



Master of Engineering and Master of Science Program in
Computer Engineering (International Program)
Revised Curriculum B.E. 2565

Computer Engineering Department
Faculty of Engineering
King Mongkut's University of Technology Thonburi

ชื่อหลักสูตร

(English)	:Master of Engineering and Master of Science Program in Computer Engineering (International Program)
(ภาษาไทย)	:หลักสูตรวิศวกรรมศาสตรมหาบัณฑิต และวิทยาศาสตรมหาบัณฑิต สาขาวิชาวิศวกรรมคอมพิวเตอร์ (หลักสูตรนานาชาติ)

ชื่อปริญญาและสาขาวิชา

ชื่อเต็ม

(English)	: Master of Engineering (Computer Engineering)
(ภาษาไทย)	: วิศวกรรมศาสตรมหาบัณฑิต (วิศวกรรมคอมพิวเตอร์)
(English)	: Master of Science (Computer Engineering)
(ภาษาไทย)	: วิทยาศาสตรมหาบัณฑิต (วิศวกรรมคอมพิวเตอร์)

ชื่อย่อ

(English)	: M.Eng. (Computer Engineering)
(ภาษาไทย)	: วศ.ม. (วิศวกรรมคอมพิวเตอร์)
(English)	: M.Sc. (Computer Engineering)
(ภาษาไทย)	: วท.ม. (วิศวกรรมคอมพิวเตอร์)

โครงสร้างหลักสูตร

Total Required Credits must not be less than 37 credits

Program Structure of

Plan A type A2 (24-credit thesis)

A. Core courses	4	Credits
B. Elective courses	9	Credits
C. Thesis	24	Credits

Plan A type A2 (12-credit Thesis)

A. Core courses	4	Credits
B. Elective courses	21	Credits
C. Thesis	12	Credits

Plan B (6-credit professional project)

A. Core courses	4	Credits
B. Elective courses	27	Credits
C. Professional Project	6	Credits

During the student orientation, details about curriculum, courses, study plans, and registration recommendation will be provided. Research areas of faculty members will also be introduced so that students can decide on research advisors whose research areas suit their interests and contact the corresponding professors for further discussion.

For all the study plans, the student must be able to analyze and evaluate existing knowledge and technologies in computer engineering and must be able to improve or develop a software/hardware system, process, tool, or algorithm to solve research or professional problems in computer engineering in an ethical way.

The difference among the study plans is distinguished by the characteristics of problem under consideration and the expected output work. For **Plan A type A2** (24-credit thesis), the output work is expected to have a research contribution that is published in an journal with impact factor or one journal paper in Scopus database. For **Plan A type A2** (12-credit thesis), the output work is also expected to have a research contribution similar to **Plan A type A2** (24-credit thesis) but with less problem complexity and smaller scale, which can be published in a proceeding of an international conference at the least. For **Plan B** (6-credit professional project), the output work is expected to be a practical solution to industrial problems, with a national publication.

รายวิชา

English Language Foundation Course		non-credits (S/U)
Code	Title	(L-P-S)
LNG 601	วิชาภาษาอังกฤษพื้นฐานสำหรับหลักสูตรนานาชาติ (Foundation English for International Programs)	3 (2-2-9)

A. Core Courses 4 Credits

Code	Title	(L-P-S)
CPE 600	หลักการวิจัยและเขียนเอกสารวิจัยเชิงเทคนิค Research Methodology and Technical Research Writing	3 (3-0-9)
CPE 601	สัมมนาเชิงวิศวกรรมคอมพิวเตอร์ Computer Engineering Seminar	1 (0-2-3)

B. Elective Courses 9/21/27 Credits

Student can select and register any course in the following fields, B1-B6, at least 9 credits for Plan A type A2 (24-credit thesis), at least 21 credits for Plan A type A2 (12-credit thesis) and 27 credits for Plan B (6-credit professional project).

B.1. Applied Mathematics

Code	Title	(L-P-S)
CPE 610	การวิเคราะห์อัลกอริทึมและการออกแบบ Algorithm Analysis and Design	3 (3-0-9)
CPE 611	ทฤษฎีแถวคอย Queuing Theory	3 (3-0-9)
CPE 612	ทฤษฎีเกม Game Theory	3 (3-0-9)
CPE 613	วิธีการหาค่าที่เหมาะสมที่สุด Optimization Methods	3 (3-0-9)

CPE 614	คณิตศาสตร์แบบไม่ต่อเนื่องเชิงประยุกต์ Applied Discrete Mathematics	3 (3-0-9)
CPE 615	การออกแบบการทดลองและการวิเคราะห์ข้อมูล Experimental Design and Data Analysis	3 (3-0-9)

B.2. Data Science

Code	Title	(L-P-S)
CPE 620	การทำเหมืองข้อมูล Data Mining	3 (3-0-9)
CPE 621	การสร้างภาพข้อมูล Data Visualization	1 (1-0-3)
CPE 622	วิทยาศาสตร์ข้อมูลสำหรับธุรกิจ Data Science for Business	2 (2-0-6)
CPE 623	การทำเหมืองข้อความและการวิเคราะห์เครือข่ายทางสังคม Text Mining and Social Network Analytics	3 (3-0-9)
CPE 624	การจัดการกับข้อมูลขนาดใหญ่ Big Data	3 (3-0-9)
CPE 625	การประมวลผลด้วยคอมพิวเตอร์ สมรรถนะสูงและคลาวด์ High Performance and Cloud Computing	3 (3-0-9)

B.3. Graphics, Image Processing, and User Interface

Code	Title	(L-P-S)
CPE 630	คอมพิวเตอร์ช่วยเหลือเพื่อการออกแบบเรขภาพ Computer Aided Geometric Design	3 (3-0-9)
CPE 631	การจำลองแบบเรขภาพขั้นสูง Advanced Geometric Modeling	3 (3-0-9)
CPE 632	การปฏิสัมพันธ์ระหว่างมนุษย์และคอมพิวเตอร์ Human Computer Interaction	3 (3-0-9)
CPE 633	การทำลายน้ำดิจิทัลสำหรับเนื้อหาสื่อประสม Digital Watermarking for Multimedia Content	3 (3-0-9)

CPE 634	การออกแบบเกมดิจิทัลเพื่อการศึกษา Digital Educational Game Design	3 (3-0-9)
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B.4. Cognitive Computing

Code	Title	(L-P-S)
CPE 640	ปัญญาประดิษฐ์ Artificial Intelligence	3 (3-0-9)
CPE 641	การประมวลผลภาษาธรรมชาติ Natural Language Processing	3 (3-0-9)
CPE 642	การประมวลผลเสียงพูด Speech Processing	3 (3-0-9)
CPE 643	การเรียนรู้ของเครื่องแบบประยุกต์ Applied Machine Learning	3 (3-0-9)

B.5. Software, Systems, and Security

Code	Title	(L-P-S)
CPE 650	วิศวกรรมซอฟต์แวร์ Software Engineering	3 (3-0-9)
CPE 651	การค้นคืนข้อมูลสื่อประสม Multimedia Information Retrieval	3 (3-0-9)
CPE 652	การคำนวณที่ได้แรงบันดาลใจจากสิ่งมีชีวิตในธรรมชาติ Bio-inspired Computing	3 (3-0-9)
CPE 653	การประมวลผลภาพดิจิทัลและการวิเคราะห์ Digital Image Processing and Analysis	3 (3-0-9)
CPE 654	การประสานกันของสมองกับคอมพิวเตอร์ Brain-Computer Interface	3 (3-0-9)
CPE 655	ความมั่นคงของข้อมูลสำหรับการสื่อสารสื่อประสม Data Security for Multimedia Communications	3 (3-0-9)

B.6. Special Topics

Code	Title	(L-P-S)
CPE 661	หัวข้อพิเศษ 1 Special Topics I	1 (1-0-3)

CPE 662	หัวข้อพิเศษ 2 Special Topics II	2 (2-0-6)
CPE 663	หัวข้อพิเศษ 3 Special Topics III	3 (3-0-9)

C. Thesis and Project (24/12/6)

Code	Title	(L-P-S)
CPE 700	วิทยานิพนธ์ Thesis	24 (0-0-96)
CPE 701	วิทยานิพนธ์ Thesis	12 (0-0-48)
CPE 702	โครงการวิจัยสายอาชีพ Professional Project	6 (0-0-24)

แผนการศึกษา

Plan A type A2 (24-credit thesis)

Year 1 Semester 1

CPE 600	Research Methodology and Technical Research Writing	3 (3-0-9)
CPE 601	Computer Engineering Seminar	1 (0-2-3)
CPE 6xx	Elective I	3 (3-0-9)
CPE 6xx	Elective II	3 (3-0-9)
Total		10 (9-2-30)
Hours per week		41
Accumulated credits		10

Year 1 Semester 2

CPE 6xx	Elective I	3 (3-0-9)
CPE 700	Thesis	6 (0-0-24)
Total		9 (3-0-33)
Hours per week		36
Accumulated credits		19

Year 2 Semester 1

CPE 700	Thesis	9 (0-0-36)
Total		9 (0-0-36)
Hours per week		63
Accumulated credits		28

Year 2 Semester 1

CPE 700	Thesis	9 (0-0-36)
Total		9 (0-0-36)
Hours per week		63
Accumulated credits		37

- Note: 1. Student cannot receive more than 5 thesis credits before passing the proposal exam.
2. Students cannot receive more than 22 credits before a paper is submitted.
3. Student can register in 1 or 2 electives credits but the total credit throughout the program must be at least 37 credits.
4. The proposal defense and the final defense cannot take place in the same semester.

Plan A type A2 (12-credit Thesis)

Year 1 Semester 1

CPE 600	Research Methodology and Technical Research Writing	3 (3-0-9)
CPE 601	Computer Engineering Seminar	1 (0-2-3)
CPE 6xx	Elective I	3 (3-0-9)
CPE 6xx	Elective II	3 (3-0-9)
Total		10 (9-2-30)
Hours per week		41
Accumulated credits		10

Year 1 Semester 2

CPE 6xx	Elective I	3 (3-0-9)
CPE 6xx	Elective II	3 (3-0-9)
CPE 701	Thesis	3 (0-0-12)
Total		9 (6-0-30)
Hours per week		36
Accumulated credits		19

Year 2 Semester 1

CPE 6xx	Elective I	3 (3-0-9)
CPE 6xx	Elective II	3 (3-0-9)
CPE 701	Thesis	3 (0-0-12)
Total		9 (6-0-30)

Hours per week	36
Accumulated credits	28

Year 2 Semester 2

CPE 6xx	Elective I	3 (3-0-9)
CPE 701	Thesis	6 (0-0-24)
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	Total	9 (3-0-33)
	Hours per week	36
	Accumulated credits	37

- Note: 1. Student cannot receive more than 5 thesis credits before passing the proposal exam.
2. Students cannot receive more than 10 credits before a paper is submitted.
3. Student can register in 1 or 2 electives credits but the total credit throughout the program must be at least 37 credits.
4. The proposal defense and the final defense cannot take place in the same semester.

Plan B (6-credit professional project)

Year 1 Semester 1

CPE 600	Research Methodology and Technical Research Writing	3 (3-0-9)
CPE 601	Computer Engineering Seminar	1 (0-2-3)
CPE 6xx	Elective I	3 (3-0-9)
CPE 6xx	Elective II	3 (3-0-9)
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	Total	10 (9-2-30)
	Hours per week	41
	Accumulated credits	10

Year 1 Semester 2

CPE 6xx	Elective I	3 (3-0-9)
CPE 6xx	Elective II	3 (3-0-9)

CPE 6xx	Elective III	3 (3-0-9)
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	Total	9 (9-0-27)
	Hours per week	36
	Accumulated credits	19
<u>Year 2 Semester 1</u>		
CPE 6xx	Elective I	3 (3-0-9)
CPE 6xx	Elective II	3 (3-0-9)
CPE 702	Professional Project	3 (0-0-12)
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	Total	9 (6-0-30)
	Hours per week	36
	Accumulated credits	28
<u>Year 2 Semester 2</u>		
CPE 6xx	Elective I	3 (3-0-9)
CPE 6xx	Elective II	3 (3-0-9)
CPE 702	Professional Project	3 (0-0-12)
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	Total	9 (6-0-30)
	Hours per week	36
	Accumulated credits	37

- Note: 1. The student cannot receive more than 3 project credits before passing the proposal exam.
2. The student can register in 1 or 2 electives credits but the total credit throughout the program must be at least 37 credits.
3. The proposal defense and the final defense cannot take place in the same semester.

Requirements on thesis study plans

For the study Plan A type A2 (24-credit thesis), a student must register CPE 700 for 24 credits and Plan A type A2 (12-credit thesis), a student must register CPE 701 for 12 credits in Year 1 Semester 2. Before requesting for an approval to

take the final thesis defense from the Faculty of Engineering, the following two conditions must be met:

- The student must have the TETET score of 5.0, or other equivalent standard English tests (see section 2.2).
- Plan A type A2 (24-credit thesis), the student must either *publish* the thesis work in English in a full refereed ISI international journal accredited by the University or *publish an international journal or two international conference papers in Scopus database*.
- Plan A type A2 (12-credit thesis), the student must *publish and present* the thesis work in *a refereed international conference in Scopus database*.

Requirements on professional project study plan

For Plan B (6-credit professional project), the student taking this plan must register CPE 702 for 6 credits starting in Year 2 Semester 1. Before requesting for an approval to take the final project defense from the Faculty of Engineering, the defense is also a comprehensive examination. The student must have the TETET English score of at least 5.0, or other equivalent standard English tests (see section 2.2). In addition, the student must *publish and present* the professional project work in a national/international refereed conference.

CPE 610	<p>Algorithm Analysis and Design</p> <p>Prerequisite: None</p> <p>Roles of algorithms in computing. Growth of functions and algorithm complexity. Brute-force. Divide-and-conquer. Probabilistic analysis and randomized algorithms. Heap sort. Quick sort. Sorting in linear time. Dynamic programming. Greedy algorithms. Amortized analysis. Graph algorithms. Linear programming. String matching. Approximation algorithm. NP completeness.</p> <p>Learning Outcome:</p> <ol style="list-style-type: none"> 1. Student can explain and analyze the worst-case time complexity of an algorithm. 2. Student can compare and contrast the efficiency of algorithms using asymptotic complexity. 3. Student can design efficient algorithms using standard algorithm design techniques. 4. Student can apply standard algorithms to problems in computer science and engineering areas. 	3 (3-0-9)
CPE 611	<p>Queueing Theory</p> <p>Pre-requisite: None</p> <p>Stochastic modeling techniques for analyzing the performance of computer systems, networks, and protocols. Markov chains and basic queueing theory. Non-Markovian queues. Generalized loss networks. Phase-type queues and the matrix-analytic methods. Fluid models. Bound and approximation techniques. Discrete-time queues.</p> <p>Learning Outcome: Student can apply stochastic performance modeling methods to solve computer engineering problems.</p>	3 (3-0-9)
CPE 612	<p>Game Theory</p> <p>Pre-requisite: None</p> <p>Fundamentals of game theory with an emphasis on applications for communication networks. Non-cooperative and cooperative game models for</p>	3 (3-0-9)

wireless access networks, resource allocation, power control, and quality of services. Analysis of the convergence properties of games such as the existence, uniqueness and efficiency of the Nash equilibrium and designing efficient and robust distributed algorithms.

Learning Outcome:

1. Student can explain the fundamentals of game theory.
2. Student can apply the game fundamentals and design a game model to solve a problem in wireless networking.
3. Student can analyze the convergence properties of games for wireless networking.

CPE 613 Optimization Methods 3 (3-0-9)

Prerequisite: None

Optimization design using mathematical modeling. Heuristic approach modeling to optimize the design of various system types including hardware systems, software systems, embedded systems, and network systems. Design constraints consideration includes system reliability, quality of services, and investment cost. Single- objective optimization, multi- objective optimization with evolutionary algorithms (MOEAs).

Learning Outcome:

1. Student can develop techniques to solve single- objective and multi- objective optimization problems.
2. Student can work as a team with acceptable writing and presenting skills.

CPE 614 Applied Discrete Mathematics 3 (3-0-9)

Prerequisite: None

Applications of discrete mathematics in formal method to analyze various computer hardware and software systems such as communication protocols, distributed systems, and algorithms. Proof techniques. Logic theory. Logic programming with PROLOG. Functional programming. Temporal logic. Model checking. Graph theory. Automata. Petri nets. Colored Petri Nets. and Process Algebra.

Learning Outcome:

1. Student can identify computer development process and apply formal methods to create formal specification.
2. Student can apply discrete mathematics to guide and verify the formal specification and the development of the system.

CPE 615	Experimental Design and Data Analysis Pre-requisite: None Review of probability and random variables. Data collection methods. Graphical display of data. Exploratory data analysis. Correlation. Confidence interval. Hypothesis testing and decision errors. Regression models. Simple comparative experiments. Single factor experiments and analysis of variance. Factorial design. Multivariate analysis. Learning Outcome: <ol style="list-style-type: none"> 1. Student can design scientific experiments to collect data and analyze the data using standard statistical techniques. 2. Student can interpret meaningful results. 	3 (3-0-9)
CPE 620	Data Mining Prerequisite: None Concepts and methods for finding hidden and potentially useful information from small to huge amounts of data using various techniques. Association rule. Descriptive and predictive models. Classification. Statistics. Nearest neighbor. Clustering. Decision tree. Neural networks. Rule induction. Data warehousing. Data preparation. OLAP and information retrieval. Applications of data mining and advanced concepts. Learning Outcome: <ol style="list-style-type: none"> 1. Student can develop various techniques to solve data mining problems. 2. Student can work as a team with acceptable writing and presenting skills. 	3 (3-0-9)
CPE 621	Data Visualization Prerequisite: None Basic concepts of data visualization. Data types. MVC architecture in data visualization. Data model. Data preparation. Groups and sets. Table calculation.	1 (1-0-3)

3. Student can design and implement program on the high-performance computing system.

CPE 630	Computer Aided Geometric Design Prerequisite: None Foundations of geometric modeling. Concepts and mathematic theory of curve and surface modeling. Bézier, Said-Ball, Wang-Ball, DP and B-Spline curves, and their geometric properties. Algorithms for computing a point on these curves for both polynomial (non-rational) and rational ones. Relationships among those curves defined and proven by the polar form approach. Degree elevation and degree reduction. Rectangular surfaces and triangular patches. Learning Outcome: Student can apply concepts and techniques of computer aided geometric design algorithms.	3 (3-0-9)
CPE 631	Advanced Geometric Modeling Prerequisite: CPE 630 or CPE 631 Advanced techniques in geometric modeling. Concepts and mathematical theory of curve, surface and solid modeling. Algorithms and applications related to the various types of application systems in geometric modeling. Learning Outcome: Student can apply concepts and techniques of advanced geometric modeling algorithms.	3 (3-0-9)
CPE 632	Human Computer Interaction Pre-requisite: None Theory and practice of effective user interface design. Interaction design, implementation, and evaluation. Theories behind successful human-computer interaction. Awareness of established procedures for good user interface design. Usability engineering process. Novel interface designs. Learning Outcome: <ol style="list-style-type: none"> 1. Student can apply knowledge and skill in human-computer interaction in the design or evaluate of computer systems. 2. Student can research for new information and concept to use in the design, Team working in multidisciplinary and culturally diverse environments. 	3 (3-0-9)

3. Student can read, write and communicate efficiently in English.

CPE 633 Digital Watermarking for Multimedia Content 3 (3-0-9)

Prerequisite: None

Introduction to digital image processing. Image and MATLAB. Image display. Point processing. Neighborhood processing. Image geometry. Fourier transform. Color models. Color processing. Image Coding & compression. Cryptography for watermark security. Digital watermarking fundamentals. Watermarking evaluation. Image watermarking techniques. Attacks on digital watermarks. Video coding concept. Watermarking a video sequence. Spatial domain based image watermarking for digital networks and its improving methods. Frequency domain based image watermarking for social networks. Document watermarking against printing and scanning attacks. Digital watermarking for camera-captured image.

Learning Outcome:

1. Student can add a watermark signal into a digital image for copyright protection purpose using the digital image processing and cryptographic techniques learned in the class.
2. Student can start doing research in image watermarking area.

CPE 634 Digital Educational Game Design 3 (3-0-9)

Prerequisite: None

Foundations of digital game design. Concepts and mathematic theory of digital game design Digital educational game design and development life cycle. Game classification. Introduction to practical concepts of game and its components including Natural funativity theory, Maslow's hierarchy of needs. Game Mechanic, Dynamic and Aesthetic. Storytelling. Character design. Scene design. Level design. Game flow and difficulty. Outcome-Based Learning Theory. Game Design Document.

Learning Outcome:

1. Student can apply concepts and techniques of digital game.
2. Student can explain the basic principles of digital game design.

3. Student can evaluate, select and implement appropriate procedures to efficiently develop fun games.

CPE 640	<p>Artificial Intelligence</p> <p style="text-align: right;">3 (3-0-9)</p> <p>Prerequisite: None</p> <p>State-of-the-art topics in artificial intelligence fields. Hands-on experiences in implementation of several simple AI applications, such as intelligent agents. Problem-solving and searching for solutions. Uninformed search, heuristic search, game search, constraint satisfaction problems. Theorem proving, propositional calculus, first order logic, inference with clauses, resolution. Classical planning, deterministic planning, STRIPS planning. Knowledge representation, inference rules, semantics, semantic nets, frame-based. Bayesian inference, Bayesian networks, HMMs, making decision, planning in stochastic domains.</p> <p>Learning Outcome: Design their own intelligent system and implement of such a system with their own fields of interest.</p>
CPE 641	<p>Natural Language Processing</p> <p style="text-align: right;">3 (3-0-9)</p> <p>Prerequisite: None</p> <p>Natural language processing and its application. Structural analysis of natural languages. Semantic interpretation. Grammar writing for computer to build parsers for various languages. Review of current natural language processing systems for information technology.</p> <p>Learning Outcome: Student can apply knowledge and skills in natural language processing tasks, research various issues in language processing and language understanding, function and manage in team work, be able to read, write, and communicate efficiently in English.</p>
CPE 642	<p>Speech Processing</p> <p style="text-align: right;">3 (3-0-9)</p> <p>Prerequisite: None</p> <p>Bases of speech processing. Computer sound system and digital audio. Human speech production and perception. Speech recognition concepts including, spectral analysis, spectral feature, language model, and hidden Markov model.</p>

Speech synthesis concepts including, concatenative synthesis, phonetics, and prosody.

Learning Outcome:

1. Student can explain the basis of speech processing.
2. Student can create simple speech recognition, synthesis and spoken dialog systems.
3. Student can customize the existing speech processing systems for performing specific tasks.

CPE 643 Applied Machine Learning 3 (3-0-9)

Pre-requisite: CPE 640

Hands-on experiences in implementation of several advance topics in machine learning field. Unsupervised learning. Self-organizing maps. Inductive learning. Reinforcement learning. Artificial neural networks. Stochastic neural networks. Convolutional networks. Deep learning. Genetic programming and robotics.

Learning Outcome:

1. Student can develop techniques to solve several machine learning topics.
2. Student can work as a team with acceptable writing and presenting skills.

CPE 650 Software Engineering 3 (3-0-9)

Prerequisite: None

Introduction to the goals and practices of software engineering. Independent literature research and reporting on current topics and issues in software engineering research. New tools and paradigms for specification, design, implementation and testing. New programming paradigms. Model checking. Executable designs. Design for evolution, automation of test generation and execution.

Learning Outcomes:

1. Student can identify and explain the core objectives of software engineering. Identify and elaborate on major questions in current software engineering research.
2. Student can summarize and critique a software engineering research article.

3. Student can design a research project to investigate an important issue in software engineering research.

CPE 651	Multimedia Information Retrieval Prerequisite: None Basic concepts of information retrieval and specific applications such as search engine. Text and multimedia representations. Similarity measurements. Information retrieval architecture and techniques in indexing, compressing, ranking, categorization, and feature selection. Implementation of search engine. Extracting features through querying. Evaluation of search engine results with standard methods. Internet retrieval using data from web crawler from online websites. Learning Outcome: <ol style="list-style-type: none"> 1. Student can explain basic concepts of multimedia information retrieval. 2. Student can use various methods in extracting features, calculate similarity, index data, compress data, select features, and evaluate results. Also, build a search engine from corpus or multimedia database. 	3 (3-0-9)
CPE 652	Bio-inspired Computing Prerequisite: None Characteristics of Natural Systems, Cellular Automata, Evolutionary Algorithms, Genetic Algorithms, Genetic Programming, Swarm Intelligence, Particle Swarm Optimization, Ant Colony Optimization, Artificial Bee Colony, Artificial Neural Networks, Quantum Computing Learning Outcomes: <ol style="list-style-type: none"> 1. Student can explain the concepts of inspiration, motivation, and computation behind bioinspired computing models. 2. Student can apply computing models to solve problems. Survey and explore more literatures. 	3 (3-0-9)
CPE 653	Digital Image Processing and Analysis Pre-requisite: None	3 (3-0-9)

To introduce the fundamental concepts of image processing and common analytical methods. Students is exposed with image enhancement and restoration techniques. To understand image compression techniques, segmentation, and morphological processing techniques.

Learning Outcome:

1. Student can explain fundamental concepts of image processing.
2. Student can apply common analytical methods on images, and evaluate the techniques for image enhancement and image restoration. Explain compression, segmentation, and morphological.

CPE 654 Brain-Computer Interface

3 (3-0-9)

Pre-requisite: None

Understand concepts of BCI and its history. Explore interface techniques of partial invasive and non-invasive. Students can acquire EEG signal and pre-process it. Apply signal processing to brain signal e.g., spatial, temporal, spectral, spatial-temporal filters. Apply feature extraction and build Machine Learning models on brain signal.

Learning Outcome:

1. Student can identify different types of BCI signals from various instruments.
2. Student can capture brain signal and apply suitable preprocesses techniques.
3. Student can process brain signal, extract feature, and build machine learning models.

CPE 655 Data Security for Multimedia Communications

3 (3-0-9)

Pre-requisite: None

Reviews on symmetrical and asymmetrical encryption algorithms, hash function, MAC, digital signature. Various cryptographic techniques, Implementations: protecting the integrity of a sequence of images, key distribution scheme for one-way broadcasting, hiding cipher text by cascading algorithms. Speech security systems. Principle of image compression & JPEG compression standard.

Principle of video compression & MPEG compression standard. Selective encryption. Reduced complexity encryption. Copyright protection technologies based on digital watermarking techniques. Digital watermarking based on modification of image pixels & modification of DWT coefficients. Fingerprinting schemes in communication systems. Secure distribution of copyright data.

Learning Outcome:

1. Student can identify security problems in a practical system, analyze and design solution for such problems.
2. Student can start doing research in data security area.

CPE 661	<p>Special Topic I</p> <p>Pre-requisite: None</p> <p>Special topic in computer engineering.</p> <p>Learning Outcome:</p> <ol style="list-style-type: none"> 1. Student can develop techniques to solve special topic in computer engineering. 2. Student can write and present technical information. 	1 (1-0-3)
CPE 662	<p>Special Topic II</p> <p>Pre-requisite: None</p> <p>Special topic in computer engineering.</p> <p>Learning Outcome:</p> <ol style="list-style-type: none"> 1. Student can develop techniques to solve special topic in computer engineering. 2. Student can write and present technical information. 	2 (2-0-6)
CPE 663	<p>Special Topic III</p> <p>Pre-requisite: None</p> <p>Special topic in computer engineering.</p> <p>Learning Outcome:</p> <ol style="list-style-type: none"> 1. Student can develop techniques to solve special topic in computer engineering. 	3 (3-0-9)

2. Student can write and present technical information.

CPE 700	<p>Thesis</p> <p style="text-align: right;">24 (0-0-96)</p> <p>Pre-requisite: None</p> <p>Self-research and study in computer engineering research topics under the supervision of an advisor. Develop research skill in conducting experiments and analyzing the result. Also publish result in a peer-review journal or top tier conference.</p> <p>Learning Outcome:</p> <ol style="list-style-type: none"> 1. Student can conduct research, analyze data and synthesize research findings, report research findings in written and verbal forms. 2. Student can publish result in international conference or journal.
CPE 701	<p>Thesis</p> <p style="text-align: right;">12 (0-0-48)</p> <p>Pre-requisite: None</p> <p>Self-research and study in computer engineering research topics under the supervision of an advisor. Develop research skill in conducting experiments and analyzing the result. Also publish result in an international conference.</p> <p>Learning Outcome:</p> <ol style="list-style-type: none"> 1. Student can conduct research, analyze data and synthesize research findings, report research findings in written and verbal forms. 2. Student can publish result in international conference or a journal.
CPE 702	<p>Professional Project</p> <p style="text-align: right;">6 (0-0-24)</p> <p>Pre-requisite: None</p> <p>Supervised investigation in professional areas of computer engineering to be presented in the form of a report. Develop a solution to a problem and present the solution in writing and other media. Also, be able to write a paper to present the solution as a national paper.</p> <p>Learning Outcome:</p>

1. Student can conduct research in professional/industrial areas, analyze data and synthesize research findings, report research findings in written and verbal forms.
2. Student can present a solution as a national conference paper or better.