Doctor of Philosophy Program in Electrical Engineering Curriculum Revised in Year 2022

1. Course Title : Doctor of Philosophy (Electrical Engineering)

2. Doctoral Degree : Ph.D. (Electrical Engineering)

3. Academic Institution : Faculty of Engineering, Naresuan University

4. Duration:

First Semester : June - October

Second Semester : November – March

5. Background and Rational:

The doctor of philosophy program in electrical engineering is offered in the areas of power electrical engineering, electronics and embedded systems, automatic control systems, signal processing and analysis, communications electrical engineering, and related areas in biomedical engineering, rehabilitation engineering, computer engineering, robotics, pattern recognition (branch of AI), deep learning, and development of IoT technology.

6. Objectives:

1) To have outstanding in academic abilities, especially in implementation of research findings within various fields of Electrical Engineering.
2) To operate dynamic self-development for keeping up to date with the rapid advancement of innovations in many fields of Electrical Engineering.
3) To do possessing an active inquiry mind to conduct advanced research in Electrical Engineering for building innovative mindset, curiosity and vision.

7. Course Synopsis and Methodology:

7.1 The structure of the curriculum

The curriculum structure is in accordance with the Ministry of Education's standards as follows.

Description	Number of credits in the revised curriculum 2022			
	Type 1.1	Type 1.2	Type 2.1	Type2.2
1. Course work - a minimum of	-	-	12	24
1.1 Core courses	-	-	3	6
1.2 Elective courses	-	-	9	18
2. Dissertation	48	72	36	48
3. Required Non-credit	6	6	6	6
Total credits throughout the course	48	72	48	72

The Ph.D. course is divided into two types focusing on research to develop academician and higher professionals. Type 1 is a research-based focusing on creating new knowledge. Furthermore, Type 2 is a research-based focusing on creating a high-impact thesis and resulting in the development of academic and professional paths. Each Type is divided into two sub-types; therefore, the course is divided into four sub-types. The students of the four sub-types may be required to take some coursework or participate in some academic activities with no credit awarded, and are required to study extra courses as following:

(1) Type 1.1 Students who hold a master's degree are required to complete more than 48 credits of the thesis course.

(2) Type 1.2 Students who hold an undergraduate degree are required to complete more than 72 credits of the thesis course.

(3) Type 2.1 Students who hold a master's degree are required to complete more than 36 credits of the thesis course and more than 12 credits of the coursework courses.

(4) Type 2.2 Students who hold an undergraduate degree are required to complete more than 48 credits of the thesis course and more than 24 credits of the coursework courses.

Course of the four sub-types also includes at least six non-credit courses.

7.2 Study plan

7.2.1) Study Plan in Type 1.1

1st Year in

First Semester

303690	Advanced Research Methodology (Non-credit)		3 (3-0-6)
303697	Seminar 1 (Non-credit)		1 (0-2-1)
303661	Dissertation 1, Type 1.1		6 credits
		Total	**6 credits**

1st Year in

Second Semester

303662	Dissertation 2, Type 1.1		6 credits
		Total	**6 credits**

2nd Year in

First Semester

303663	Dissertation 3, Type 1.1		9 credits
303698	Seminar 2 (Non-credit)		1 (0-2-1)
		Total	**9 credits**

2nd Year in

Second Semester

303664	Dissertation 4, Type 1.1		9 credits
		Total	**9 credits**

3rd Year in

First Semester

303665	Dissertation 5, Type 1.1		9 credits
303699	Seminar 3 (Non-credit)		1 (0-2-1)
		Total	**9 credits**

3rd Year in

Second Semester

303666	Dissertation 6, Type 1.1		9 credits
		Total	**9 credits**

7.2.2) Study Plan in Type 1.2

1st Year in First Semester

303671	Dissertation 1, Type 1.2	9 credits
303690	Advanced Research Methodology (Non-credit)	3 (3-0-6)
	Total	**9 credits**

1st Year in Second Semester

303672	Dissertation 2, Type 1.2	9 credits
	Total	**9 credits**

2nd Year in First Semester

303673	Dissertation 3, Type 1.2	9 credits
303697	Seminar 1 (Non-credit)	1 (0-2-1)
	Total	**9 credits**

2nd Year in Second Semester

303674	Dissertation 4, Type 1.2	9 credits
	Total	**9 credits**

3rd Year in First Semester

303675	Dissertation 5, Type 1.2	9 credits
303698	Seminar 2 (Non-credit)	1 (0-2-1)
	Total	**9 credits**

3rd Year in Second Semester

303676	Dissertation 6, Type 1.2	9 credits
	Total	**9 credits**

4th Year in First Semester

303677	Dissertation 7, Type 1.2	9 credits
303699	Seminar 3 (Non-credit)	1 (0-2-1)
	Total	**9 credits**

4th Year in Second Semester

303678	Dissertation 8, Type 1.2	9 credits
	Total	**9 credits**

7.2.3) Study Plan in Type 2.1

1st Year in

First Semester

303601	Advanced Mathematics in Electrical Engineering		3 (3-0-6)
303690	Advanced Research Methodology (Non-credit)		3 (3-0-6)
303697	Seminar 1 (Non-credit)		1 (0-2-1)
		Total	**3 credits**

1st Year in

Second Semester

303681	Dissertation 1, Type 2.1		3 credits
3036xx	Elective Course (1)		3 (2-2-5)
3036xx	Elective Course (2)		3 (2-2-5)
		Total	**9 credits**

2nd Year in

First Semester

303698	Seminar 2 (Non-credit)		1 (0-2-1)
303682	Dissertation 2, Type 2.1		6 credits
3036xx	Elective Course (3)		3 (2-2-5)
		Total	**9 credits**

2nd Year in

Second Semester

303683	Dissertation 3, Type 2.1		9 หน่วยกิต
		Total	**9 credits**

3rd Year in

First Semester

303699	Seminar 3 (Non-credit)		1 (0-2-1)
303684	Dissertation 4, Type 2.1		9 credits
		Total	**9 credits**

3rd Year in

Second Semester

303685	Dissertation 5, Type 2.1		9 หน่วยกิต
		Total	**9 credits**

7.2.4) Study Plan in Type 2.2

	1st Year in First Semester		
303601	Advanced Mathematics in Electrical Engineering		3 (3-0-6)
303690	Advanced Research Methodology (Non-credit)		3 (3-0-6)
3036xx	Elective Course (1)		3 (2-2-5)
3036xx	Elective Course (2)		3 (2-2-5)
		Total	**9 credits**
	1st Year in Second Semester		
303602	Data Analysis		3 (2-2-5)
3036xx	Elective Course (3)		3 (2-2-5)
3036xx	Elective Course (4)		3 (2-2-5)
		Total	**9 credits**
	2nd Year in First Semester		
303691	Dissertation 1, Type 2.2		6 credits
303697	Seminar 1 (Non-credit)		1 (0-2-1)
3036xx	Elective Course (5)		3 (2-2-5)
		Total	**9 credits**
	2nd Year in Second Semester		
303692	Dissertation 2, Type 2.2		6 credits
3036xx	Elective Course (6)		3 (2-2-5)
		Total	**9 credits**
	3rd Year in First Semester		
303693	Dissertation 3, Type 2.2		9 credits
303698	Seminar 2 (Non-credit)		1 (0-2-1)
		Total	**9 credits**
	3rd Year in Second Semester		
303694	Dissertation 4, Type 2.2		9 credits
		otal	**9 credits**
	4th Year in First Semester		
303695	Dissertation 5, Type 2.2		9 credits
303699	Seminar 3 (Non-credit)		1 (0-2-1)
		Total	**9 credits**
	4th Year in Second Semester		
303696	Dissertation 6, Type 2.2		9 credits
		Total	**9 credits**

7.3 Course Content

7.3.1 Core Courses

303601 Advanced Mathematics in Electrical Engineering 3 (3-0-6)

Higher-order ordinary differential equations; Nonlinear ODEs; Partial Differential Equations; matrix theory; linear algebra; probability theory; applications of mathematics in electrical engineering.

303602 Data Analysis 3 (2-2-5)

Mathematical tools; optimization theory; smoothing filters; linear and nonlinear regression analysis; cluster analysis; modern spectral analysis techniques; autoregressive system; moving average processes.

7.3.2 Elective Courses

303603 Modern Energy Management System 3 (2-2-5)

Principles of energy management, effective energy management, energy policy, audit planning, strategic planning, energy systems, modern electric energy management, economic analysis, energy system, alternative energy and applications, energy security.

303604 Special Topics in Advanced Electrical Engineering 3 (2-2-5)

Study and discuss topics that are up to date with technological advances in electrical engineering.

303605 Finite Element Method for Electrical Machines 3 (2-2-5)

Principles of finite element method, boundary value problems, electromagnetic problems, two-dimensional analysis, three-dimensional analysis, eigenvalue problems, vector finite elements, ideal electrical machines, model of electrical machines by finite element method.

7.3.2 Elective Courses

303611 Electrical Machine Dynamics 3 (2-2-5)

Mathematical models of DC; synchronous and induction machines; transient phenomena analysis in individual machines; effect of self and mutual inductances in AC machines; applications of numerical and analytical methodologies for electrical machines.

303612 Analysis and Model Synthesis for Photovoltaic Systems 3 (2-2-5)

Configurations of photovoltaic systems; electrical characteristic analysis of photovoltaic system components such as solar array, battery, and power converter in transient and steady states; development of mathematical models for photovoltaic system components; computer-based analysis of photovoltaic system components.

303613 Integration of Distributed Generation and Electric Vehicle in Power System 3 (2-2-5)

Distributed generation technologies; distributed generation and electricity system architectures; impacts of distributed generation on the power system; planning and control operation of power system with integrated distributed generation; protection design; electric vehicles technologies and charging infrastructures; impacts of Grid-to-Vehicle and Vehicle-to-Grid on power grids and integration of renewable sources.

303614 Electrical Machines Design and CAD 3 (2-2-5)

Operating principle of electrical machine; CAD for electrical machine; computational model of electrical machine; two- dimensional electrical machine model; three- dimensional electrical machine model; analysis methodology in CAD for electrical machine.

7.3.2 Elective Courses

303615 Interleaving Technique for DC Power Converters 3 (2-2-5)

Types and operating principles of DC power converters; configuration of DC interleaved converters; control signal generation for interleaved switches; analysis of transient and steady- state characteristics of DC interleaved converters by using state- space averaging technique.

303616 Energy Policy and Planning Project 3 (2-2-5)

Energy planning; policy and economy; government policies; economic analysis; energy project identification and development; cost concepts; cost- benefit analysis; project evaluation and decision making; investment and financing energy projects; case studies.

303617 Methods for Energy Analysis 3 (2-2-5)

Productivity and efficiency analysis; performance benchmarking; regression analysis; econometric models and energy forecast; energy- economy modeling; energy balances; energy input- output analysis; energy- economy wide impact models, relation between economic, environment and society.

303618 Energy Price Theory and Applications 3 (2-2-5)

Theory of consumer; theory of producer; theory of market; price elasticity of demand, production and cost functions; pricing of exhaustible and renewable energy resources; energy resource considerations from energy pricing in their implications; case studies.

7.3.2 Elective Courses

303619 Energy, Environment and Climate Change 3 (2-2-5)

Energy use and the greenhouse effects; greenhouse gases and climate change; technology options for GHG emission mitigation; policy option for GHG emission mitigation; international climate change convections, protocols and perspectives.

303620 Low-dimensional Nanostructures 3 (2-2-5)

Introduction to related nanotechnologies; heterojunction; quantum well structure; quantum wire structure; quantum dot structure; behaviors of electron in low- dimensional structures; tunneling; interactions with electric and magnetic field; related electronic devices, i.e., diode, laser, photodetector and transistor.

303621 Microphotonics and Nanophotonics 3 (2-2-5)

Optical waveguides: two- dimensional and three-dimensional waveguides; interaction between optical waveguides; optical waveguide devices; photonic crystals and photonic band gaps; photonic-crystal fibers; structures and optical properties of quantum nanostructures: quantum wells, quantum wires, quantum dots, and interaction among these structures; their applications in nanoelectronic and nanophotonic devices; coupled quantum nanostructures.

303622 Advanced Biomedical Electronics 3 (2-2-5)

Theory and design of electronic systems for biomedical instrumentation of rehabilitation engineering and assistive technology; literature reviews and projects for biomedical electronics.

7.3.2 Elective Courses

303623 Fabrication Technology of Integrated Circuits 3 (2-2-5)

Integrated circuit fabrication technology, crystal growth, chemical vapor deposition; vapor phase epitaxy; liquid phase epitaxy; molecular beam epitaxy; thermal oxidation; thermal diffusion; ion implantation, metallization, lithography, annealing; assembly and packaging; future technology trends.

303624 Modern Electronic Devices 3 (2-2-5)

Basic crystal structure of solids; quantum mechanics of solids; semiconductor at equilibrium; carrier transportation; excessive carrier in non- equilibrium semiconductor; pn junction; pn junction diode; metal- semiconductor junction; bipolar junction transistor; metal- oxide-semiconductor field effect transistor; optoelectronic integrated circuits; light emitting diode; photodetector; semiconductor laser; solar cells; trends in future developments.

303625 Nanoelectronics 3 (2-2-5)

Introduction to nanotechnology; nanoscale fabrications (photolithography, electron-beam lithography and self-assembly); nanoscale characterizations (e.g. SEM, TEM, AFM); 2D, 1D, and 0D quantum structures; single electron devices; electronic devices from carbon nanotubes and graphene, molecular electronics; DNA chips; quantum dot cellular automata; MEMS/NEMS; spintronics.

7.3.2 Elective Courses

303626 Radio-frequency Circuit Design and CAD 3 (2-2-5)

Transistor parameters and its design of amplifiers at high frequency; matching network; impedance matching with microstrip line and stub; Smith's chart and its use for matching networks and design of amplifiers; bias stability; scattering parameters and its use for oscillator design and stability determining; CAD for radio-frequency circuit design.

303627 Serial Communication Architectures of Electronic Circuits 3 (2-2-5)

Embedded system design in programmable devices; a study of serial communication architectures of electronic circuits such as universal serial bus (USB); controller area network (CAN); serial advanced technology attachment (SATA), and modern communication technology; discussions and presentations for advantages and drawbacks of the interesting serial communication architectures.

303628 Solid-state Physics for Electronic Engineers 3 (2-2-5)

Crystal structures and lattices; dynamics of crystal lattices; lattice vibration and thermal properties of crystals; crystalline defects; elementary quantum mechanics; modern theory of solids; quantum theory of metals; quantum theory of electrons in periodic lattices; semiconductors and their electrical and optical properties; dielectric materials and insulation; magnetism and magnetic resonances; superconductivity; optical properties of materials.

7.3.2 Elective Courses

303629 Quantum Mechanics for Electrical Engineering 3 (2-2-5)

Schroedinger's equation; bound states; wave packets and uncertainty principles; tunneling; scattering by simple barriers; expectation values and operators; angular momentum; hydrogen atom; expansion principle and matrix formulation; perturbation theory.

303631 System Identification and Learning Theory 3 (2-2-5)

Linear time-invariant and time-varying systems models; parameter estimation methods; convergence and consistency; recursive identification methods; model structure selection and model validation; linear discriminants; support vector machines; decision trees; Bayes' classifier; unsupervised learning; dimensionality reduction; least-square optimization.

303632 Iterative Learning Control 3 (2-2-5)

D-type Iterative Learning Control (ILC) for dynamic process; robust optimal design for the first order linear-type ILC; analysis of higher order linear-type ILC; linear and nonlinear ILC design for multiple-input and multiple-output (MIMO) dynamic systems; nonlinear-type ILC scheme; monotonic convergence of ILC; ILC design for iteration-varying model of uncertain system.

303633 Nonlinear Systems and Adaptive Control 3 (2-2-5)

Introduction to nonlinear systems with fundamental properties; phase plane analysis; stability analysis: Lyapunov stability and input-output stability; perturbation theory; analysis of feedback systems; Popov criterion; small gain theorem; basics of differential geometry; feedback linearization; geometric nonlinear control; nonlinear controller design; self-turning control; model-reference adaptive control; adaptive predictive control with its applications.

7.3.2 Elective Courses

303634 Robots and Control 3 (2-2-5)

Overview of robot technology; classification of robots; robot coordinate system and kinematics; dynamics and control of robot; Jacobian matrix relating velocities and static forces; linear and angular acceleration relationships; robot mechanism design; linear and nonlinear control; robot operating system.

303635 Random Processes 3 (2-2-5)

An introduction to the concepts of random variables; functions of random variables and random processes; study of the spectra properties of random processes and of the response of linear systems to random inputs; introduction to linear mean square estimation; applications in signal processing and control system.

303636 Detection and Estimation Theory 3 (2-2-5)

Fundamentals of signal detection and estimation; formulation of maximum likelihood; multidimensional probability theory, signal and noise problems; Kalman filter structure; applications in signal processing and control system.

303637 Smart Grid Technology 3 (2-2-5)

Concept of smart grid; smart grid definition, origin and current status; energy savings and financial management; energy management in buildings and home automation; intelligent monitoring and outage management; smart components for smart grid; advance metering infrastructure (AMI); cyber and physical security system; demand response; energy storage systems and microgrid.

303638 Advanced Image Processing 3 (2-2-5)

Basic techniques of image processing; topics include image formation, digitization, linear shift- invariant processing, feature detection, motion.

7.3.2 Elective Courses

303639 Mixed Signal System Design and Implementation 3 (2-2-5)

The design and implementation of mixed signal systems using programmable devices; study of programmable device architecture; arithmetic circuits; memory and memory interfacing; circuit implementation using JTAG boundary scan; bus system architecture; analogue to digital conversion methods; implementations of real systems by using field-programmable gate array (FPGA), applications in specific integrated circuit (ASIC) or system-on-a-chip (SoC).

303641 Spectral Estimation and Modeling 3 (2-2-5)

Processing and modeling of random discrete-time signals; random time series, autocorrelation and cross-correlation sequences and their generation; filtering of random sequences; Wiener filters; matched filters; modeling assumption errors; one-step predictors; rational modeling of random sequences; parametric and non-parametric spectral estimation.

303642 Radar System Analysis and Design 3 (2-2-5)

Theory and practice of radar systems used for detection, tracking, and location of targets; measurement of range and velocity; pulse compression; design of radar transmitters, receivers, and antennas.

303643 Spread Spectrum Communications 3 (2-2-5)

Study of direct sequence and frequency hopping methods; synchronization; resistance to jamming; low probability of detection; spreading codes and their generation; system performance; rake receivers; code division multiple access (CDMA); cellular CDMA applications.

7.3.2 Elective Courses

303644 Multi-channel Communications 3 (2-2-5)

Techniques in multi-channel communications; multi-input multi-output (MIMO) systems; multi-antenna techniques for transmit and receive diversity; orthogonal frequency division multiplexing (OFDM) including modulation and demodulation, carrier bit loading, multipath mitigation, frequency domain equalization, and peak-to-average power reduction.

303645 Electromagnetic Wave Propagation 3 (2-2-5)

Wave propagation in planarly layered media; wave propagation in circular cylindrically layered media; wave propagation in spherically layered media; wave propagation in periodic structures; wave propagation in anisotropic media; wave propagation in bi-anisotropic media.

303646 Electromagnetic Wave Scattering 3 (2-2-5)

Wave scattering by planar surfaces; wave scattering by circular cylinders; wave scattering by spheres; wave scattering by wedges; wave scattering by periodic rough surfaces; wave scattering by periodic media.

303647 Green's Functions in Electromagnetic Theory 3 (2-2-5)

Sturm-Liouville problems; Green's function in closed form; Green's function in series form; Green's function in integral form; Green's functions for rectangular cross-section waveguides; Green's functions for circular cross-section waveguides; Green's functions in homogeneous media.

7.3.2 Elective Courses

303648 Optical Fiber Communication Systems 3 (2-2-5)

Optical fiber structures; optical transmission properties; signal attenuation in optical fiber; optical transmitters and optical receivers; fiber dispersion; chromatic dispersion; polarization mode dispersion; Nonlinear effects in Fibers; optical fiber communication design; power budget consideration; dispersion management; optical fiber amplifier; Coarse Wavelength Division Multiplexing (CWDM); Dense Wavelength Division Multiplexing (DWDM); optical fiber networks; optical components; optical fiber measurements.

303649 Finite Element Method for Electromagnetics 3 (2-2-5)

Variational principles for electromagnetic problems; eigenvalue problems; vector finite elements; absorbing boundary conditions; finite element-boundary integral methods; finite elements and eigenfunction expansion; finite element analysis in the time domain.

303650 Antenna Analysis and Design 3 (2-2-5)

Integral equations; moment method; traveling wave antennas; broadband antennas; horn antennas; microstrip antennas; reflector antennas; antenna design.

303651 Sensor Networks 3 (2-2-5)

Sensor networks architecture; factors influencing the design of sensor networks; sensor network applications; application layer; transport layer protocols; routing algorithms; medium access control protocols; error control algorithms; physical layer; localization and target detection algorithms; time synchronization algorithms; sensor and actor (actuator) networks.

7.3.2 Elective Courses

303652 Principle of Photonics 3 (2-2-5)

This course introduces photonics, optoelectronics, lasers and fiber-optics. The course begins by analyzing optical propagation, reflection/refraction at interfaces and optics in anisotropic media. Dielectric waveguides and fiber optics are discussed, together with methods of modulating radiation for communications. The course concludes with semiconductor optics: laser diodes, LEDs, photo-detectors and communication systems.

303653 Nonlinear Optics 3 (2-2-5)

Fundamentals for nonlinear optics; models of nonlinear optics response; nonlinear wave equation; quantum theory for nonlinear optics; optical Kerr effect; and applications of nonlinear optics.

303654 Simulation of Communication Systems 3 (2-2-5)

Introduction to simulation; Modeling methodology; Discrete time signals and systems; System modeling; Review of probability and random processes; Monte Carlo simulation and random number generation; Testing of random number generators; Modeling of functional blocks in communication systems; Estimation of parameters and performance measures from simulation; Importance sampling; Variance reduction techniques; Simulation optimization.

303655 Space-Time Coding 3 (2-2-5)

Introduction to coding techniques for multi-input multi-output (MIMO) systems; Space-Time Channel and Signal Models; Capacity of Space-Time Channels; Space-time block codes; Space-time trellis codes; Spatial Multiplexing; Space-Time Co-channel Interference Mitigation; Space-time coding for frequency selective fading channels.

7.3.3 Dissertation

303661 Dissertation 1, Type 1.1 6 credits

Study the elements of thesis, review literature and related research, and determine thesis title.

303662 Dissertation 2, Type 1.1 6 credits

Develop concept paper and prepare the summary of literature and related research synthesis.

303663 Dissertation 3, Type 1.1 9 credits

Develop research instruments and research methodology, and prepare thesis proposal in order to present it to the committee.

303664 Dissertation 4, Type 1.1 9 credits

Collect data and report the progress of the thesis to the thesis advisor.

303665 Dissertation 5, Type 1.1 9 credits

Analyze data and prepare a draft of the thesis.

303666 Dissertation 6, Type 1.1 9 credits

Prepare full-text thesis and research article in order to get published according to the graduation criteria.

303671 Dissertation 1, Type 1.2 9 credits

Study the elements of thesis, review literature and related research, and determine thesis title.

303672 Dissertation 2, Type 1.2 9 credits

Develop concept paper.

303673 Dissertation 3, Type 1.2 9 credits

Prepare the summary of literature and related research synthesis.

303674 Dissertation 4, Type 1.2 9 credits

Develop research instruments and research methodology, and prepare thesis proposal in order to present it to the committee.

7.3.3 Dissertation

303675 Dissertation 5, Type 1.2 9 credits

Collect data and report the progress of the thesis to the thesis advisor.

303676 Dissertation 6, Type 1.2 9 credits

Collect data, analyze data, and report the progress of the thesis to the thesis advisor.

303677 Dissertation 7, Type 1.2 9 credits

Analyze data and prepare a draft of the thesis.

303678 Dissertation 8, Type 1.2 9 credits

Prepare full-text thesis and research article in order to get published according to the graduation criteria.

303681 Dissertation 1, Type 2.1 3 credits

Study the elements of thesis, review literature and related research, and determine thesis title.

303682 Dissertation 2, Type 2.1 6 credits

Develop concept paper and prepare the summary of literature and related research synthesis.

303683 Dissertation 3, Type 2.1 9 credits

Develop research instruments and research methodology, and prepare thesis proposal in order to present it to the committee.

303684 Dissertation 4, Type 2.1 9 credits

Collect data, analyze data, and prepare a draft of the thesis.

303685 Dissertation 5, Type 2.1 9 credits

Prepare full-text thesis and research article in order to get published according to the graduation criteria.

303691 Dissertation 1, Type 2.2 6 credits

Study the elements of thesis, review literature and related research, and determine thesis title.

7.3.3 Dissertation

303692 Dissertation 2, Type 2.2 6 credits

Develop concept paper and prepare the summary of literature and related research synthesis.

303693 Dissertation 3, Type 2.2 9 credits

Develop research instruments and research methodology, and prepare thesis proposal in order to present it to the committee.

303694 Dissertation 4, Type 2.2 9 credits

Collect data and report the progress of the thesis to the thesis advisor.

303695 Dissertation 5, Type 2.2 9 credits

Analyze data and prepare a draft of the thesis.

303696 Dissertation 6, Type 2.2 9 credits

Prepare full-text thesis and research article in order to get published according to the graduation criteria.

7.3.4 Non-credit Required Courses

303690 Advanced Research Methodology 3 (3-0-6)

Essential skills in research including to research question, literature review, research planning, research design, advanced data analysis, research discussion, research presentation, concept paper writing, academic writing, important research ethics and relevant standards.

303697 Seminar 1 1 (0-2-1)

A formal presentation of current topics in electrical engineering and technology with an emphasis on researching, reviewing and criticizing academic articles / research paper, presentation is performed in English.

7.3.4 Non-credit Required Courses

303698 Seminar 2 1 (0-2-1)

Manuscript preparation and practice, editor's perspective towards manuscript revision process, a formal presentation of current review articles unrelated to research dissertation through an emphasis on analysis of previous research articles with both support and against issues, the presenter should analyze and criticize the articles, presentation is performed in English.

303699 Seminar 3 1 (0-2-1)

Practice in editing process for a research publication, a formal presentation of current review articles related to research dissertation through an emphasis on analysis of previous research articles with both support and against issues, the presenter should analyze and criticize the articles, presentation is performed in English.

8. Graduation Conditions:

Accordance with Naresuan University Regulations for Graduate Studies B.E. 2016 and Naresuan University Regulations for Graduate Studies 3rd Addition Edition B.E. 2020. The criteria for graduation are as stated in the 2016 university regulations for graduated studies as described below:

8.1) Curriculum Type 1.1 & 1.2 Under Naresuan University Regulation

8.1.1) Having completed the duration of study as specified by the course

8.1.2) Having registered all courses as required by the course

8.1.3) Having passed the English proficiency test as announced by the University

8.1.4) Having passed the Qualifying Examination

8.1.5) Having purposed the thesis and passed the oral presentation

8.1.6) At least 2 thesis articles or parts of them have been published or, at least, accepted to be published as a full paper in a national/international journal as qualified by Higher Education Commission

8.2) Curriculum Type 2.1 & 2.2 Under Naresuan University Regulation

8.2.1 Having completed the duration of study as specified by the course

8.2.2 Having registered all courses as required by the course

8.2.3 Having passed the English proficiency test as announced by the University

8.2.4 Having registered all courses as required by the course

8.2.5 Having a grade point average of not less than 3.00

8.2.6 Having passed the Qualifying Examination

8.2.7 Having purposed the thesis and passed the oral presentation

8.2.8 Thesis or a part of it has been published or, at least, accepted to be published as a full paper in a national/international journal as qualified by Higher Education Commission

9. Applicants' Qualification:

9.1) Applicants are required to successfully complete a Bachelor's or the equivalent degree with excellence academic results or a Master's / equivalent degree from an institution accredited by Ministry of Education as well as English proficiency test score according to the Naresuan University's Criteria Announcement.

9.2) Applicants must have no records from a court of being imprisoned other than a misdemeanor by carelessness.

9.3) Applicants must never have no records of being expelled from any institution due to a misconduct.

9.4) Applicants must be in good health and have no diseases or conditions that can be obstructive in studying.

9.5) Applicants must possess all qualifications as prescribed by the University.

9.6) The University will consider the applicants through the committee's selection or entrance examination or either process as prescribed by the University. The admission will be announced in advance.

9.7) Applicants, pass the screening process but awaiting the graduation approval, will be allowed to enroll when all required qualification as prescribed by the University are completed.

9.8) Admission criteria of the curriculum are required to have extra qualification as following:

Type 1.1

Applicants have all the qualifications according to Naresuan University regulations regarding graduate education in the 2016, and in cases where the above is not met, it is at the discretion of the lecturer responsible for the curriculum.

Type 1.2

Applicants have at least three years of work experience in a related field, and in cases where the above is not met, it is at the discretion of the lecturer responsible for the curriculum. In addition, applicants have all the qualifications according to Naresuan University regulations regarding graduate education in the 2016

Type 2.1

Applicants have all the qualifications according to Naresuan University regulations regarding graduate education in the 2016, and in cases where the above is not met, it is at the discretion of the lecturer responsible for the curriculum.

Type 2.2

Applicants have all the qualifications according to Naresuan University regulations regarding graduate education in the 2016, and in cases where the above is not met, it is at the discretion of the lecturer responsible for the curriculum.

10. Document Required:

10.1) Certificate of Employment
10.2) Academic Transcript
10.3) Recommend Letters
10.4) State of Purpose
10.5) Health Certificate
10.6) English Proficiency Test

11. Contact:

11.1) In the case that applicants request additional information about the Doctor of Philosophy program in electrical engineering, please contact the three lecturers responsible for the curriculum as follows:

Name: Associate Professor Dr.Suchart Yammen
Address: EE426, Department of Electrical and Computer Engineering, Faculty of Engineering, Naresuan University, Tambon Thapho, Mueang District, Phitsanulok 65000 Thailand
Phone: (+ 66) 055 964 288 **E-mail:** sucharty@nu.ac.th

Name: Associate Professor Dr.Somporn Ruangsinchaiwanicha
Address: EE502, Department of Electrical and Computer Engineering, Faculty of Engineering, Naresuan University, Tambon Thapho, Mueang District, Phitsanulok 65000 Thailand
Phone: (+ 66) 055 964 338 **E-mail:** sompornr@nu.ac.th

Name: Assistant Professor Dr. Piyadanai Pachanapan
Address: EE204, Department of Electrical and Computer Engineering, Faculty of Engineering, Naresuan University, Tambon Thapho, Mueang District, Phitsanulok 65000 Thailand
Phone: (+ 66) 055 964 322 **E-mail:** piyadanip@nu.ac.th

11.2) The program coordinator regarding the curriculum management.

Name: Miss Rungnapa Thuamthaisong
Title: Academic Officer and International Relationship Officer
Address: Graduate Study Unit, Educational Service Section, Office of the Secretary, Faculty of Engineering, Naresuan University, Muang District, Phitsanulok 65000 Thailand
Phone: (+ 66) 055 963 951 **E-mail:** rungnaphat@nu.ac.th
Fax: (+ 66) 055 694 000

Updated Date: *November 1, 2023*