

DEPARTMENT OF ELECTRICAL ENGINEERING

The undergraduate curriculum is designed to provide students with a broad and firm foundation in physical science and electrical engineering, which is essential for an electrical engineering pursuing his/her career as a practitioner or researcher.

Electrical engineering courses begin in the sophomore year with electric circuits, electrical machines and electromagnetic. During the junior year, the students have to study further fundamental subjects related to electrical power, electronics, communications, and control systems. Courses in engineering mathematics are also included in the curriculum to strengthen the students ability in analysis. During the senior year, students can select their specialization by taking subjects from the approved elective list as well as the Electrical Engineering Project.

Laboratory works in various disciplines of electrical engineering are included in the curriculum. The objective of these courses is to develop the students' skills in operating test equipment, resourcefulness in solving practical problems, and ability to analyze test results.

The Department of Electrical Engineering offers two graduate programs leading to the degree of Master of Engineering and the degree of Doctor of Philosophy.

For Master degree, the applicant must hold a Bachelor's Degree either in Electrical Engineering or in related fields of study and must also meet the requirements of the Graduate School.

The program consists of 36 credits, of which 3 are required core courses in applied mathematics, 9 are major requirement, 6 required elective courses in related fields, and 18 are thesis:

The major requirement consists of 11 strategic research areas (SRA) namely:

1. Advanced Control and Optimization
2. Biomedical Engineering
3. Embedded Systems and Robotics
4. High Voltage Engineering
5. Microwave and Lightwave Communications
6. Multimedia and Signal Processing
7. Nanoelectronics and Photonics
8. Power Electronics
9. Power and Energy Systems
10. Telecommunications and Information Networking
11. Smart Grid and Renewable Energy

For Ph.D. Program, the applicant must meet one of the following requirements :

1. The applicant who holds a Bachelor's Degree in Electrical Engineering must obtain the second honor degree or the minimum 3.25 grade point average and must also meet the requirement of the Graduate School.

2. The applicant who holds a Master's Degree in Electrical Engineering must obtain good or excellent in master thesis and must also meet the requirement of the Graduate School.

Moreover, each student has to pass the following requirements in order to achieve his or her study :

1. For the applicant who holds a Master's Degree with more than 3.5 grade point average, must take credits from the seminar and listed elective courses with the approval of the major advisor.

In addition to fulfilling the course requirement, the student is required to submit a thesis of 60 credits, satisfactorily pass an oral examination and one part or more of the thesis has been accepted to be published in international journal.

2. For the applicant who holds a Master's Degree with grade point average less than 3.5, is required to pass at least 12 credits from the listed elective courses with the approval of the major advisor and the seminar courses.

In addition to fulfilling the course requirement, the student is required to submit a thesis of 48 credits, satisfactorily pass an oral examination and one part or more of the thesis has been accepted to be published in international journal.

3. The applicant who holds a Bachelor's degree is required to pass 24 credits from the listed elective and the seminar courses with the approval of the major advisor.

In addition to fulfilling the course requirement, the student is required to submit a thesis of 48 credits, satisfactorily pass an oral examination and one part or more of the thesis has been accepted to be published in international journal.

HEAD :

Komson	Petcharaks,	Dr.Sc. Techn. (Swiss Federal Inst. of Tech Zurich)
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PROFESSORS :

Boonchai	Techaumnat,	D.Eng. (Kyoto)
Bundhit	Eua-arporn,	Ph.D. (London)
David	Banjerdpongchai,	Ph.D. (Stanford)
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Chaodit	Aswakul,	Ph.D. (London)
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Kulyos	Audomvongseree,	D.Eng. (Tokyo)
Lunchakorn	Wuttisittikulij,	Ph.D. (Essex)
Mana	Sriyudthsak,	D.Eng. (Tokyo Tech)
Nisachon	Tangsangiumvisai,	Ph.D. (London)
Prasit	Teekaput,	Ph.D. (VPI & Su)
Somchai	Ratanathammaphan,	D.Eng. (Chula)
Songphol	Kanjanachuchai,	Ph.D. (Cambridge)
Supavadee	Aramvith,	Ph.D. (Washington)
Thavatchai	Tayjanant,	Ph.D. (Alberta)
Watcharapong	Khovidhungij,	Ph.D. (UCLA)
Watit	Benjapolakul,	D.Eng. (Tokyo)

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Arporn	Teeramongkonrasmee,	Ph.D. (Chula)
Chaiyachet	Saivichit,	Ph.D. (London)
Chanachana	Tangwongsan,	Ph.D. (Wisconsin)
Chanin	Wissawinthanon,	Ph.D. (Minnesota)
Charnchai	Pluempitiwiriyaewj,	Ph.D. (Carnegie Mellon)
Cherdkul	Sopavanit,	M.Eng. (Chula)
Jitkomut	Songsiri	Ph.D. (UCLA)
Komson	Petcharaks,	Dr.Sc. Techn. (Swiss Federal Inst. of Tech Zurich)
Manop	Wongsaisuwan,	D.Eng. (Tokyo Tech)
Naebboon	Hoonchareon,	Ph.D. (Purdue)
Pasu	Kaewplang,	Ph.D. (Chula)
Somboon	Sangwongwanich,	D.Eng. (Nagoya)
Sotdhipong	Phichaisawat,	Ph.D. (Brunel, UK)
Suchin	Arunsawatwong,	Ph.D. (Manchester)
Supatana	Auethavekiat	Ph.D. (Tokyo)
Surachai	Chaitusaney	Ph.D. (Tokyo)
Surapong	Suwankawin,	Ph.D. (Chula)
Suree	Pumrin,	Ph.D. (Washington)
Suvit	Nakpeerayuth,	M.Eng. (Chula)
Taptim	Angkaew,	D.Eng. (Osaka)
Wanchalerm	Pora,	Ph.D. (London)
Weerapun	Rungseevijitprapa,	Dr.-Ing. (Hannover)
Widhyakorn	Asdornwised,	D.Eng. (Chula)

**ELECTRICAL ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM
COMMON TO ENGINEERING STUDENTS**

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
THIRD SEMESTER			SIXTH SEMESTER		
2102201	ELECTRICAL ENGINEERING MATHEMATICS I	3	2102308	PROPERTIES OF ELECTRICAL ENGINEERING MATERIALS	3
2102203	PROBABILITY AND STATISTICS FOR ELECTRICAL ENGINEERING	3	2102371	PRINCIPLES OF COMMUNICATIONS AND LABORATORY	3
2102209	ELECTRICAL ENGINEERING ESSENTIALS	3	2102386	ELECTRONIC CIRCUITS AND LABORATORY	4
2102213	CIRCUIT THEORY I AND LABORATORY	4	2102xxxx	COMPULSORY ELECTIVES	6
2103213	ENGINEERING MECHANICS I	3	xxxxxxx	GENERAL EDUCATION III	<u>3</u>
2301207	CALCULUS III	<u>3</u>			19
		19			
FOURTH SEMESTER			SUMMER SEMESTER		
2102202	ELECTRICAL ENGINEERING MATHEMATICS II	3	2100301	ENGINEERING PRACTICE	2
2102214	CIRCUIT THEORY II AND LABORATORY	3			
2102222	ENGINEERING ELEC TROMAGNETICS	3	SEVENTH SEMESTER		
2102253	ELECTRICAL MACHINES I AND LABORATORY	4	2102490	ELECTRICAL ENGINEERING PRE-PROJECT	1
5500208	COMMUNICATION AND PRESENTATION SKILLS	3	2102xxxx	COMPULSORY ELECTIVES	6
xxxxxxx	GENERAL EDUCATION I	<u>3</u>	2102xxxx	COMPULSORY ELECTIVES (LAB)	2
		19	2102xxxx	ELECTIVES	3
			5500308	TECHNICAL WRITING FOR ENGINEERING	<u>3</u>
					15
FIFTH SEMESTER			EIGHTH SEMESTER		
2102311	ELECTRICAL MEASUREMENT AND INSTRUMENTATION	3	2102499	ELECTRICAL ENGINEERING PROJECT	3
2102333	LINEAR CONTROL SYSTEMS I AND LABORATORY	4	xxxxxxx	ELECTIVES	3
2102360	ELECTRICAL POWER SYSTEM I	3	xxxxxxx	GENERAL EDUCATION IV	3
2102385	SEMICONDUCTOR DEVICES I	3	xxxxxxx	FREE ELECTIVES	<u>6</u>
2102387	FUNDAMENTALS OF DIGITAL SYSTEMS AND LABORATORY	3			15
xxxxxxx	GENERAL EDUCATION II	<u>3</u>			
		19			

TOTAL CREDITS FOR GRADUATION = 144

Compulsory Elective/Elective courses

Category	Power	Control	Communications	Electronics
Compulsory Elective (At least 14 credits)	2102356 Electrical Machines II (3) 2102446 Fundamental of Power Electronics (3) 2102458 High Voltage Engineering I (3) 2102459 High Voltage Engineering Laboratory (1) 2102461 Electrical Power Systems II (3) 2102465 Electrical Power Laboratory (1)	2102401 Random Processes for EE (3) 2102432 Linear Control Systems II (3) 2102433 Digital Control Systems (3) 2102435 Industrial Automation (3) 2102436 Control and Instrumentation Laboratory (1)	2102322 Telecommunication Transmission (3) 2102423 Digital Signal Processing (3) 2102425 Data Communications (3) 2102472 Fundamental of Digital Communication (3) 2102473 Communication Engineering Laboratory (1)	2102444 Introduction to Embedded Systems (3) 2102446 Fundamental of Power Electronics (3) 2102447 Electronics Engineering Laboratory (1) 2102488 Semiconductor Devices II (3) 2102489 Principle of Analog Circuit Design (3)
Elective (At least 6 credits)	<i>See the list of Elective courses from form the Electrical Department announcement, in which it can be updated annually.</i>			

Notes

- A student must select 2 fields in the compulsory elective courses from Compulsory Elective category, with a minimum of 2 lecture subjects and one laboratory subject in each selected field.
- The total credits for Compulsory Elective category must be at least 14.
- In case, the student selects 2102401 RANDOM PROCESSES FOR EE and/or 2102446 FUNDAMENTAL of POWER ELECTRONICS, and/or 2102307 SIGNALS AND SYSTEMS he or she can declare them only in one field.
- A student must select courses from Elective category with a total of at least 6 credits.
- The Compulsory Elective/Elective courses can also be selected as free elective course(s).

NAME OF THE DEGREE

: Master of Engineering
: M. Eng.

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Jakapan	Lee,	M.Eng. (Tokyo Tech)
Panuwat	Janpugdee	Ph.D. (Ohio State)

COURSE REQUIREMENTS**1. Required Courses****(1.1) Compulsory Electives in Applied Mathematics**

		3 credits	from
2102502	Random Signals and Systems	3(3-0-9)	
2102504	Introduction to Mathematical Analysis	3(3-0-9)	
2102505	Introduction to Optimization Techniques	3(3-0-9)	
2102506	Finite Element Analysis for Electrical Engineers	3(3-0-9)	
2102507	Computational Techniques For Engineers	3(3-0-9)	
(1.2)	2102790 Electrical Engineering Seminar	2(2-0-6)	

2) Compulsory Electives in Electrical Engineering**Research Area** 9 credits from**- Advanced Control and Optimization**

2102531	System Identification	3(3-0-9)
2102536	Nonlinear Control Systems I	3(3-0-9)
2102631	Optimal Control Systems	3(3-0-9)
2102635	Control System Theory	3(3-0-9)
2102637	Multivariable Control Systems	3(3-0-9)
2102638	Nonlinear Control Systems II	3(3-0-9)
2102731	Infinite-Dimensional Control Systems	3(3-0-9)
2102732	Convex Optimization and Engineering Applications	3(3-0-9)

- Biomedical Engineering

2102523	Statistical Signal Processing in Biomedical Engineering	3(3-0-9)
2102547	Cognitive Engineering	3(3-0-9)
2102585	Biomaterial Science	3(3-0-9)
2102588	Biomedical Electronics	3(3-0-9)
2102611	Medical Instrumentation	3(3-0-9)
2102668	Biosensors	3(3-0-9)
2102675	Pattern Recognition	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)
2102785	Advanced Sensor Theory	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)

- Embedded Systems and Robotics

2102540	Microcomputer Systems	3(3-0-9)
2102544	Advanced Embedded Systems	3(3-0-9)
2102545	Digital Integrated Circuits	3(3-0-9)
2102546	Analog Integrated Circuits	3(3-0-9)
2102581	Digital Circuit Design	3(3-0-9)
2102642	Computer Vision and Video Electronics	3(3-0-9)
2102645	Embedded System Design	3(3-0-9)

- High Voltage Engineering		
2102553	Fundamentals of Electromagnetic Compatibility	3(3-0-9)
2102558	Insulation Coordination	3(3-0-9)
2102650	Electrical Transients in Power Systems	3(3-0-9)
2102656	Power System Protection	3(3-0-9)
2102754	Electric Field Analysis in High Voltage Engineering	3(3-0-9)
2102755	Power System Electromagnetic Transient Simulation	3(3-0-9)

- Microwave and Lightwave Communications		
2102520	Optical Fiber Transmissions and Networks	3(3-0-9)
2102521	Access Networks	3(3-0-9)
2102620	Electromagnetic Theory	3(3-0-9)
2102623	Antenna and Radar Systems	3(3-0-9)
2102625	Computational Electromagnetics for Microwave and Photonics	3(3-0-9)
2102674	Optical Communication	3(3-0-9)

- Multimedia and Signal Processing		
2102571	Multimedia Communication	3(3-0-9)
2102574	Information Theory	3(3-0-9)
2102605	Fourier Transforms and its Applications	3(3-0-9)
2102675	Pattern Recognition	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)
2102874	Speech Processing	3(3-0-9)
2102875	Digital Video Processing	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)

- Nanoelectronics and Photonics		
2102549	Semiconductor Fabrication Technology	3(3-0-9)
2102582	Photonic Devices in Optical Communication Systems	3(3-0-9)
2102583	Introduction to Quantum Mechanics	3(3-0-9)
2102584	Introduction to Nanoelectronics	3(3-0-9)
2102589	Laser Engineering	3(3-0-9)
2102663	Solar Cell Technology	3(3-0-9)
2102680	Semiconductor Lasers	3(3-0-9)
2102682	Solid-State Physics for Electronics Engineers	3(3-0-9)
2102684	Guided-Wave Optics and Nanophotonics	3(3-0-9)

- Power Electronics		
2102543	Advanced Electric Motor Drives	3(3-0-9)
2102548	Switched-Mode Electrical Power Processing I	3(3-0-9)
2102601	Power and Energy Technologies in Smart Grids	3(3-0-9)
2102686	Switched-Mode Electrical Power Processing II	3(3-0-9)

- Power and Energy Systems		
2102550	Power Electronics in Electrical Power Systems	3(3-0-9)
2102551	Computational Methods for Power System Analysis and Design	3(3-0-9)

2102552	Introduction to Distributed Generation	3(3-0-9)
2102554	Power System Harmonics	3(3-0-9)
2102555	Fundamentals of Power Quality	3(3-0-9)
2102556	Power System Economics	3(3-0-9)
2102601	Power and Energy Technologies in Smart Grids	3(3-0-9)
2102651	Power System Stability	3(3-0-9)
2102656	Power System Protection	3(3-0-9)
2102757	Power System Reliability	3(3-0-9)

- Telecommunications and Information Networking		
2102525	Internet and Network Security	3(3-0-9)
2102577	Telecommunication Network	3(3-0-9)
2102578	Satellite Communications	3(3-0-9)
2102602	Information and Communication Technologies in Smart Grids	3(3-0-9)
2102627	Reliability and Survivability of Communication Networks and Systems	3(3-0-9)
2102628	Graph Theory and Combinatorial Optimization	3(3-0-9)
2102629	Traffic Engineering and Queuing Theory	3(3-0-9)
2102674	Optical Communication	3(3-0-9)
2102677	Broadband Network and Design	3(3-0-9)
2102770	Wireless Communications and Networking	3(3-0-9)
2102774	Telecommunications Switching, Transmission and Signaling	3(3-0-9)

- Smart Grids and Renewable Energy
Select 9 credits from the list of Compulsory Electives in Electrical Engineering Research Areas or Elective Courses as given in the curriculum which are relevant to Smart Grids.

3) Elective Courses		6 credits
2102598	Special Problems in Electrical Engineering I	3(3-0-9)
2102697	Special Problems in Electrical Engineering II	3(3-0-9)

Select 6 credits from the list of Compulsory Electives in Applied Mathematics or Compulsory Electives in Electrical Engineering Research Areas or Elective Courses as given in the curriculum.

- Smart Grids and Renewable Energy		6 credits
2102601	Power and Energy Technologies in Smart Grids	3(3-0-9)
2102602	Information and Communication Technologies in Smart Grids	3(3-0-9)

4) THESIS			
2102813	THESIS	18	credits
2102816	THESIS	36	credits

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

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COURSE REQUIREMENTS**1) Required Courses**

2102791	Electrical Engineering Seminar I	2(2-0-6)
2102792	Electrical Engineering Seminar II	2(2-0-6)
2102793	Electrical Engineering Seminar III	2(2-0-6)
2102794	Electrical Engineering Seminar IV	2(2-0-6)

2) Compulsory Electives in Applied Mathematics

		3 credits	from
2102502	Random Signals and Systems		3(3-0-9)
2102504	Introduction to Mathematical Analysis		3(3-0-9)
2102505	Introduction to Optimization Techniques		3(3-0-9)
2102506	Finite Element Analysis for Electrical Engineers		3(3-0-9)
2102507	Computational Techniques for Engineers		3(3-0-9)

3) Compulsory Electives in Electrical Engineering Research Area

		9 credits	from
	- Advanced Control and Optimization		
2102531	System Identification		3(3-0-9)
2102536	Nonlinear Control Systems I		3(3-0-9)
2102631	Optimal Control Systems		3(3-0-9)
2102635	Control System Theory		3(3-0-9)
2102637	Multivariable Control Systems		3(3-0-9)
2102638	Nonlinear Control Systems II		3(3-0-9)
2102731	Infinite-Dimensional Control Systems		3(3-0-9)
2102732	Convex Optimization and Engineering Applications		3(3-0-9)

- Biomedical Engineering

2102523	Statistical Signal Processing in Biomedical Engineering		3(3-0-9)
2102547	Cognitive Engineering		3(3-0-9)
2102585	Biomaterial Science		3(3-0-9)
2102588	Biomedical Electronics		3(3-0-9)
2102611	Medical Instrumentation		3(3-0-9)
2102668	Biosensors		3(3-0-9)
2102675	Pattern Recognition		3(3-0-9)
2102676	Digital Image Processing		3(3-0-9)
2102785	Advanced Sensor Theory		3(3-0-9)
2102876	Adaptive Signal Processing		3(3-0-9)

- Embedded Systems and Robotics

2102540	Microcomputer Systems		3(3-0-9)
2102544	Advanced Embedded Systems		3(3-0-9)
2102545	Digital Integrated Circuits		3(3-0-9)
2102546	Analog Integrated Circuits		3(3-0-9)
2102581	Digital Circuit Design		3(3-0-9)
2102642	Computer Vision and Video Electronics		3(3-0-9)
2102645	Embedded System Design		3(3-0-9)

- High Voltage Engineering

2102553	Fundamentals of Electromagnetic Compatibility		3(3-0-9)
2102558	Insulation Coordination		3(3-0-9)

2102650	Electrical Transients in Power Systems	3(3-0-9)
2102656	Power System Protection	3(3-0-9)
2102754	Electric Field Analysis in High Voltage Engineering	3(3-0-9)
2102755	Power System Electromagnetic Transient Simulation	3(3-0-9)

- Microwave and Lightwave Communications

2102520	Optical Fiber Transmissions and Networks	3(3-0-9)
2102521	Access Networks	3(3-0-9)
2102620	Electromagnetic Theory	3(3-0-9)
2102623	Antenna and Radar Systems	3(3-0-9)
2102625	Computational Electromagnetics for Microwave and Photonics	3(3-0-9)
2102674	Optical Communication	3(3-0-9)

- Multimedia and Signal Processing

2102571	Multimedia Communication	3(3-0-9)
2102574	Information Theory	3(3-0-9)
2102605	Fourier Transforms and its Applications	3(3-0-9)
2102675	Pattern Recognition	3(3-0-9)
2102676	Digital Image Processing	3(3-0-9)
2102874	Speech Processing	3(3-0-9)
2102875	Digital Video Processing	3(3-0-9)
2102876	Adaptive Signal Processing	3(3-0-9)

- Nanoelectronics and Photonics

2102549	Semiconductor Fabrication Technology	3(3-0-9)
2102582	Photonic Devices in Optical Communication Systems	3(3-0-9)
2102583	Introduction to Quantum Mechanics	3(3-0-9)
2102584	Introduction to Nanoelectronics	3(3-0-9)
2102589	Laser Engineering	3(3-0-9)
2102663	Solar Cell Technology	3(3-0-9)
2102680	Semiconductor Lasers	3(3-0-9)
2102682	Solid-State Physics for Electronics Engineers	3(3-0-9)
2102684	Guided-Wave Optics and Nanophotonics	3(3-0-9)

- Power Electronics

2102543	Advanced Electric Motor Drives	3(3-0-9)
2102548	Switched-Mode Electrical Power Processing I	3(3-0-9)
2102601	Power and Energy Technologies in Smart Grids	3(3-0-9)
2102686	Switched-Mode Electrical Power Processing II	3(3-0-9)

- Power and Energy Systems

2102550	Power Electronics in Electrical Power Systems	3(3-0-9)
2102551	Computational Methods for Power System Analysis and Design	3(3-0-9)
2102552	Introduction to Distributed Generation	3(3-0-9)
2102555	Fundamentals of Power Quality	3(3-0-9)
2102556	Power System Economics	3(3-0-9)

2102601	Power and Energy Technologies in Smart Grids	3(3-0-9)
2102651	Power System Stability	3(3-0-9)
2102656	Power System Protection	3(3-0-9)
2102757	Power System Reliability	3(3-0-9)

- Telecommunications and Information Networking

2102525	Internet and Network Security	3(3-0-9)
2102577	Telecommunication Network	3(3-0-9)
2102578	Satellite Communications	3(3-0-9)
2102602	Information and Communication Technologies in Smart Grids	3(3-0-9)
2102627	Reliability and Survivability of Communication Networks and Systems	3(3-0-9)
2102628	Graph Theory and Combinatorial Optimization	3(3-0-9)
2102629	Traffic Engineering and Queuing Theory	3(3-0-9)
2102674	Optical Communication	3(3-0-9)
2102677	Broadband Network and Design	3(3-0-9)
2102770	Wireless Communications and Networking	3(3-0-9)
2102774	Telecommunications Switching, Transmission and Signaling	3(3-0-9)

- Smart Grids and Renewable Energy

Select 9 credits from the list of Compulsory Electives in Electrical Engineering Research Areas or Elective Courses as given in the curriculum.

**4) Elective Courses 12 credits
Select from any 21026xx, 21027xx and 2108xx in item 3), and the following course**

2102697	Special Problems in Electrical Engineering II	3(3-0-9)
2102796	Advanced Topics in Electrical Engineering I	3(3-0-9)
2102797	Advanced Topics in Electrical Engineering II	3(3-0-9)

- Smart Grids and Renewable Energy

2102601	Power and Energy Technologies in Smart Grids	3(3-0-9)	6 credits
2102602	Information and Communication Technologies in Smart Grids	3(3-0-9)	

5) Dissertation

2102828	Dissertation	48	credits
2102829	Dissertation	60	credits
2102830	Dissertation	72	credits
2102894	Doctoral Dissertation Seminar	S/U	
2102897	Qualifying Examination	S/U	

**COURSES DESCRIPTIONS IN ELECTRICAL ENGINEERING
(B.ENG.)**

**2102201 Electrical Engineering
Mathematics I 3(3-0-6)**

Condition : Prerequisite 2301108

First-order and higher-order ordinary differential equations; series solutions of ordinary differential equations; Fourier series; Fourier integral and transform; Laplace transform; partial fraction expansion; partial differential equations; boundary-value problem; applications in Electrical Engineering.

**2102202 Electrical Engineering
Mathematics II 3(3-0-6)**

Condition : Prerequisite 2301108

Systems of linear equations; elementary row operations; rank; matrix algebra; inverse of a matrix; LU factorization; determinants; vector spaces and subspaces; bases and dimensions; linear transformation and matrix representation; coordinate vectors; change of basis; eigenvalues and eigenvectors; diagonalization and similarity transformation; functions of a square matrix; Cayley-Hamilton theorem; infinite series, matrix exponentials; applications to differential equations; functions of a complex variable; analytic functions and derivatives; elementary functions; integration in the complex plane; Cauchy's integral theorem; Taylor and Laurent series; residue theorem and applications; conformal mapping.

**2102203 Probability and Statistics for
Electrical Engineering 3(3-0-6)**

Condition : Prerequisite 2301108

Elements of probability: axioms of probability, conditional probability, independent events, Bayes' theorem. random variables: discrete and continuous random variables, probability functions, function of r.v., expectation, variance, covariance, moments, moment generating functions, Markov's and Chebyshev's inequalities, the weak law of large numbers. special random variables: Bernoulli, binomial, multinomial, geometric, Poisson, hypergeometric, negative binomial, uniform, normal (Gaussian), exponential, gamma, chi-square, t, F. sampling: sample mean, sample variance, histogram, sampling distributions from a normal population. Parameter estimation: method of moments, maximum likelihood method, confidence interval, bias, mean square error. hypothesis testing: types and probability of error, tests concerning mean and variance of normal populations.

2102209 Electrical Engineering Essentials 3(3-0-6)

Basic knowledge and understanding of present trends of electrical engineering technology in various fields, i.e., electrical power, electronics, control, and communication, based on which the students can grasp the whole picture of electrical engineering. The course is composed of lectures, hands-on laboratories in basic applications and MATLAB, and study trip. The lectures will be given by the Department staffs and invited experts from the industries, and will cover the topics ranging from basic researches to state-of-the-art technologies of each field.

2102213 Circuit Theory I and Laboratory 4(3-3-6)

DC concepts; Ohm's law; Kirchhoff's laws; circuit components; passive sign convention; periodic functions; sinusoidal steady state; phasor representations; impedances and admittances; node and mesh analysis; superposition theorem; source transformation; Thevenin and Norton theorem; maximum power transfer; phasor diagram; AC power analysis; polyphase circuits; laboratories on electrical circuits and measuring equipments.

2102214 Circuit Theory II and Laboratory 3(3-1-5)

Condition : Prerequisite 2102213 Corequisite 2102201

Transient and steady-state responses: first-Order and second-order circuits, step response, zero-input and zero-state responses; Laplace transform analysis for circuit and transfer function applications: transient and steady-state responses, network and systems, frequency response, bode plots, resonant circuit; principles of basic filtering: low-pass filter, band-pass filter and high-pass filter, two-port networks: basic two-port parameters; interconnected two-port networks; hands-on activities for some relevant contents.

2102222 Engineering Electromagnetics 3(3-0-6)

Condition: Prerequisite 2301207

Vector analysis; electrostatic fields in free space; electrostatic fields in dielectrics and conductors; Laplace equation and simple solution method; energy in electrostatic fields; convection current and conduction currents; magnetostatic fields; magnetic forces; energy in magnetostatic fields; electromagnetic induction and Maxwell's equations; time-harmonic electromagnetic fields and their phasors; plane waves in an unbounded medium; free-space, dielectric and conductor; electromagnetic power transmission, Poynting's theorem.

2102253 Electrical Machines I and Laboratory 4(3-3-6)

Condition: Prerequisite 2102213

Basic principles of electromechanical energy conversion: electromagnetic forces, Faraday's law, Ampere's law, Gauss's law, magnetic materials, magnetic circuits; dc machine constructions; steady-state analysis, characteristics, and testing of dc generators and dc motors; construction and characteristics of transformers; fundamentals of ac machines; ac machine constructions; rotating magnetic fields; steady-state analysis, characteristics, and testing of synchronous generators and induction motors; hands-on activities and experimental topics related with the lecture.

2102307 Signals and Systems 3(3-0-6)

Condition: Prerequisite 2102202, 2102214

Classification of signals and systems; linear time-invariant (LTI) systems; time domain and frequency domain models of the continuous linear time-invariant (LTI) systems; convolution integral and impulse response; Fourier series and Fourier transforms; Bode plot of signals and LTI systems; Laplace transforms; analysis of LTI systems using Laplace transforms; applications to circuit analysis, feedback control, and communications.

2102308 Properties of Electrical Engineering Materials 3(3-0-6)

Structure of materials; electrical properties of materials; magnetic properties of materials; electrical conductors; introduction to semiconductor devices; superconductivity; solid, liquid and gas dielectrics; applications of materials in electrical power.

2102311 Electrical Measurements and Instrumentation 3(3-0-6)

Condition: Prerequisite 2102213

Units and standard of electrical measurement; instrument classification and characteristics; measurement analysis; measurement of DC and AC current and voltage using analog and digital instruments; power, power factor and energy measurement; measurement of resistance, inductance, capacitance; frequency and period/time-interval measurement; noises; transducers; calibration.

2102322 Telecommunication Transmission 3(3-0-6)

Condition: Prerequisite 2102222

Wire and wireless communication; wire communication network; Z, Y, S, ABCD matrices; connection and basic circuits, network transformation, transmission quantities, signal transmission circuit techniques, wave filters, attenuator, impedance matching, transmission line theory, equation, solution for low, medium, high frequencies, primary and secondary constant; incident and reflected waves, standing wave ratio, line characteristics for open, short, terminated load, lossless and lossy lines; reflections in time domain, bounce diagrams, near-end and far-end crosstalk, differential signaling, composite line, types of cable and unshielded twisted pair, coaxial cable; current cable standards.

2102333 Linear Control Systems I and Laboratory 4(3-3-6)

Condition: Prerequisite 2102202, Corequisite 2102214 for EE students Prerequisite 2310312, 2102391 for non-EE students

Open-loop and closed-loop control systems; mathematical models of physical systems; linearization; block diagrams; signal flow graphs; basic control actions and compensations; time-domain responses; Routh-Hurwitz stability test; control system design by the root locus method; Bode and Nyquist plots; Nyquist stability criterion; control system design by frequency response method. computer simulation and experiment of control system design.

2102356 Electrical Machines II 3(3-0-6)

Condition: Prerequisite 2102253

Magnetic energy and coenergy; forces and torques in electromagnetic systems; starting and speed control methods of dc motors; structure and connection of three-phase transformers; parallel connection of transformers; characteristics of salient-pole synchronous generators; parallel operation of synchronous generators; characteristics and starting methods of synchronous motors; speed control of induction motors; characteristic of single-phase induction motors.

2102360 Electrical Power Systems I 3(3-0-6)

Condition: Prerequisite 2102213

Introduction to power systems; sources of electric energy; power system structure; load characteristics; basic power system calculation; electric power plants; transmission line parameters; transmission line model and performance analysis; power transformer model and per-unit system; electrical power distribution system; power system equipment.

2102371 Principles of Communications and Laboratory 3(3-1-5)

Condition: Prerequisite 2102203 or Consent of Faculty

Communication models, wire/cable and wireless/radio; an overview of signals, linear systems and Fourier transform; analog modulation; random process and noise in communication systems; digital baseband transmission and power spectrum analysis; Nyquist's sampling theorem and quantization; pulse code modulation, delta modulation and time division multiplexing; introduction to digital modulation and information theory; introduction to communication systems (transmission lines, radio wave propagation, microwave components and communication, satellite communications, optical communication).

2102385 Semiconductor Devices I 3(3-0-6)

Crystal properties and growth of semiconductors; atoms and electrons; energy band and charge carriers in semiconductors; excess carriers in semiconductors; junctions; field-effect transistors; bipolar junction transistors; optoelectronic devices; power devices.

2102386 Electronic Circuits and Laboratory 4(3-3-6)

Condition: Prerequisite 2102213

Semiconductor devices; current-voltage and frequency characteristics; analysis and design of diode circuits; analysis and design of BJT, MOS, CMOS and BiCMOS transistor circuits, operational amplifier and its applications, power supply module; experimental topics relate to semiconductor devices, transistor amplifiers, frequency response, operational amplifier and its applications.

2102387 Fundamentals to Digital Circuits 3(3-1-5)

Number systems and codes; Boolean algebra; minterms and maxterms; sum-of-products and product-of-sums; Karnaugh maps; two-level and

multi-level gate circuits; medium-scale combinational circuits: multiplexer, encoder, and decoder; combinational circuit design; sequential circuits: latch, flip-flop; register, and counter; analysis of clocked sequential circuits: Moore and Mealy machines; circuits for arithmetic operations: adder, subtractor, and multiplier; MOS and CMOS logic; VHDL for digital system design; logic simulation and FPGA programming.

2102391 Electrical Engineering I 3(3-0-6)
Condition : Prerequisite 2304104 or 2304108

DC circuit analysis; ac single-phase and three-phase circuit analysis; Kirchhoff's laws; complex power; basic principles, efficiency and connections of transformers; characteristics, operation, speed control and applications of dc motors, single-phase and three-phase induction motors; introduction to low-voltage electrical system design and protection.

2102392 Electrical Engineering Laboratory I 1(0-3-0)
Condition : Corequisite 2102391

A laboratory work on electric circuits and machines: dc and ac circuits; three-phase circuits; transformers; dc generators; dc motors; induction motors.

2102401 Random Processes for Electrical Engineering 3(3-0-6)
Condition: Prerequisite 2102203

Basic concepts of probability theory; random variables; stochastic processes; mean, covariances, and correlations; stationary random processes; analysis of random signals; power spectral density; response of linear systems to random signals; amplitude modulation by random signals; optimum linear estimators.

2102420 Principles of Antennas 3(3-0-6)
Condition : Prerequisite 2102222

Basic definition and theory; isotropic point source; power and field patterns; directivity and gain; efficiency, polarization; input impedance and bandwidth; Friis transmission equation, radiation from current elements; ground effects; radiation properties of wire and loop antennas; array antenna; Yagi-Uda antenna and log-periodic antenna; aperture antenna; microstrip antenna; modern antenna for current applications; antenna characteristics measurement.

2102421 Principles of Microwave Engineering 3(3-0-6)
Condition : Prerequisite 2102222

Review of Maxwell's equations, plane waves; microwave transmission lines and waveguides; microwave network analysis; impedance and equivalent voltage and current; the s-matrix; signal flow graphs, impedance matching and tuning, microwave resonators; power dividers and directional couplers; microwave filters; point-to-point microwave link; radar system; microwave propagation; basic of microwave measurement; microwave biological effects and safety.

2102422 Principles of Telecommunication 3(3-0-6)
Condition: Prerequisite 2102371 or Consent

of faculty

Introduction to telecommunications; layered communication architectures; transmission medium: wired and wireless; data link layer protocols: flow control and error control; medium access control; circuit switching and packet switching; throughput and delay performance analysis of communication link; introduction to network topology, flows and graph theory; routing principles in circuit-switched and packet-switched networks; introduction to queuing theory and basic simulation techniques; Overviews of cellular mobile phone networks, optical networks, Internet and satellite systems.

2102423 Digital Signal Processing 3(3-0-6)

Continuous-time and discrete-time signals, spectral analysis; decimation and interpolation; sampling rate conversion; discrete-Fourier transform (DFT) and fast Fourier transform (FFT); probabilistic methods in DSP; design of FIR, IIR digital filters, multirate systems and filter banks; discrete wavelet transform; introduction to some DSP applications such as image processing, speech and audio processing, array processing.

2102425 Data Communications 3(3-0-6)

Introduction to data communications and networks; layered protocols and network architectures; basics of data transmission (characteristics of transmission media, modulation, multiplexing); data link protocols (error detection, error correction, data link control protocols); point-to-point protocols at network layer (routing, flow control, error recovery); delay models in data networks; multi-access communications (Aloha, CSMA, multi-access reservations); network security; cloud network, architecture and system.

2102426 Traffic Engineering in Communication Networks 3(3-0-6)

Traffic engineering overview; traffic characteristics; performance evaluation by computer simulation; introduction to traffic models in non-queuing/queuing systems; application of traffic engineering in communication networks.

2102427 Multimedia Compression Technology 3(3-0-6)

Introduction to multimedia compression technology; statistical methods: Huffman coding, facsimile compression, arithmetic coding; dictionary methods; image compression methods; wavelet methods; video compression methods; audio compression methods.

2102428 Introduction to Image Processing 3(3-0-6)

Fundamentals of image processing; image enhancement and restoration; image segmentation; line and edge detection; morphology; image representations; chain code; boundary and area descriptors; pyramid and multiresolution image representations.

2102432 Linear Control Systems II 3(3-0-6)

Condition: Prerequisite 2102333
 State-space representation of dynamic systems; mathematical modeling of complex engineering systems;

autonomous linear dynamical systems; stability analysis; linear dynamical systems with inputs and outputs; controllability and state transfer; observability and state estimation; state feedback and linear quadratic regulator; observer design; observer-based controller; case study emphasizing computer-aided analysis and design.

2102433 Digital Control Systems 3(3-0-6)

Condition: Prerequisite 2102333

Introduction to digital control; linear discrete-time system analysis; sampled-data systems; discrete equivalents to continuous transfer functions; design of digital control systems using transform techniques; design of digital control systems using state-space methods: pole placement design, estimator design; quantization effects.

2102435 Industrial Automation 3(3-0-6)

Condition : Prerequisite 2102333, 2102386

Thermal sensors; mechanical sensors; optical sensors; signal conditioning; final control elements; programmable logic control (PLC); distributed control system (DCS); communication modules; human machine interface (HMI); alarm management systems; selected applications to factory automation and process automation.

2102436 Control and Instrumentation Laboratory 1(0-3-0)

Experimental topics related to control systems and instrumentation.

2102444 Introduction to Embedded Systems 3(3-0-6)

Condition : Prerequisite 2102387 or Consent of faculty

Embedded system architecture; microprocessor/microcontroller; memory; I/O and peripherals; embedded C programming; interrupt; DMA and embedded system networks.

2102446 Fundamentals of Power Electronics 3(3-0-9)

Condition : Prerequisite 2102213

Basic principles of power electronics for electrical power processing and control; basic power converters: AC-to-DC converter, DC-to-DC converter, AC-to-AC converter, DC-to-AC converter and their operations; basic characteristics of semiconductor power devices: diodes, transistors and thyristors.

2102447 Electronic Engineering Laboratory 1(0-3-0)

Condition: Prerequisite 2102213

Experimental topics related to analog and digital electronic circuits

2102456 Electrical System Design 3(3-0-6)

Basic design concepts; codes and standards; power distribution schemes; electrical wires and cables; raceways; electrical equipment and apparatus; load calculation; power factor improvement and capacitor bank circuit design; lighting and appliances circuit design;

motor circuit design; load, feeder, and main schedule; emergency power systems; short circuit calculation; grounding systems for electrical installation.

2102457 Fundamentals of Light and Lighting 3(3-0-6)

Condition: Consent of faculty

Light, eyes, vision; definition and terminology in light and lighting; light sources, luminaries and control gears; measurement of lights; principle of lighting calculation; lighting quality and energy efficiency; basic lighting design and simulation.

2102458 High Voltage Engineering I 3(3-0-6)

Condition: Consent of faculty

Uses of high voltage and overvoltage in power systems; generation of high voltage for testing; high voltage measurement techniques; electric field stress and insulation techniques, breakdown of gas; liquid and solid dielectric; high voltage testing techniques; lightning and protection; insulation coordination.

2102459 High Voltage Engineering Laboratory I 1(0-3-0)

Condition : Prerequisite 2102458

A laboratory work on high voltage engineering: generation of dc and ac high voltages and impulse voltages; measurement of electric field dielectric losses; breakdown characteristics, partial discharges; electrical tests of insulators; RIV test of insulators; BIL test on transformers; sparkover test on lightning arresters; behavior of air gaps under dc, ac and impulse voltages; characteristics of impulse voltage dividers; protective devices; grounding resistance measurement.

2102461 Electrical Power Systems II 3(3-0-6)

Condition : Prerequisite 2102360

Power system modeling; network equations; load flow analysis; economic operation of power systems; symmetrical faults; symmetrical components; unsymmetrical faults; protective devices and power system protection; power system stability.

2102463 Electrical Power System Protection 3(3-0-6)

Condition : Prerequisite 2102360

Introduction and philosophies of power system protection; instrument transformer; protective relays; non-directional and directional overcurrent and earth fault protection; differential protection; protection of transmission line, power transformers, generators, motors, buses, reactors and shunt capacitors.

2102464 Fundamentals of Electric Motor Drives 3(3-0-6)

Condition: Prerequisite 2102253

Electric drive components; load characteristics; operating region of drives; braking methods of motors; calculation of motor ratings for various loads; control circuits and control methods of dc motors; control circuits and control methods of ac motors; servo drive systems; applications of electric drives.

2102465 Electrical Power Laboratory 1(0-3-0)

Experimental topics related to power systems and electrical machines.

2102472 Fundamental of Digital Communication 3(3-0-6)

Condition: Prerequisite 2102371 or Consent of Faculty

Signals and Spectra; random signals and power spectral density; review of sampling theorem; probability and random processes; baseband and bandpass transmission; baseband digital modulation and pulse shaping; bandpass digital modulation; detection theory; coherent and non-coherent receiver; performance analysis: bit and symbol error rate; channel equalization; time synchronization; multipath fading channels; spread spectrum techniques; multichannel and multicarrier systems; introduction to information theory; source coding, channel coding.

2102473 Communication Engineering Laboratory 1(0-3-0)

Hands-on laboratory in three major areas related to communication engineering, namely, telecommunications, electromagnetic waves and digital signal processing.

2102474 Communication System Design 3(3-0-6)

Condition : Prerequisite 2102422

Trends of telecommunication; wiring (twisted pair, coaxial, optical fiber and standard interfaces such as RS-232); switching, PABX and call center; architectures, characteristics and standards of local area network (LAN); metropolitan area network (MAN) and wide area network (WAN); intelligent buildings; Internet and intranet; cable and security management; design of intelligent buildings; design of MAN and WAN; economic consideration; traffic and future planning for expansion; applications and case studies.

2102479 Optical Fiber Communication 3(3-0-6)

Condition : Prerequisite 2102322

Overview of optical fiber communications; wave guiding in optical fibers, mode theory for dielectric circular waveguides; signal distortion in optical fibers due to loss and dispersion; optical sources, laser diodes; modulation techniques; photodetector, optical receiver operation; digital transmission systems, power budget analysis; dispersion management; optical fiber amplifiers; principle and components in WDM systems; introduction to FTTH.

2102488 Semiconductor Devices II 3(3-0-6)

Condition : Prerequisite 2102385

Review of physics and properties of semiconductors; compound semiconductors; metal-semiconductor junctions; heterojunctions; MESFET; heterojunction transistors (HEMT and HBT); microwave devices; introduction to quantum and nano-electronic devices.

2102489 Principles of Analog Circuit Design 3(3-0-6)

Condition : Prerequisite 2102386

Transistor fabrication in integrated circuits; transistor modeling in integrated circuits; passive devices in integrated circuits; one- and two-transistor amplifiers; differential amplifiers; current sources and active loads; voltage and current references; output stages; operational amplifier analysis; frequency response; feedback, stability, and compensation; basic operational amplifier design; basic communication circuits; commercial analog circuits; applications of analog circuits.

2102490 Electrical Engineering Pre-Project 1(0-2-1)

Condition : Consent of Faculty

Problem framework; guidelines for problem solving and solution of an electrical engineering project.

2102499 Electrical Engineering Project 3(0-6-3)

Condition : Consent of Faculty

Practical and interesting projects or problems in various fields of electrical engineering: power, electronics, control systems and communications.

COURSE DESCRIPTIONS IN ELECTRICAL ENGINEERING (M.Eng., Ph.D.)

2102502 Random Signals and Systems 3(3-0-9)

Statistical independence and conditional probability; Hilbert space of 2^{nd} -order random variables; conditional mean and covariance of multidimensional Gaussian distribution; Bayesian estimator; stationary discrete-time random signals; discrete-time linear systems with random signals input-output relation; rational spectral densities factorization; continuous-time stationary Gaussian processes and spectral factorization; ergodic processes; Hilbert space of square integrable functions on a time interval; Karhunen-Loeve vs. Fourier series expansion of random signals; discrete-time Kalman filtering problem formulation; innovation sequence and update formula; propagate formula; Kalman filter equations.

2102504 Introduction to Mathematical Analysis 3(3-0-9)

Mathematical proofs; basic set theory; the real number system; topology on the real line; sequence and convergence; limit and continuity of functions; vector spaces and linear operators; normed linear spaces; bounded operators; inner-product spaces; orthogonality and orthonormal bases; adjoint operators; applications to electrical engineering topics.

2102505 Introduction to Optimization Techniques 3(3-0-9)

Condition : Prerequisite 2102202 or

2102205 or Consent of Faculty

Review of linear algebra; solution of nonlinear equations; optimality conditions for unconstrained optimization; numerical methods for unconstrained optimization: steepest descent, Newton's, variable metric and conjugate gradient methods; optimality conditions for constrained optimization; numerical methods for constrained optimization: penalty and barrier function

methods, sequential quadratic programming; solution of linear programs by the simplex method.

2102506 Finite Element Analysis for Electrical Engineers 3(3-0-9)
Condition : Prerequisite 2102201 , 2102202 or Consent of Faculty

Introduction of domain-dividing methods; fundamentals of discretization; elements and interpolating functions; mapped elements; weighted residual method; variational principle; electrostatic and electro-quasistatic problems; heat transfer; fluid flow problems; magnetic field problems; electromagnetic wave analysis; programming considerations; numerical quadratures; solutions of linear equation system; finite element analysis in practice; advanced topics.

2102507 Computational Techniques for Engineers 3(3-0-9)
Condition : Prerequisite 2102205 or Consent of Faculty

Mathematical preliminaries; computer arithmetics; solutions of nonlinear equations; solving system of linear equations; approximating functions; numerical differentiation and integration; numerical solutions of ordinary differential equations.

2102520 Optical Fiber Transmissions and Networks 3(3-0-9)
Condition : Consent of Faculty

Overview of optical fiber telecommunication; enabling technologies for optical fiber transmissions; standard for optical fiber transmission; signal propagation in optical fiber; design of optical fiber point- optical fiber telecommunication; enabling technologies for optical fiber transmissions; standard for optical fiber transmission; signal propagation in optical fiber; design of optical fiber point-to-point link; dispersion compensation methods and their optimum design rules; wavelength division multiplexed(WDM) transmission systems; Dense WDM (DWDM); long-haul EWDM transmission design; enabling technologies for optical fiber networks; standard for optical fiber networks; first generation optical networks; access networks; FTTx; SONET and SDH optical ring network; FTTx; SONET and SDH optical ring network; DWDM networks: ring, mesh, and broadcast-and-selective topologies; design of DWDM optical local-area-network (LAN), DWDM optical metropolitan-area network (MAN), and DWDM optical wide-area network (WAN); engineering DWDM network; fiber system installations; fiber system tests and measurements; recent trends in fiber-optic transmissions and networks.

2102521 Access Networks 3(3-0-9)
Condition : Consent of Faculty

Overview of access networks, access networks and core networks, xDSL: Variety of DSL versions; Standards of xDSL systems and components; Transmission of DSL signal in twisted pair and limitations; xDSL system design; business models in xDSL, HFC: standards of HFC and Docsis; HFC systems and components; transmission of video and data in HFC and limitations; HFC system

design; business model in HFC, FTTx: variety of FTTx versions; standards of FTTx; FTTx systems and components; transmission of optical signals in FTTx system and limitations; FTTx system design; business models in FTTx, PLC: standards of PLC system; PLC systems and components; transmission of PLC signals in power system; PLC system design WiMAX : standards of WiMAX; WiMAX systems and components; of PLC signals in power system; PLC system, PLC system design, WiMAX: standards of WiMAX; WiMAX systems and components; transmission of WiMAX signals WiMAX system design; business models in WiMAX, WiFi: standards of WiFi; WiFi systems and components; transmission of WiFi signals; WiFi system design, other minor access networks: Bluetooth UWB; FSO; comparison of access networks nature of access networks; future trends.

2102523 Statistical Signal Processing in Biomedical Engineering 3(3-0-9)
Condition : Prerequisite 2102207 or Consent of Faculty

Characterization of signals and linear time-invariant systems; conversion of continuous-time signals to discrete-time signals; modeling of stochastic signals from white noise; energy and power signals; the principles of autocorrelation for discrete-time signals; linear prediction and optimum linear filtering; Least-Squares methods for system modeling and filtering design; all topics focused on biomedical engineering perspective.

2102525 Internet and Network Security 3(3-0-9)
Condition : Consent of Faculty

Overview of internet TCP/IP protocol and multimedia traffics; medium access controls protocols; wireless LAN networks; gigabit Ethernet; dynamic routing protocols (RIP and OSPF), LAN switching transport layer protocols: UDP and TCP, IP multicast, NAT, DHCP, DNS, SNMP; routing mechanism and congestion control algorithms; future broadband networks: WDM technology, advanced network architecture, network simulation, performance analysis, and measurement; network security; basic concept of cryptography: secret-key, public-key, digital signatures; authentication and identification schemes; intrusion detection: viruses; security of electronic mail and the World Wide Web; electronic commerce: payment protocols, electronic cash and firewalls.

2102531 System Identification 3(3-0-9)
Condition : Prerequisite (2102332 or 2102333) and 2102203 or Consent of Faculty

Models for linear time-invariant systems; properties of estimators; consistency, unbiasedness, and efficiency of estimators; linear least-squares method and its variants; instrument variable estimation; maximum-likelihood estimation; maximum a posteriori estimation; minimum mean square error estimation; model structure selection and model validation; recursive identification; experiment design and choice of input signals; real-world applications of system identification.

2102536 Nonlinear Control Systems I 3(3-0-9)
Condition: Prerequisite 2102432 or Consent of Faculty

Introduction to nonlinear control systems; state-space and phase-plane analyses; describing functions; Lyapunov stability; circle and Popov criteria; nonlinear control systems design.

2102540 Microcomputer Systems 3(3-0-9)

*Condition : Prerequisite 2102444 or
Consent of Faculty*

Microcomputer hardware: CPU, bus, memory, I/O units; interfacing techniques and programming; interfacing peripherals; software design techniques; real time systems and programming; microcomputer operating systems; high-level languages; microcomputer applications in control and instrumentation.

2102543 Advanced Electric Motor Drives 3(3-0-9)

*Condition: Prerequisite 2102356 or
Consent of Faculty*

Modeling and dynamic equations of dc motors; control principles of motor drives; semiconductor devices used in motor drive systems; various converter topologies for dc motor drives; modeling and dynamic equations of induction and synchronous motors; control principles of induction and synchronous motors; various inverter topologies for ac motor drives.

2102544 Advanced Embedded Systems 3(3-0-9)

*Condition: Prerequisite 2102444 or Consent of
Faculty*

Hardware and software platforms for embedded systems; devices and buses; embedded programming; real time operating system; hardware-software co-design in an embedded system; testing.

2102545 Digital Integrated Circuits 3(3-0-9)

Condition : Consent of Faculty

Internal circuits of different families of gates; NMOS, CMOS, ECL, and PECL; internal configuration of large-scale integrated circuits including ROM, RAM, PAL, PLA and FPGA; dynamic digital circuits such as domino and clocked circuits; input/output interface circuits; testing and verification of digital integrated circuits.

2102546 Analog Integrated Circuits 3(3-0-9)

Condition : Consent of Faculty

MOS transistor models; operational amplifier design; stability and frequency compensation of feedback amplifiers; bandgap references; switched-capacitor circuits; effect of nonlinearity and mismatch; oscillators and phase lock loops.

2102547 Cognitive Engineering 3(3-0-9)

Introduction to cognitive science from Descartes concepts to Informatics; Psychophysics: visual system, auditive system and somatosensory system; human cognitive function: sensory-motor system, perception, memory, learning, reasoning, decision making and problem solving, instrumentation and cognitive process: signal detection, image perception, speech recognition; applications of sensors and actuators in cognitive process;

examples of computational modeling and brain process: artificial intelligence, neural network.

2102548 Switched-Mode Electrical Power Processing I 3(3-0-9)

Condition : Consent of Faculty

Analysis of PWM converters and their derivatives; phase-controlled rectifier and PWM inverter operations and characteristics; PWM converters modeling using circuit averaging and averaged-switch modeling technique; dc and ac models of PWM converters; converters transfer functions; modeling of Pulse-Width Modulators; control of PWM converters; applications of phase-controlled rectifiers, PWM converter and inverters; analysis of resonant inverters using fundamental frequency approximation and their applications.

2102549 Semiconductor Fabrication Technology 3(3-0-9)

*Condition : Prerequisite 2102385 or
Consent of Faculty*

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

2102550 Power Electronics in Electrical Power Systems 3(3-0-9)

Condition : Consent of Faculty

Basic structure of electrical power system networks; fundamentals of power flow in power systems; basic characteristics of transmission systems; compensation in transmission systems; interconnection of power systems through FACTS and HVDC; active and reactive power flow control; voltage and current compensation for power quality; power electronic circuits for conversion of renewable energy generation.

2102551 Computational Methods for Power System Analysis and Design 3(3-0-9)

*Condition: Prerequisite 2102461 or
Consent of Faculty*

Power network representation and reconfiguration algorithms; problem formulation and solution methods for the studies fundamental to planning, design and operation of electric power systems including power flow, security assessments, optimal power flow and fault calculations; dynamic simulation for power system studies.

2102552 Introduction to Distributed Generation 3(3-0-9)

*Condition : Co-requisite 2102461 or
Consent of Faculty*

Introduction to Distributed Generation (DG); technologies of DG; power generation systems: synchronous, induction, converter; DG impact on load flow and voltage profiles; DG impact on fault and protection; and DG impact on power quality.

2102553 Fundamental of Electromagnetic Compatibility 3(3-0-9)
Condition: Consent of Faculty

EMI/EMC understanding and measurements; sources of EMI; definition and effect of EMI; EMI measurements and methods; EMC/ EMI limitation and protection with suitable equipment and system grounding; ground system tests and maintenance; shielding theory, materials and performance; different types of filter selection and usage.

2102555 Fundamentals of Power Quality 3(3-0-9)
Condition : Consent of Faculty

Definitions and technical terms of power quality ; sources and effects of power quality disturbances; harmonics and interharmonics analysis voltage sag analysis; voltage fluctuations and flicker analysis; Power quality standards and mitigation techniques.

2102556 Power System Economics 3(3-0-9)
Condition : Prerequisite 2102461

Economic dispatch problems; economic dispatch considering transmission system losses; introduction to unit commitment planning; microeconomic theory; power pool structure; bilateral contract structure; power system analysis considering market structures.

2102558 Insulation Coordination 3(3-0-9)
Condition : Prerequisite 2102458

Switching overvoltage between phase and ground, between phase and phase and at substation; lightning overvoltage on transmission line and at substation; lightning protection for transmission line and substation; selection of lightning arrester; insulation coordination according to IEC60071.

2102571 Multimedia Communication 3(3-0-9)
Condition : Consent of Faculty

Introduction to multimedia communication; image coding standards; video coding standards; audio coding standards; speech coding standards; IP networks; wireless networks; multimedia communication protocols; multimedia communication applications.

2102574 Information Theory 3(3-0-9)
Condition : Consent of Faculty

Information theory; probability and entropy; the source coding theorem; symbol codes; stream codes; communication over a noisy channel; the noisy-channel coding theorem; error-correcting codes; constrained noiseless channels; marginalization; low-density parity-check codes; convolutional codes and turbo codes; other modern codes.

2102577 Telecommunication Network 3(3-0-9)
Condition : Consent of Faculty

Telecommunication network fundamentals; multiplexing and switching; OSI principle; various network equipment technologies; network interconnection; signaling in network and applications; various network interconnection types; network management activities; telecommunication network management; network evaluation; network performance.

2102578 Satellite Communications 3(3-0-9)
Condition : Consent of Faculty

Fundamentals of satellite communication; satellite orbits; satellites; satellite link design; modulation and multiplexing; multiple access; earth station; error control coding; polarization; interference; VSAT; various types of satellites and their operations such as geostationary, non-geostationary, low earth orbit, direct broadcast and global positioning systems.

2102581 Digital Circuit Design 3(3-0-9)
Condition : Prerequisite 2102383 or 2102387 or Consent of Faculty

Introduction to digital circuit design; synthesis of logic circuits; CAD tools and VHDL; standard chips, programmable logic devices and gate arrays; optimized implementation of logic functions; combinational circuit design; synchronous sequential circuit design; system controller; digital system design; microcontroller based design.

2102582 Photonic Devices in Optical Communication Systems 3(3-0-9)
Condition : Consent of Faculty

Fundamentals of semiconductor physics; electronic and optical properties of semiconductors; optical processes in semiconductors; junction theory; propagation of light; waveguide theory; waveguide couplers, coupled-mode theory; operating principles, structures and properties of LEDs, laser diodes, photodetectors, optical modulators/switches, optical amplifiers and semiconductor optical amplifiers (SOAs); the fabrication technology of photonic devices.

2102583 Introduction to Quantum Mechanics 3(3-0-9)
Condition: Consent of Faculty

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

2102584 Introduction to Nanoelectronics 3(3-0-9)
Condition : Prerequisite 2102385 or Consent of Faculty

Introduction to nanotechnology, nanoscale fabrication (e.g. photolithography, electron-beam lithography, self-assemble growth); nanoscale characterisations (e.g. SEM, TEM, AFM); 1D quantum structure (quantum wires); 0D quantum structure (quantum dots); single electron devices, carbon nanotubes; molecular electronics, DNA chips, quantum dot cellular automata; MEMS/NEMS; spintronics.

2102585 Biomaterial Science 3(3-0-9)
Condition : Consent of Faculty

Biological interactions with materials or any invasion: protein adsorption, blood coagulation, inflammation, immunology, hypersensitivity and infection; various types of biomaterials that have been used in biomedical applications: metals, synthetic polymers, hydrogel, ceramics, composites, and natural materials.

2102588 Biomedical Electronics 3(3-0-9)

Condition : Consent of Faculty

Electrical signals in human body; action potential in cells; electrodes; amplifiers; transducers; electronic monitoring systems: ECG, EEG, EMG; blood pressure and blood flow measurement; catheterisation; electrical hazards and prevention; medical instrumentation; computer in medicine.

2102589 Laser Engineering 3(3-0-9)

*Condition : Prerequisite 2102385 or
Consent of Faculty*

Fundamental theory: energy states in atoms, electron-population inversion, spontaneous emissions, stimulated emissions; principles of lasers; coherent light; gas lasers; solid-state lasers, semiconductor lasers; applications of lasers in medical science, precision measurement, telecommunications, material processing, spectroscopy, display hologram and nonlinear optics.

2102598 Special Problems in Electrical Engineering 3(3-0-9)

Condition : Consent of Faculty

Special problems assigned by the instructor with consent of the head of the Department.

2102601 Power and Energy Technologies in Smart Grids 3(3-0-9)

Condition : Consent of Faculty

Introduction to smart grids; fundamentals principles of electrical power system operation and control; distributed generation; microgrid and active networks; introduction to wide area monitoring and wide area protection systems; renewable energy generation; energy storage; electric vehicle; grid connection codes; renewable energy policy and regulations.

2102602 Information and Communication Technologies in Smart Grids 3(3-0-9)

Condition : Consent of Faculty

Substation operation and related communication within substation; equipment in distribution system; communication between control centers; architecture and components of Automatic Meter Infrastructure/Automatic Meter Reading including phasor measurement unit, digital fault recorder and interoperability; energy efficiency within home, building and factory; communication channels in smart: wired, wireless, optical fiber; network layer, sensing/control and control protocol; database management and cyber security.

2102605 Fourier Transforms and its Applications 3(3-0-9)

Condition : Consent of Faculty

Fourier's theorem; Fourier transforms of functions; discrete Fourier transform; other related transforms; applications to electric networks, sampling, antennas, noise waveforms, Fourier optics and statistics.

2102611 Medical Instrumentation 3(3-0-9)

Condition : Consent of Faculty

Basic concepts of amplifiers, signal processing, electrodes, biopotential, sensors, medical devices, therapeutic devices, medical imaging, electrical safety; measurement of blood pressure, blood flow, and biopotential signals; designing and constructing simple medical instruments.

2102620 Electromagnetic Theory 3(3-0-9)

*Condition : Prerequisite 2102322 or
Consent of Faculty*

Maxwell's equations; theorem of electromagnetic energy and power; properties of materials in electromagnetic fields; boundary conditions; theorems of electromagnetic fields, duality principle, uniqueness, image theory, equivalence principle, induction theorem, reciprocity; potential functions; electromagnetic wave equations, plane wave functions, cylindrical wave functions, spherical wave functions; mathematical tools for electromagnetic fields, separation of variables technique, transverse resonance method, perturbation and variational techniques, Green's functions, geometric algebra; solution methods for electrostatic, magnetostatic, and quasi-static fields problems; plane wave propagation problems, propagation in unbounded medium, multilayered medium, and anisotropic medium; wave guidance problems, field analysis in typical waveguides, modal expansion method; resonators and filters; radiation problems, radiation from current sources and apertures; scattering problems, scattering by cylinder, wedge, and sphere; optical waves, optical waveguides, optical wave propagation in photonic crystal.

2102623 Antennas and Radar Systems 3(3-0-9)

Condition : Consent of Faculty

Introduction and fundamental parameter of antennas; Transmitting and receiving antennas; Friis Transmission equation; Basic antenna types; Phased array antennas; Smart antennas and multiple-input/multiple-output (MIMO) systems; Introduction and basic principle of radar systems; Radar cross section; Radar equation; Continuous wave radar, Pulsed radar, Target tracking radar.

2102625 Computational Electromagnetics for Microwave and Photonics 3(3-0-9)

Condition : Consent of Faculty

Basic concept of numerical modeling for electromagnetic problems; computational methods and programming techniques for solving linear electromagnetic wave problems in frequency domain for microwave and photonic applications such as finite-element method (FEM), boundary-element method (BEM), finite-volume method (FVM), and meshless method; computational methods and programming techniques for solving linear electromagnetic problems in time domain such as finite-difference time-domain (FDTD), finite-element time-domain (FETD), and finite-volume time-domain (FVTD).

2102627 Reliability and Survivability of Communication Networks and Systems 3(3-0-9)

Condition : Consent of Faculty

Fundamental probability; network reliability; approaches to calculating network reliability; generic reliability and maintainability concepts; network survivability; fiber transport system components and signals; APS; dual homing; self healing rings; SONET analysis; DCS networks; survivable network design; IP and ATM network survivability.

2102628 Graph Theory and Combinatorial Optimization 3(3-0-9)

Condition : Consent of Faculty

Introduction to graph theory; concept of paths, cycles and trees; various types of graphs; transshipment problem; shortest path problem; maximum flows problem; minimum cost flows problem; network optimization; matching; Matriods and greedy algorithms; applications.

2102629 Traffic Engineering and Queuing Theory 3(3-0-9)

Condition : Consent of Faculty

Fundamentals of traffic engineering and queuing theory: quality of service and system performance analysis; revision on probability theory; computer simulation: discrete-time simulation, discrete-event simulation, confidence interval estimation; fundamental mathematical models: stochastic process, discrete-time Markov chain (DTMC), continuous-time Markov chain (CTMC), birth and death processes; theory of non-queuing/loss system; queuing theory; advances in traffic engineering and queuing theory.

2102631 Optimal Control Systems 3(3-0-9)

Condition : Prerequisite 2102505 or Consent of Faculty

Discrete-time linear quadratic regulator; calculus of variations; continuous-time linear quadratic regulator; time-optimal control; constrained control input problem; the Pontryagin's maximum principle; singular control; dynamic programming; optimal controller design; computational methods in optimal controller synthesis.

2102635 Control System Theory 3(3-0-9)

Condition: Consent of Faculty

Review of linear algebra; least-squares methods and minimum norm methods; mathematical descriptions of dynamic systems; solutions of linear dynamic equations; stability, controllability, observability; internal stability of interconnected systems; state feedback; linear quadratic regulation; observers and observer-based compensation; introduction to nonlinear systems.

2102637 Multivariable Control Systems 3(3-0-9)

Condition : Consent of Faculty

Performance issues in multivariable systems; uncertainties and robustness; multivariable control system designs: frequency domain methods, LOG and LTR methods, parameter optimization methods; H_2 and H_∞ control; model reduction.

2102638 Nonlinear Control Systems II 3(3-0-9)
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Condition : Consent of Faculty

Input-output stability; small gain theorems; basic of differential geometry; feedback linearization; geometric nonlinear control theory; nonlinear control system design.

2102642 Computer Vision and Video Electronics 3(3-0-9)

Condition : Consent of Faculty

Human vision; geometric camera models; image segmentation; object recognition; video signals and standards; video input and output circuits; computer vision and digital video applications.

2102645 Embedded System Design 3(3-0-9)

Condition : Consent of Faculty

Practical examples; performance evaluation; complex system designs: automotive, multimedia, biomedical instrumentation, measurement instrumentation, and robot.

2102650 Electrical Transient in Power Systems 3(3-0-9)

Condition : Prerequisite 2102458 or Consent of Faculty

Introduction to electrical transient; switching transient: simple and abnormal switch transients, transients in three phase circuits; transient in conversion equipment; electromagnetic phenomena under transient conditions; lighting effects on power systems; traveling wave on transmission line; effects of transient voltage on transformer windings; protection of systems and equipment against transient overvoltage and insulation co-ordination; computer aids to the calculation of electrical transients.

2102651 Power System Stability 3(3-0-9)

Condition : Prerequisite 2102461 or Consent of Faculty

Basics and descriptions of power system stability problems; mathematical reviews of state-space analysis and numerical integration; reference frame theory; synchronous machine representation in stability studies; power network representations and characteristics; excitation system components and functions; active power and frequency control; transient stability; small-signal stability; methods of improving transient and small-signal stability.

2102656 Power System Protection 3(3-0-9)

Condition : Consent of Faculty

Principles of power system protection; relays and their operating principles and characteristics; and protection of generators, motors, transformers, buses and lines.

2102663 Solar Cell Technology 3(3-0-9)

Condition : Consent of Faculty

Band theory of semiconductors; optical properties of semiconductor; structure of solar cells; characteristics of solar cells; equivalent circuit of solar cells; p-n junction

silicon solar cells; polycrystalline silicon solar cells; amorphous silicon solar cells; gallium arsenide solar cells; $\text{CuInSe}_2/\text{CdS}$ solar cells; photovoltaic system design; concentrated sunlight system; photovoltaic system applications.

2102668 Biosensors 3(3-0-9)
Condition : Consent of Faculty

Necessary concepts relevant to the principle of measuring chemical and biological phenomena with emphasis on integrating these concepts of develop to apply and to construct novel instruments for observing, examining, and controlling various phenomena in the field of biotechnology, medical science, chemical engineering for both fundamental research and process development in industrial production.

2102674 Optical Communication 3(3-0-9)
Condition : Prerequisite 2102605 or Consent of Faculty

An outline of optical communication systems; properties of laser light; characteristics of optical communication; fundamentals of optical fiber; light sources; modulation and demodulation; optical devices; optical communication and applications.

2102675 Pattern Recognition 3(3-0-9)
Condition : Prerequisite 2102383 or 2102387 or Consent of Faculty

Statistical pattern recognition: linear discriminant functions, Bayesian decision theory, maximum-likelihood and Bayesian parameter estimation.

2102676 Digital Image Processing 3(3-0-9)
 Image perception; image digitization; image enhancement; image restoration; image segmentation; image compression; morphological image processing; image representation and description.

2102677 Broadband Network And Design 3(3-0-9)
Condition : Consent of Faculty

Demand for ATM broadband network; ATM fundamentals; ATM broadband network operation, administration and maintenance (OAM) fundamentals; ATM network management; quality of service (QoS) and ATM performance; policing in ATM networks; 3G/4G wireless network architectures; next-generation wireless networks; wireless access technologies; demand for broadband network services; network design approaches; introductory graph theory and topological design; campus/LAN/WAN design; leased-line network consideration; requirements definition and service provider selection; network planning and management; network design project management.

2102680 Semiconductor Lasers 3(3-0-9)
Condition : Prerequisite 2102222 and 2102385 or Consent of Faculty

A review of semiconductor physics; optical process in semiconductor; junction theory; waveguide theory; coupler-mode theory; fundamental of semiconductor lasers ; semiconductor laser structure and its characteristics; quantum well lasers; dynamic

single-mode lasers; vertical cavity surface emitting lasers; array lasers; quantum wire and quantum dot lasers; quantum cascade lasers; semiconductor laser modeling; the fabrication technology of semiconductor lasers.

2102682 Solid-State Physics for Electronics Engineers 3(3-0-9)
Condition : Consent of Faculty

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.

2102684 Guided-Wave Optics and Nanophotonics 3(3-0-9)
Condition : Consent of Faculty

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

2102686 Switched-Mode Electrical Power Processing II 3(3-0-9)
Condition : Consent of Faculty

Modeling of PWM converters using state-space averaging technique; state-space averaging of non-ideal converters; Analysis of PWM converters operating in discontinuous conduction mode; modeling of DCM PWM converters; current-mode control of PWM converters; current-programmed control; current-programmed converter model and transfer functions; current-programmed controller model; switched-mode rectifiers; switching loss reduction technique; snubbers for PWM switches; ZVS ZCS single resonant switches; analysis of basic converters using single resonant switches; analysis of resonant inverters and resonant converters;

2102697 Special Problems in Electrical Engineering II 3(3-0-9)
Condition : Consent of Faculty

Special problems in various fields of electrical engineering.

2102731 Infinite-Dimensional Control System 3(3-0-9)

Semigroup theory and evolution equations; stability theory; controllability, observability and realizability; linear quadratic optimal control; frequency-domain approach; controller design for infinite-dimensional systems.

2102732 Convex Optimization and Engineering Applications 3(3-0-9)

Condition : Prerequisite 2102505 or Consent of Faculty

Convex sets, functions, and optimization problems; basics of convex analysis; least-squares, linear and quadratic programs, semidefinite programming, minimax, extremal volume, and other problems; localization methods: cutting-plane, ellipsoid algorithms; optimality conditions, duality theory, theorems of alternative, and applications; interior-point methods; applications to control systems and other engineering topics.

2102754 Electric Field Analysis in High Voltage Engineering 3(3-0-9)

Basics of electric field analysis : practical problems in the field analysis of high-voltage systems : Introduction to numerical methods in field analysis; charge simulation method: surface charge method; boundary element method; examples of field analysis; comparison of methods: advanced topics.

2102755 Power System Electromagnetic Transient Simulation 3(3-0-9)

Analysis of power system transient phenomena: lightning surges, switching surges, temporary overvoltage; modeling technique of lines and cables, transformers, rotating machines, arresters, protective systems.

2102757 Power System Reliability 3(3-0-9)

Condition : Prerequisite 2102651, 2102652 or Consent of Faculty

Reliability evaluation and reliability indices; comparison between deterministic and probabilistic criterias; operating state modeling of power system equipment; generation system modeling; generation system reliability evaluation; generation system expansion planning; interconnection system reliability evaluation; operating reserve; composite system reliability evaluation; distribution system reliability evaluation.

2102770 Wireless Communications and Networking 3(3-0-9)

Overview of future broadband wireless systems for voice video data and multimedia services; wireless channel characterization and statistical models, narrowband and wideband; capacity of wireless channels; advanced digital modulation: spread spectrum, multicarrier modulation, CDMA, OFDM, multiuser systems, multiple input/output systems (MIMO), adaptive modulation; future wireless networks: sensor networks, automated motorways, Ad-Hoc networks design and applications.

2102774 Telecommunications Switching, Transmission and Signaling 3(3-0-9)

Telecommunications traffic; congestion; mathematical model of telecommunications traffic; lost-call systems; queuing systems; switching networks; single-stage networks; gradings; link systems; grades of service of link systems; non-blocking networks; space and time switching; time-division switching networks; grades of service of time-division switching networks; non-blocking time-division switching networks; synchronization; telecommunications transmission systems; transmission of the 64-kbps signal; PCM primary rate transmission; higher order PCM transmission; optical fiber transmission system; SDH transmission system; subscriber networks; signaling; signalling networks; signalling system No. 7 levels.

2102785 Advanced Sensor Theory 3(3-0-9)

Condition : Consent of Faculty

Principle and theory of physical and chemical sensors; thermodynamics and sensor operation; sensor fabrication technology; micro-machining; sensor fusion; intelligent sensors; data processing and analytical methods.

2102790 Electrical Engineering Seminar 2(2-0-6)

Condition : Consent of Faculty

Seminar in current research topics in electrical engineering including technical writing and presentation techniques of research works and thesis. Literature reviews of international journal papers relevant to the research topic. Submit a summary report in the forms of technical paper and thesis proposal which describes the motivation, problem formulation, main results and, examples.

2102791 Electrical Engineering Seminar I 2(2-0-6)

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102792 Electrical Engineering Seminar II 2(2-0-6)

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102793 Electrical Engineering Seminar III 2(2-0-6)

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102794 Electrical Engineering Seminar IV 2(2-0-6)

Preliminary lectures by instructors; seminar on current and new topics in electrical engineering, in which each student is required to present an oral and written report.

2102796	Advanced Topics in Electrical Engineering I	3(3-0-9)
	Interesting topics or new developments in the field of electrical engineering.	
2102797	Advanced Topics in Electrical Engineering II	3(3-0-9)
	Interesting topics or new developments in the field of electrical engineering.	
2102874	Speech Processing	3(3-0-9)
	<i>Condition : Consent of Faculty</i>	
	Sampling; scalar quantization; vector quantization; speech modeling; speech perception; psychoacoustic; waveform coding; vocoders; hybrid coding; feature extraction; phonemes; statistical model training (HMM); speaker verification; text-to-speech (TTS); noise reduction techniques.	
2102875	Digital Video Processing	3(3-0-9)
	<i>Condition : Consent of Faculty</i>	
	Analog and digital video; video sampling and rate conversion; video modeling; two-dimensional motion estimation; foundation of video coding: binary coding, quantization, transform coding; image and video compression standards; error control in video communications.	
2102876	Adaptive Signal Processing	3(3-0-9)
	<i>Condition : Consent of Faculty</i>	
	Adaptive filtering and linear time-invariant filters together with their applications; linear optimum filtering including the principle of orthogonality and minimum mean-squared error performance criterion; least-mean-square (LMS) algorithm, and the method of least-squares and recursive least-squares.	
2102813	Thesis	18 credits
2102816	Thesis	36 credits
2102828	Dissertation	48 credits
2102829	Dissertation	60 credits
2102830	Dissertation	72 credits
2102894	Doctoral Dissertation Seminar	0(0-0-0)
2102897	Qualifying Examination	0(0-0-0)