



Doctor of Philosophy Programme in  
Electrical and Computer Engineering  
International Programme  
Curriculum Revision 2022 (2565 B.E.)

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

## ชื่อหลักสูตร

- (ภาษาไทย) : หลักสูตรปรัชญาดุษฎีบัณฑิต สาขาวิชาวิศวกรรมไฟฟ้าและคอมพิวเตอร์  
(หลักสูตรนานาชาติ)
- (ภาษาอังกฤษ) : Doctor of Philosophy Program in Electrical and Computer  
Engineering (International Program)

## ชื่อปริญญาและสาขาวิชา

- ชื่อเต็ม (ภาษาไทย) : ปรัชญาดุษฎีบัณฑิต (วิศวกรรมไฟฟ้าและคอมพิวเตอร์)  
(ภาษาอังกฤษ) : Doctor of Philosophy (Electrical and Computer Engineering)
- ชื่อย่อ (ภาษาไทย) : ประ.ด. (วิศวกรรมไฟฟ้าและคอมพิวเตอร์)  
(ภาษาอังกฤษ) : Ph.D. (Electrical and Computer Engineering)

## โครงสร้างหลักสูตร

### Total required credits in the programme

- Plan A1: 48 credits for students with master degree, without coursework
- Plan B1: 48 credits for students with master degree, with course work
- Plan B2: 75 credits for students without master degree (with bachelor degree), with course work

### Programme Structure

#### Plan A1: without course work

Core Course	0	credits (S/U)
Elective Course	0	credits
Dissertation Credit	48	credits
Total	48	credits

**Plan B: with course work****Plan B1:**

Core Course	6	credits
Elective Course	6	credits
Dissertation Credit	36	credits
Total	48	credits

**Plan B2:**

Core Course	6	credits
Elective Course	21	credits
Dissertation Credit	48	credits
Total	75	credits

## รายวิชา

### Core Courses (6 credits)

Code	Title	(L-P-S)
CPE 691	Research Methodology ระเบียบวิธีวิจัย	2 (2-0-6)
CPE 710	Independent Study การศึกษาแบบอิสระ	3 (0-0-12)
CPE 711	Electrical and Computer Engineering Seminar 1 สัมมนาเชิงวิศวกรรมไฟฟ้าและคอมพิวเตอร์	1 (2-0-3)

### Remark:

- Plan A1 Select CPE 691 (S/U) and CPE 711 (S/U)
- Plan B1 Select 6 credits from CPE 691, CPE 710 and CPE 711 as core courses
- Plan B2 Select 6 credits from CPE 691, CPE 710 and CPE 711 as core courses

### Elective Courses

Code	Title	(L-P-S)
CPE 600	Technical Research Writing หลักการเขียนเอกสารวิจัยเชิงเทคนิค	3 (3-0-9)
CPE 610	Algorithm Analysis and Design การวิเคราะห์อัลกอริทึมและการออกแบบ	3 (3-0-9)
CPE 611	Queuing Theory ทฤษฎีแถวคอย	3 (3-0-9)
CPE 612	Game Theory ทฤษฎีเกม	3 (3-0-9)
CPE 613	Optimization Methods วิธีการหาค่าที่เหมาะสมที่สุด	3 (3-0-9)
CPE 614	Applied Discrete Mathematics คณิตศาสตร์แบบไม่ต่อเนื่องเชิงประยุกต์	3 (3-0-9)

CPE 615	Experimental Design and Data Analysis การออกแบบการทดลองและการวิเคราะห์ข้อมูล	3 (3-0-9)
CPE 620	Data Mining การทำเหมืองข้อมูล	3 (3-0-9)
CPE 623	Text Mining and Social Network Analysis การทำเหมืองข้อความและการวิเคราะห์เครือข่ายทางสังคม	3 (3-0-9)
CPE 621	Data Visualization การสร้างภาพข้อมูล	1 (1-0-3)
CPE 622	Data Science for Business วิทยาศาสตร์ข้อมูลสำหรับธุรกิจ	2 (2-0-6)
CPE 624	Big Data การจัดการกับข้อมูลขนาดใหญ่	3 (3-0-9)
CPE 625	High Performance and Cloud Computing การประมวลผลด้วยคอมพิวเตอร์ สมรรถนะสูงและคลาวด์	3 (3-0-9)
CPE 630	Computer-Aided Geometric Design คอมพิวเตอร์ช่วยเหลืเพื่อการออกแบบเรขภาพ	3 (3-0-9)
CPE 631	Advanced Geometric Modeling การจำลองแบบเรขภาพขั้นสูง	3 (3-0-9)
CPE 632	Human Computer Interaction การปฏิสัมพันธ์ระหว่างมนุษย์และคอมพิวเตอร์	3 (3-0-9)
CPE 633	Digital Watermarking for Multimedia Content การทำลายน้ำดิจิทัลสำหรับเนื้อหาสื่อประสม	3 (3-0-9)
CPE 634	Digital Educational Game Design การออกแบบเกมดิจิทัลเพื่อการศึกษา	3 (3-0-9)
CPE 640	Artificial Intelligence ปัญญาประดิษฐ์	3 (3-0-9)
CPE 641	Natural Language Processing การประมวลผลภาษาธรรมชาติ	3 (3-0-9)

CPE 642	Speech Processing การประมวลผลเสียงพูด	3 (3-0-9)
CPE 643	Applied Machine Learning การเรียนรู้ของเครื่องแบบประยุกต์	3 (3-0-9)
CPE 650	Software Engineering วิศวกรรมซอฟต์แวร์	3 (3-0-9)
CPE 651	Multimedia Information Retrieval การค้นคืนข้อมูลสื่อประสม	3 (3-0-9)
CPE 652	Bio-inspired Computing การคำนวณที่ได้แรงบันดาลใจจากสิ่งมีชีวิตในธรรมชาติ	3 (3-0-9)
CPE 653	Digital Image Processing and Analysis การประมวลผลภาพดิจิทัลและการวิเคราะห์	3 (3-0-9)
CPE 654	Brain-Computer Interface การประสานกันของสมองกับคอมพิวเตอร์	3 (3-0-9)
CPE 655	Data Security for Multimedia Communications ความมั่นคงของข้อมูลสำหรับการสื่อสารสื่อประสม	3 (3-0-9)
CPE 795	Special Topic (หัวข้อพิเศษ)	3 (3-0-9)
EEE 795	Special Topic (หัวข้อพิเศษ)	3 (3-0-9)
ENE 795	Special Topic (หัวข้อพิเศษ)	3 (3-0-9)
INC 795	Special Topic (หัวข้อพิเศษ)	3 (3-0-9)

These elective courses are graduate courses offered by the four departments which are Computer Engineering, Electrical Engineering, Electronics and Telecommunication Engineering, and Control System and Instrumentation Engineering.

#### A. Dissertation (48/60)

Code	Title	(L-P-S)
CPE 790	Dissertation (Plan B1) วิทยานิพนธ์ (แผน B1)	36 (0-0-144)
CPE 791	Dissertation (Plan A1 and Plan B2) วิทยานิพนธ์ (แผน A1 และ B2)	48 (0-0-192)

## แผนการศึกษา

**Plan A1:** Students in this plan are required to take CPE 691 Research Methodology and CPE 711 Electrical and Computer Engineering Seminar without credit (S/U)

### Year 1 Semester 1

CPE 691	Research Methodology	2 (2-0-6) (S/U)
Total		2 (2-0-6)
Hour/Week		= 8

### Year 1 Semester 2

CPE 711	Electrical and Computer Engineering Seminar	1 (2-0-3) (S/U)
CPE 791	Dissertation	8 (0-0-32)
Total		9 (2-0-35)
Hour/Week		= 37

### Year 2 Semester 1

CPE 791	Dissertation	10 (0-0-40)
Total		10 (0-0-40)
Hour/Week		= 40

### Dissertation Proposal is recommended

### Year 2 Semester 2

CPE 791	Dissertation	10 (0-0-40)
Total		10 (0-0-40)
Hour/Week		= 40

### Year 3 Semester 1

CPE 791	Dissertation	10 (0-0-40)
Total		10 (0-0-40)
Hour/Week		= 40

### Year 3 Semester 2

CPE 791	Dissertation	10 (0-0-40)
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Total	10 (0-0-40)
Hour/Week	= 40

Students in this study plan A1 must pass the Qualifying Examination within the first three semesters (year 2, term 1), before dissertation credit(s) can be registered. Then the Dissertation Proposal can be obtained in the following semester, after the QE is passed.

**Plan B1: With course work**

Year 1 Semester 1

CPE 691 Research Methodology	2 (2-0-6)
CPE 710 Independent Study	3 (0-0-12)
Total	5 (2-0-18)
Hour/Week	= 20

Year 1 Semester 2

CPE 711 Electrical and Computer Engineering Seminar	1 (2-0-3)
CPE/EEE/ENE/INC 795 Elective	3 (3-0-9)
CPE/EEE/ENE/INC 795 Elective	3 (3-0-9)
CPE 790 Dissertation	2 (0-0-8)
Total	9 (8-0-29)
Hour/Week	= 37

Year 2 Semester 1

CPE 790 Dissertation	9 (0-0-36)
Total	9 (0-0-36)
Hour/Week	= 36

**Dissertation Proposal is recommended**

Year 2 Semester 2

CPE 790 Dissertation	9 (0-0-36)
Total	9 (0-0-36)
Hour/Week	= 36

## Year 3 Semester 1

CPE 790 Dissertation	8 (0-0-32)
Total	8 (0-0-32)
Hour/Week	= 32

## Year 3 Semester 2

CPE 790 Dissertation	8 (0-0-32)
Total	8 (0-0-32)
Hour/Week	= 32

Students in this study plan B1 must pass the Qualifying Examination within the first three semesters (year 2, term 1), before dissertation credit(s) can be registered. Then the Dissertation Proposal can be obtained in the following semester, after the QE is passed.

**Plan B2:** With course work

## Year 1 Semester 1

CPE/EEE/ENE/INC 795 Elective	3 (3-0-9)
CPE/EEE/ENE/INC 795 Elective	3 (3-0-9)
CPE/EEE/ENE/INC 795 Elective	3 (3-0-9)
Total	9 (9-0-27)
Hour/Week	= 36

## Year 1 Semester 2

CPE/EEE/ENE/INC 795 Elective	3 (3-0-9)
CPE/EEE/ENE/INC 795 Elective	3 (3-0-9)
CPE/EEE/ENE/INC 795 Elective	3 (3-0-9)
Total	9 (9-0-27)
Hour/Week	= 36

## Year 2 Semester 1

CPE 691 Research Methodology	2 (2-0-6)
CPE 710 Independent Study	3 (0-0-12)
CPE/EEE/ENE/INC 795 Elective	3 (3-0-9)

CPE 791	Dissertation	2 (0-0-8)
Total		10 (5-0-35)
Hour/Week		= 40
Year 2 Semester 2		
CPE 711	Electrical and Computer Engineering Seminar	1 (2-0-3)
CPE 791	Dissertation	9 (0-0-36)
Total		10 (2-0-39)
Hour/Week		= 41
Year 3 Semester 1		
CPE 791	Dissertation	10 (0-0-40)
Total		10 (0-0-40)
Hour/Week		= 40

#### **Dissertation Proposal is recommended**

Year 3 Semester 2		
CPE 791	Dissertation	9 (0-0-36)
Total		9 (0-0-36)
Hour/Week		= 36
Year 4 Semester 1		
CPE 791	Dissertation	9 (0-0-36)
Total		9 (0-0-36)
Hour/Week		= 36
Year 4 Semester 2		
CPE 791	Dissertation	9 (0-0-36)
Total		9 (0-0-36)
Hour/Week		= 36

Students in this study plan B2 must pass the Qualifying Examination within the first four semesters (year 2, term 2), before dissertation credit(s) can be registered. Then the Dissertation Proposal can be obtained in the following semester, after the QE is passed.

## คำอธิบายรายวิชา และผลลัพธ์การเรียนรู้ของรายวิชา

CPE 691 Research Methodology

2 (2-0-6)

**Pre-requisite:** None

Introduction to Research Methodology, Explaining Behavior, Developing and Evaluating Theories of Behavior, Getting Ideas for Research, Choosing a Research Design, Making Systematic Observations, Choosing and Using Research Subjects, Understanding Ethical Issues in the Research Process, Using Non-experimental Research, Using Survey Research, Using Between-Subjects and Within-Subjects Experimental Designs, Using Specialized Research Designs, Using Single-Subject Designs, Describing Data, Using Inferential Statistics, Using Multivariate Design and Analysis, Reporting Your Research Results.

**Learning Outcome:** Able to describe the research process and the principle activities, skills and ethics associated with it. Construct an effective research proposal for their Ph.D. study.

CPE 710 Independent Study

3 (0-0-12)

**Pre-requisite:** None

An in-depth study of an approved topic which will lead to formulation of dissertation proposal.

**Learning Outcome:** Able to conduct initial research and/or experiment on a research problem.

CPE 711 Electrical and Computer Engineering Seminar

1 (2-0-3)

**Prerequisite:** None

Oral presentation in public on a research topic related to the dissertation or the progress of the dissertation.

**Learning Outcome:** Familiar with reading research papers and develop literature evaluation and research skills. Prepare for the Qualifying Examination.

**CPE 790 Dissertation****48 (0-0-192)****Prerequisite: None**

Conduct an original research on a topic related to Electrical and/or Computer Engineering under the supervision and approval of the advisory committee.

**Learning Outcome:** Able to conduct advanced research with contribution to the global research community. Publish research findings in high ranking international journal(s) and conference proceedings.

**CPE 791 Dissertation****60 (0-0-240)****Prerequisite: None**

Conduct an original research on a topic related to Electrical and/or Computer Engineering under the supervision and approval of the advisory committee.

**Learning Outcome:** Able to conduct advanced research with contribution to the global research community. Publish research findings in high ranking international journal(s) and conference proceedings.

**CPE 600 Technical Research Writing****3 (3-0-9)****Pre-requisite: None**

Approaches and processes in conducting research in science and engineering. Ethical principles in research. Techniques for critical reviews of literatures. Finding research topics. Quantitative research methods. Research proposal development. Research project management. Writing techniques for technical and research articles.

**Learning Outcome:** Able to write academic papers and reviews in computer engineering fields using appropriate language. Knowledge of structure of technical writing.

**CPE 610 Algorithm Analysis and Design****3 (3-0-9)****Prerequisite: None**

Roles of algorithms in computing. Growth of functions and algorithm complexity. Brute-force. Divide-and-conquer. Probabilistic analysis and randomized algorithms. Sorting algorithms. Dynamic programming. Greedy algorithms. Amortized analysis. Graph algorithms. Linear programming. String matching. Approximation algorithm. NP completeness.

**Learning Outcome:** Explain and analyze the worst-case time complexity of an algorithm. Compare and contrast the efficiency of algorithms using asymptotic complexity. Design efficient algorithms using standard algorithm design techniques. Apply standard algorithms to problems in computer science and engineering areas.

**CPE 611 Queueing Theory****3 (3-0-9)****Pre-requisite: None**

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.

**Learning Outcome:** Apply stochastic performance modeling methods to solve computer engineering problems.

**CPE 612 Game Theory****3 (3-0-9)****Pre-requisite: None**

Fundamentals of game theory with an emphasis on applications for communication networks. Non-cooperative and cooperative game models for 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:** Explain the fundamentals of game theory Apply the game fundamentals and design a game model to solve a problem in wireless networking. 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:** Apply appropriate techniques to solve single-objective and multi-objective optimization problems. Be able to 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:** Identify computer development process and apply formal methods to create formal specification. Apply discrete mathematics to guide and verify the formal specification and the development of the system.

### **CPE 615 Experimental Design and Data Analysis**

**3 (3-0-9)**

**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:** Design scientific experiments to collect data and analyze the data using standard statistical techniques. Be able to interpret meaningful results.

### **CPE 620 Data Mining**

**3 (3-0-9)**

**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:** Apply various techniques to solve data mining problems. Be able to work as a team with acceptable writing and presenting skills.

### **CPE 621 Data Visualization**

**1 (1-0-3)**

**Prerequisite:** None

Basic concepts of data visualization. Data types. MVC architecture in data visualization. Data model. Data preparation. Groups and sets. Table calculation. Trend analysis and forecast. Data blending. Related visualization tools such as Tableau, R, and D3.js. Case studies in data modeling and visualization.

**Learning Outcome:** Identify the principle of visualization. Design and create meaningful visualization that addresses the relevant problems. Use modern visualization tools to perform the visualization task.

**CPE 622 Data Science for Business****2 (2-0-6)****Prerequisite: None**

Basis of data science. Data wrangling. Exploratory data analysis. Predictive modeling. Fitting model to the data. Similarity, neighbor, and clustering. Co-occurrence analysis. Data reduction. Data analytic thinking.

**Learning Outcome:** Identify basis of data science for data analytics. Analyze data to identify patterns in data using exploratory data analysis techniques. Create a predictive model in terms of both classification and regression. Analyze natural grouping in the data using clustering. Use co-occurrence analysis to create a recommendation system. Reduce the data dimension using PCA or MDS Use R and Tableau to analyze and create models from data.

**CPE 623 Text Mining and Social Network Analysis****3 (3-0-9)****Prerequisite: None**

Basic multimedia information retrieval concepts. Management of data in various media forms, such as texts, audios, graphics and videos. Data structure used for storing, processing multimedia data. Various query techniques such as query-by-example, content-based query, semantic-based query. Integration of various types of data.

**Learning Outcome:** Apply information retrieval techniques to create a search engine. Modify algorithms in search engine for addressing specific problems.

**CPE 624 Big Data****3 (3-0-9)****Prerequisite: None**

Bases of big data engineering and Hadoop ecosystem, visualization, structured and unstructured databases and data services with Hive and HBase. HDFS and MapReduce. Workload management (YARN). In-memory process with Spark. Data integration through Flume and Sqoop. Solr search engine. Emphasize on aspect of system and architecture as well as programming frameworks.

**Learning Outcome:** Analysis the basic concepts of big data technology and Hadoop ecosystem. Learn how to program on the Hadoop ecosystem (interactive and batch modes). Learn to

integrate data from multiple sources into a single point of view and query the data through applications.

**CPE 625 High Performance and Cloud Computing 3 (3-0-9)**

**Prerequisite: None**

Fundamental methods by which parallel programs are assembled. Important concepts for program design. Partitioning. Mapping. Granularity. Applications to multiple high performance computing platforms. Alternative programming paradigms including MapReduce, GPU's CUDA. Fundamental of cloud services PaaS, IaaS, and SaaS, the architecture of the cloud, and the concept and practice of virtualization.

**Learning Outcome:** Analysis architecture of the high performance computing systems and virtualized networked systems. Analyze system efficiency. Design and implement program on the high performance computing system.

**CPE 630 Computer Aided Geometric Design 3 (3-0-9)**

**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:** Able to apply concepts and techniques of computer aided geometric design algorithms.

**CPE 631 Advanced Geometric Modeling 3 (3-0-9)**

**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:** Able to apply concepts and techniques of advanced geometric modeling algorithms.

**CPE 632 Human Computer Interaction**

**3 (3-0-9)**

**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:** Apply knowledge and skill in human-computer interaction in the design or evaluate of computer systems. Research for new information and concept to use in the design, Team working in multidisciplinary and culturally diverse environments. Be able to 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:** Able to add a watermark signal into a digital image for copyright protection purpose using the digital image processing and cryptographic techniques learned in the class. Be able to 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:** Apply concepts and techniques of digital game. Explain the basic principles of digital game design. Evaluate, select and implement appropriate procedures to efficiently develop fun games.

**CPE 640 Artificial Intelligence****3 (3-0-9)****Prerequisite: None**

State-of-the-art topics in artificial intelligence fields. Hands-on experiences in implementation of several 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.

**Learning Outcome:** Apply techniques of AI to design and implement an intelligent system with students' own fields of interest.

**CPE 641 Natural Language Processing****3 (3-0-9)****Prerequisite: None**

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.

**Learning Outcome:** 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.

### **CPE 642 Speech Processing**

**3 (3-0-9)**

**Prerequisite:** None

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

**Learning Outcome:** Identify the basis of speech processing. Create simple speech recognition, synthesis and spoken dialog systems. 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:** Apply machine learning techniques to solve several machine learning problems. Able to 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 Outcome:** Identify and explain the core objectives of software engineering. Identify and elaborate on major questions in current software engineering research. Summarize and critique a software engineering research article. Design a research project to investigate an important issue in software engineering research.

### **CPE 651 Multimedia Information Retrieval**

**3 (3-0-9)**

**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:** Identify basic concepts of multimedia information retrieval. Know 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.

### **CPE 652 Bio-inspired Computing**

**3 (3-0-9)**

**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 Outcome:** Identify inspiration, motivation, and computation behind bioinspired computing models. Apply computing models to solve problems. Survey and explore more literatures.

**CPE 653 Digital Image Processing and Analysis****3 (3-0-9)****Prerequisite: None**

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:** Explain fundamental concepts of image processing. Able to 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, spatio-temporal filters. Apply feature extraction and build Machine Learning models on brain signal.

**Learning Outcome:** Identify different types of BCI signals from various instruments. Able to capture brain signal and apply suitable preprocesses techniques. 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:** Identify security problems in a practical system, analyze and design solution for such problems. Be able to start doing research in data security area.

CPE 795 Special Topic	3 (3-0-9)
EEE 795 Special Topic	3 (3-0-9)
ENE 795 Special Topic	3 (3-0-9)
INC 795 Special Topic	3 (3-0-9)

These four graduate elective courses are provided by the four-joined department (CPE, EEE, ENE and INC)

**Pre-requisite:** None

**Learning Outcome:** Identify knowledge in a certain subject field and able to apply the knowledge in his/her research. Able to analyze and solve problem reasonably with fairness; good moral and ethical.