectiveness of data mining, overview of data mining techniques, market basket analysis, memory-based reasoning, automatic cluster detection, link analysis, and interesting algorithms for data mining and data warehouse.

13016367 Semantic Web 3 (3-0-6)**Prerequisite:** 13016223 Artificial Intelligence

The Semantic Web has been envisioned by many to be a next generation of the current web. The Semantic Web makes it easy for anyone to publish, and access to, distributed semantic information on the Internet; this information allows computers and software agents on the Internet to communicate with each other and work together automatically. The course covers mark-up languages of web contents, that is, HTML and XML. For XML, it covers XML DTDs, XML Schemas, XPath, XLinks and XPointers, including how to process an XML document with DOM. For the Semantic Web mark-up languages, the course covers RDF, RDFS, OWL, and rule mark-up languages. Finally, the course also includes different approaches of knowledge representation of Semantic Web contents, such as First-order Logic, Description Logic, and Conceptual Graphs, as well as reasoning and communication of Semantic Web information by intelligent agents.

13016368 Intelligent Agents 3 (3-0-6)**Prerequisite:** 13016223 Artificial Intelligence

Intelligent agents are software programs that can sense their environments, choose rational actions based on their percepts, and execute these actions. Often, agents interact with other agents, either by cooperating or competing with each other; such environments are called multi-agent systems. The course covers the underlying theory of agents, the common agent architectures, methods of communication and cooperation, and the potential applications of agents. Specific topics include fundamental techniques for developing intelligent agents and multi-agent systems, including cognitive, logic-based, and belief-desire-intention architectures, inter-agent communication languages and protocols, distributed problem solving, planning, and constraint satisfaction methods, distributed models of rational behaviors, and learning and adaptation in multi-agent systems.

13016369 Introduction to Robotics 3 (3-0-6)**Prerequisite:** 13006006 Linear Algebra AND
13006008 Calculus 2

This course introduces fundamental concepts of robotics. The topics covered include forward and inverse kinematics, DH parameters, the Jacobian, trajectory planning, basics of robot control systems, including actuators and sensors for robots.

13016371 Pattern Recognition 3 (3-0-6)**Prerequisite:** 13006009 Probability and Statistics

This course studies basic concepts and methodologies of pattern recognition. The techniques include supervised and unsupervised learning, handling and scaling of multidimensional data, dimension reduction methods, feature selection and feature extraction, and validation of algorithms.

13016380 Software Development for Mobile Devices 3 (3-0-6)**Prerequisite:** 13016212 Data Structures and Algorithms

This course covers the architectures of operating systems on current mobile platforms, computer languages and software tools for developing software on mobile devices, GUI design, interfacing with various hardware devices, such as sensors, GPS receivers, and various input devices, and the use of software APIs for software development on mobile devices.

13016381 Embedded Control Systems 3 (3-0-6)**Prerequisite:** 13006006 Linear Algebra AND
13006008 Calculus 2

In this course, the students will learn how to apply control theory to embedded systems. The course will introduce basic control theory with practical insight into the tools for modeling and simulating dynamic physical systems, and the methods for designing the software for embedded microcontrollers to control them. This course covers the following topics: fundamentals of control systems, PID control, plant models, classical control system design, pole placement, optimal

control, and discrete time systems and fixed point mathematics. The students will be guided to develop corresponding software to control physical systems using the studied control algorithms.

13016382 Digital Signal Processing and Applications 3 (3-0-6)

Prerequisite: 13006006 Linear Algebra

This is a basic course in digital signal processing, covering the following topics: discrete-time signals and systems, z-transform, sampling of continuous-time signals, transform analysis of linear time-invariant systems, structures for discrete-time systems, filter design techniques, discrete Fourier transform, and the applications of digital signal processing.

13016383 Digital Signal Processor Architectures and Programming 3 (3-0-6)

Prerequisite: 13016382 Digital Signal Processing and Applications

In this course, the students will study the principles and learn to develop programs for digital signal processors. Topics covered in this course are fundamentals of digital signal processing, digital signal processing systems and development tools, architectures of digital signal processors and instruction sets, code optimization, implementation of finite impulse response filters and infinite impulse response filters, fast Fourier transform, and real-time digital signal processing.

13016384 Database Systems 3 (3-0-6)

Prerequisite: 13016237 Information Systems and Databases

This course studies the structures and mechanisms of database management systems for relational data models and some important non-relational data models. Topics include physical structures of databases, access mechanisms, query processing, transaction processing, database recovery, and concurrency control.

13016385 Distributed Computing 3 (3-0-6)

Prerequisite: 13016241 Computer Networks and Communications

This course emphasizes on distributed computing from a system software perspective. The topics include distributed system architectures, distributed programming, message passing, remote procedure calls, group communication, naming and membership problems, logical time, consistency, fault-tolerance, and recovery. It also covers concepts and architectures for distributed processing and distributed transaction processing, process synchronization and concurrency control, quality of service, security, and various middleware.

13016386 Enterprise Software Development 3 (3-0-6)

Prerequisite: 13016214 Software Engineering Principles

This course studies the design and development of large-scale software for enterprises. The students will learn important design considerations and some important architectures (including enterprise architecture) for enterprise software, learn how to interoperate between the software sub-systems, e.g. via web services and some standard of data interchange, and make this interoperability secure, and also learn how to utilize software frameworks and technologies to support the development of enterprise software.

13016387 Business Intelligence 3 (3-0-6)**Prerequisite:** 13016214 Software Engineering Principles

This course provides an introduction to the concepts of business intelligence (BI) as components and functionality of information systems. It explores how business problems can be solved effectively by using operational data to create data warehouses, and then applying data mining tools and analytics to gain new insights into organizational operations. Detailed discussion of the analysis, design and implementation of systems for BI, including: the differences between types of reporting and analytics, enterprise data warehousing, data management systems, decision support systems, knowledge management systems, big data and data/text mining. Case studies are used to explore the use of application software, web tools, success and limitations of BI as well as technical and social issues.

13016388 Selected Topics in Enterprise Software Engineering 3 (3-0-6)**Prerequisite:** None

Selected topics of current interest in software engineering for enterprises

13016389 Microprocessors and Interfacing 3 (2-2-5)**Prerequisite:** 13016204 Digital Circuit and Logic Design

This course studies some architectures of the microprocessors and microcontrollers, which are widely used in embedded systems, as well as peripherals interfacing, and software development on those architectures. The topics include the architectures of microprocessors and microcontrollers in embedded systems, memory interfacing, buses, interrupts, interfacing with input/output devices, the conversion between analog signals and digital signals, interfacing with sensors and actuators, and data communication through ports (such as RS-232 ports, USB ports, and parallel ports).

13016390 Embedded System Software 3 (2-2-5)**Prerequisite:** 13016389 Microprocessors and Interfacing

Embedded systems are anywhere ranging from wearable devices, sensors, smart phones, smart meters, air-conditioners, robots, cars, and airplanes. This course provides a comprehensive study of embedded systems in great details. It covers the popular System-on-Chip (SoC) paradigm, embedded system architectures, on-chip interconnects and memory systems, architectures of well-known embedded processors, such as ARM and ATOM processors, models of computation and scheduling of embedded systems, and finally metrics of embedded systems, i.e. performance, real-time characteristic, power consumption, reliability.

For the system development aspect, the course covers the development lifecycle of an SoC-based embedded systems. The purpose is to provide students with the knowledge and skills to design modern embedded systems. The course takes a requirement-driven design approach, where a functional specification is derived from a set of system requirements and then mapped into hardware and software components. A significant portion of the course is devoted to performance estimation of hardware-software systems, co-design and design space exploration. So the key problem is given a functional requirement of the desired system, how do the students decide which

functionalities should be implemented in hardware rather than software? How do they validate that the designed hardware/software system will meet requirements?

13016391 Computer Networking for the Internet of Things 3 (3-0-6)

Prerequisite: 13016241 Computer Networks and Communications

With very limited memory and processing power as well as low energy consumption of IoT (Internet of Things) devices, their communication networks are so designed and developed to meet these constraints. This course will focus on the emerging industrial standard of computer networks and communications technologies developed specifically for IoT devices, including network architectures and protocols layers.

Another important topic covered by this course is network security for IoT communication. It is the study how to make secure communications between IoT devices by incorporating encryption into the communication protocol. Widely use encryption techniques are also studied.

13016392 Wireless Sensor Networks 3 (3-0-6)

Prerequisite: 13016241 Computer Networks and Communications

This course is an introduction to fundamental concepts of wireless networks of embedded systems and wireless sensor networks. Topics include: wireless communication and networking technologies, i.e. Bluetooth, ZigBee, LoRa, network architecture, wireless communication protocols, and software design and programming for the wireless networks.

13016393 Selected Topics in the Internet of Things 3 (3-0-6)

Prerequisite: None

Selected topics of current interest related to the Internet of Things

13016394 Big Data 3 (3-0-6)

Prerequisite: 13016237 Information Systems and Databases

The course provides an overview of the challenges of big data and existing solutions. Covered in this course include an introduction to the following topics: data capturing, storage, processing, retrieval, analysis, and visualization. The students will also learn some useful software tools or libraries for processing or analyzing big data.

13016395 Computational Intelligence 3 (3-0-6)

Prerequisite: 13006006 Linear Algebra AND

13016212 Data Structures and Algorithms

Study of concepts, algorithms, and theories related to computational intelligence. The subject covers the following topics: neural networks, fuzzy logic, evolutionary computation, swarm intelligence, other nature-inspired algorithms, and applications of computational intelligence.

13016396 Knowledge Representation and Reasoning 3 (3-0-6)

Prerequisite: 13016223 Artificial Intelligence

This course provides a comprehensive study of contemporary techniques and languages for knowledge representation and reasoning about knowledge. The course covers semantic modeling, e.g. semantic networks, conceptual graphs, ontology representation in Semantic Web, frame representation, rule-based representation, and logical representation, e.g. first-order logic, description logic, logic of actions and beliefs. For the reasoning about knowledge, the topics include abduction, deduction, induction, as well as reasoning about time, state, events, actions, and beliefs.

13016397 Natural Language Processing 3 (3-0-6)

Prerequisite: 13016212 Data Structures and Algorithms

This course introduces the field of Natural Language Processing. It includes relevant background material in linguistics, mathematics, probabilities, and computer science. Some of the topics covered in the class are text similarity, part of speech tagging, parsing, semantics, question answering, sentiment analysis, and text summarization.

13016398 Selected Topics in Intelligent Systems 3 (3-0-6)

Prerequisite: None

Selected topics of current interest related to intelligent systems

13016399 Software Entrepreneurship 3 (3-0-6)

Prerequisite: None

In this course, the students will work in teams to study and practice skills in software entrepreneurship, through setting up and running virtual software development companies. The students will study how to find prospective commercial opportunities for a technological idea, how to acquire resources including talent and capital, and how to market the idea, as well as manage the growth. The emphasis will be on how small software companies are created and managed, the financial and legal frameworks within which such companies operate, and the management of the companies for successful operations. Topics include market studies, feasibility studies, cost analysis, intellectual property, contract negotiation, resource management, business planning, finance, and marketing. The final outcome of each group of students will be a business plan for commercializing their software products.

13016400 Digital Image Processing 3 (3-0-6)

Prerequisite: 13006006 Linear Algebra

This course introduces fundamental concepts of digital image processing. It covers the following topics: digital image, representation, digitization, histogram, point-processing, convolution, filtering, edge detection, frequency domains, image enhancement, image segmentation, and applications of digital image processing.

13016401 Computer Vision 3 (3-0-6)

Prerequisite: 13016400 Digital Image Processing

This course studies concepts and applications of computer vision. It covers the following topics: image operations, geometry, feature detection, color space, corner and interest point detection, texture analysis, shape recognition, object recognition, 3D-vision, and motion analysis.

13906401 Professional Skills and Issues 3 (3-0-6)

Prerequisite: None

This course introduces the social, ethical, legal, and professional issues involved in the widespread deployment of information technology. It teaches students to develop their own, well-argued positions on many of these issues.

13916001 Software Engineering Summer Placement 3 (0-45-0)

Prerequisite: None

This course demands the student to undertake a summer placement of at least 10 weeks to gain relevant practical experience. The objectives are to give students the experience of a real software development environment, to embed the software engineering theory, principles and tools studied through practical experience, and to develop a student's ability to evaluate and enhance their personal software process.

13916201 Advanced Programming 3 (3-0-6)

Prerequisite: 13016212 Data Structures and Algorithms

This course intends to teach the student to develop practical expertise in, and understanding of, concurrent programming in Java; to explore a variety of different concurrency control mechanisms; to substantially develop the knowledge of C gained during summer preparatory reading; to develop the students' experience and understanding of programming in a low-level language; to develop the ability to craft efficient and effective code in a pointer-rich language; to introduce concurrent programming in C using the PThreads library; to further develop the ability to select and re-use existing software components and libraries; and to enhance the students' skills in engineering software as interacting sub-systems, using interfaces and libraries to manage medium sized software development projects.

13916202 Algorithmics I 3 (3-0-6)

Prerequisite: 13016212 Data Structures and Algorithms

This course intends to develop the student's skills in the design and analysis of algorithms; to study algorithms for a range of important standard problems; to introduce the student to the theory of NP-completeness together with its practical implications; and to make the student aware of fundamental concepts of computability.

13916203 Interactive Systems 3 (3-0-6)

Prerequisite: 13016214 Software Engineering Principles

This course aims at offering students the opportunity to become familiar with one of the most important interaction paradigms; enabling students to become skilled in the use of techniques and tools for modelling, implementing and evaluating interactive systems; and enabling students to

and techniques presented to them in the context of an extended group-based software development exercise, make the students aware of the professional, social and ethical dimensions of software development, and instill in the students a professional attitude towards software development.

13916291 Team Project 9 (0-18-9)

Prerequisite: 13016214 Software Engineering Principles

This course gives students the experience of working on a substantial team based software project. The course provides the opportunity to apply the principles, practices and tools learned during the associated Professional Software Development course.

13916292 Individual Project 12 (0-24-12)

Prerequisite: 13016214 Software Engineering Principles

This course requires the students to undertake a substantial piece of individual work, involving planning, specification, design, execution, evaluation, presentation and report-writing.

13916301 Advanced Topics in Software Engineering 3 (3-0-6)

Prerequisite: None

Advanced topics of current interest in Software Engineering

13916302 Advanced Topics in Database Systems 3 (3-0-6)

Prerequisite: None

Advanced topics of current interest on database systems and technology

13916303 Selected Topics in Enterprise Software Engineering 3 (3-0-6)

Prerequisite: None

Selected topics of current interest on software engineering for enterprises

13916304 Selected Topics in the Internet of Things 3 (3-0-6)

Prerequisite: None

Selected topics of current interest related to the Internet of Things

13916305 Selected Topics in the Intelligent Systems 3 (3-0-6)

Prerequisite: None

Selected topics of current interest related to intelligent systems

13916306 Advanced Networking and Communications 3 (3-0-6)

Prerequisite: 13916206 Networked Systems

This course adds depth and some breadth to the material covered in Networked Systems. The student will learn how fundamental principles of communications theory underpin the structures

of the global telecommunications network and the Internet and determine the logic of how these networks interact.

13916307 Advanced Operating Systems 3 (3-0-6)

Prerequisite: 13916207 Operating Systems

This course will review research literature on systems programming techniques and operating systems design, discuss the limitations of deployed systems, and show how the operating system infrastructure might evolve to address the challenges of supporting modern computing systems.

13916308 Advanced Software Engineering Practices 3 (3-0-6)

Prerequisite: 13916208 Professional Software Development

This course gives students the opportunity to learn and practice advanced principles, methods and tools in Software Engineering. The course is intended for students who have experience of software development through a summer internship or similar. The course covers technical and management skills that are needed for mentoring and leading teams of software developers. The course is delivered in collaboration with an established software industry partner.

13916309 Algorithmics II 3 (3-0-6)

Prerequisite: 13916202 Algorithmics I

The aims of the course are to present a broad range of algorithm design methods, with examples chosen to reflect practical applications, to enable students to make educated choices between strategies for algorithmic problem-solving, and to convey the significance of computational complexity, and to present a range of methods for dealing with it in practice.

13916310 Artificial Intelligence 3 (3-0-6)

Prerequisite: None

This is an introductory course on Artificial Intelligence, giving the students an overview of intelligent agent design.

13916311 Big Data: Systems, Programming, and Management 3 (3-0-6)

Prerequisite: 13916205 Database Systems

Big Data is nowadays manifested in a very large number of environments and application fields pertaining to our education, entertainment, health, public governance, enterprising, etc. The course will endow students with the understanding of the new challenges big data introduces and the currently available solutions. These include (i) challenges pertaining to the modelling, accessing, and storing of big data, (ii) an understanding of the fundamentals of systems designed to store and access big data, and (iii) programming paradigms for efficient scalable access to big data.

13916312 Computer Architecture 3 (3-0-6)

Prerequisite: 13916207 Operating Systems

The course explains in depth how a computer works, by developing a digital circuit that implements an instruction set architecture. The memory system, including cache and virtual memory, and support by the architecture for the operating system, are also covered.

13916313 Computer Vision Methods and Applications 3 (3-0-6)

Prerequisite: 13006006 Linear Algebra

This course is intended to equip students with the necessary theoretical and practical understanding of image processing and computer vision techniques to enable them to meet the challenges of building advanced image-based applications. Examples of potential vision-based applications include: image understanding in mobile devices (cameras, phones, tablet computers etc.), robot vision systems, autonomous vehicle guidance and road monitoring, driver attention monitoring, image database query systems, creative media production tools, interactive gaming, augmented reality and visual biometrics, forensic image analysis, security and surveillance, and medical imaging. The course will focus on the application of recent advances in Computer Vision techniques that underpin a wide variety of systems and products based on methods such as: face detection, object recognition, tracking, segmentation and 3D imaging.

13916314 Computing Science in the Classroom 3 (3-0-6)

Prerequisite: None

This course aims to develop in students a better understanding of and confidence in Computing Science/Software Engineering as a subject; provide students with an awareness and experience of operating as a teacher and facilitator in a school environment; enable students to develop a set of key transferable skills such as reflecting on critical incidents, analysis, developing coherent arguments, communication, planning and so on; promote better relations between schools and university computing; heighten pupils' awareness of the many forms of computing, including its forms as academic discipline (computing science), distinctive profession (software engineering) and as a ubiquitous family of skills (ICT).

13916315 Cyber Security Fundamentals 3 (3-0-6)

Prerequisite: None

This course provides an introduction to the foundational aspects of computer security, such as algorithms and protocols. It also covers ways in which these systems can be attacked and techniques for thwarting these attacks.

13916316 Database Theory and Application 3 (3-0-6)

Prerequisite: None

The aim of this course is to introduce students to the concepts of information management by way of databases, including relational databases and other data management solutions. The course will provide students with the opportunity to develop skills which will assist them to manage information in the current digital age.

13916317 Distributed Algorithms and Systems 3 (3-0-6)

Prerequisite: 13916206 Networked Systems AND
13916207 Operating Systems

Distributed systems are ubiquitous in commerce and industry, from the international banking network to process control in large industrial sites. This course builds on the introductions to operating systems and networked systems in Year 3, specifically focusing on the software engineering issues raised by distributed systems and algorithms for use in distributed systems. The key feature of this course will be the assumption that a distributed system is one in which: partial failure is to be expected; local and remote operations differ greatly in cost; and an element of message passing is required for communication.

13916318 Embedded Systems 3 (3-0-6)

Prerequisite: None

This course intends to give students an understanding of the practical challenges associated with embedded software development, experience with multiple development environments for mobile/embedded software development (e.g. Symbian, Windows Mobile), and ability to develop and deploy and debug software on mobile devices.

13916319 Enterprise Cyber Security 3 (3-0-6)

Prerequisite: None

This course will focus on cyber security management within an organisation. It will ensure that students will know how to satisfy legislation related to securing personal and sensitive information and how to manage data correctly.

13916320 Functional Programming 3 (3-0-6)

Prerequisite: None

Functional programming is introduced using Haskell. The standard programming techniques, as well as some advanced topics, are covered and applied to realistic programming problems.

13916321 Human-Centred Security 3 (3-0-6)

Prerequisite: None

This course provides an introduction to the human side of information security.

13916322 Human-Computer Interaction 3 (3-0-6)

Prerequisite: 13916203 Interactive Systems

The aim of this course is to introduce students to advanced topics in Human-Computer Interaction. It focuses on multimodal interaction, novel forms in interaction, users with different abilities and social media.

13916323 Information Retrieval 3 (3-0-6)

Prerequisite: 13916205 Database Systems

The aim of this course is to present students with an in-depth examination of the theoretical and practical issues involved in providing tools to access large collections of documents, especially in the context of the World Wide Web and the practical engineering issues raised by the design and implementation of an information retrieval system.

13916324 Internet Technology 3 (3-0-6)

Prerequisite: 13916205 Database Systems

The aim of this course is to provide students with a comprehensive overview of web application development. It will provide students with the skills to design and develop distributed web applications in a disciplined manner, using a range of tools and technologies. It will also strengthen their understanding of the context and rationale of distributed systems.

13916325 IT Architecture 3 (3-0-6)

Prerequisite: 13916208 Professional Software Development

IT Architecture's key role is to design and maintain system integrity of large heterogenous enterprise systems. Such systems may involve integrating disparate systems such as legacy systems, new web-based externally facing systems, systems developed externally or in collaboration with other organisations. IT Architects may also be faced with strategic problems caused by enterprise mergers or acquisitions. Within this context, this course aims to give students: (1) an appreciation of the need for IT Architecture and the role of the IT architect; (2) an understanding of the foundations of IT architecture and the best practice in applying architectural principles.

13916326 Machine Learning 3 (3-0-6)

Prerequisite: 13006006 Linear Algebra

A practical introduction to the foundations of machine learning

13916327 Mobile Human-Computer Interaction 3 (3-0-6)

Prerequisite: 13916203 Interactive Systems

This course gives students an overview of the fields of mobile HCI and ubiquitous computing, and an understanding of the practical challenges associated with embedded software development for mobile interactive systems, and associated services.

13916328 Modelling Reactive Systems 3 (3-0-6)

Prerequisite: 13016105 Discrete Mathematics

Modelling of concurrent, communicating systems using non-probabilistic and probabilistic techniques, and verification using the SPIN and PRISM model checkers.

13916329 Multimedia Systems and Applications 3 (3-0-6)

Prerequisite: None

Multimedia has become an indispensable part of modern computer technology. It is part of everyday life be it broadcasting material, educational or entertainment materials and/or personal videos or images. Better solutions are needed due to the growth and proliferation of multimedia in

our daily life. The course will focus on advances in the development of multimedia systems and will be delivered with an emphasis on the practical side. It will introduce the theoretical and practical skills needed in handling multimedia data.

13916330 Research Methods and Techniques 3 (3-0-6)

Prerequisite: None

This course covers the fundamental principles, of the scientific method. Students will learn the core skills of planning, designing, executing, evaluating and presenting research.

13916331 Safety-Critical Systems Development 3 (3-0-6)

Prerequisite: None

This course encourages students to apply engineering techniques to support the development of safety-critical applications. It also encourages students to consider the particular methodological and professional issues that surround the development of safety-critical systems.

13916332 Software Project Management 3 (3-0-6)

Prerequisite: None

This course introduces different approaches to software project management, and a variety of tools are available to support effective management of software development projects.