

### -5.1 ABOUT THE INSTITUTE

The Board of Regents approved the curriculum leading to the degree of Bachelor of Science in Electrical Engineering (B.S. EE) on January 10, 1916. Eighty-eight years later, in 1994, the Department of Electrical Engineering transitioned into the Department of Electrical and Electronics Engineering when two additional undergraduate programs were created—the Bachelor of Science in Computer Engineering (B.S. CoE) and the Bachelor of Science in Electronics and Communications Engineering (B.S. ECE) programs. Aside from these three undergraduate programs, four graduate degree programs are offered: Master of Science and Master of Engineering in Electrical Engineering, and the Doctor of Philosophy and Doctor of Engineering (Electrical and Electronics Engineering) programs.

To enhance its role as the country's premier institution for research and higher learning in electrical and electronics engineering, the Department was officially transformed into the Electrical and Electronics Engineering Institute on October 24, 2008.

From its humble beginnings at UP Manila, transferring to Melchor Hall in UP Diliman, then the German Yia Hall, and the National Engineering Center (NEC), in 2001 the Department finally moved into its own building along Velasquez Street in UP Diliman. An additional building with a lot area of 3875 sq.m. and floor area of 7,500 sq.m. was inaugurated in 2015, while two more structures housing the Microsatellite Research Facility are expected to be constructed in 2016. These facilities collectively encompass twenty-seven research and instructional laboratories, learning facilities such as lecture rooms and meeting spaces, and student and staff work and office spaces.

### 5.2 VISION AND MISSION

The Institute's basic mission is two-fold:

- to produce excellent and innovative engineers who are motivated and committed to serve the nation, and
- to advance the field of electrical and electronics engineering.

To fulfill this mission on a nationwide scope and scale, the EEE Institute envisions itself to become the National Institute of Electrical, Electronics, and Computer Engineering as it continues to gain international recognition, achieves national impact and becomes globally significant. The Institute celebrates its centennial in 2016 with the theme "Towards a New Century of Innovative and Visionary Engineering, Education, and Research."

### 5.3 UNDERGRADUATE PROGRAMS

The Computer Engineering, Electrical Engineering, and Electronics and Communications Engineering undergraduate programs produce innovative engineers committed to serve the nation through the practice of the electrical and electronics engineering profession and its allied fields. The Bachelor of Science in Computer Engineering (B.S. CoE) program develops engineers who design and implement a broad spectrum of computing systems and components, ranging from integrated circuits, embedded systems, computer networks, and software applications. The Bachelor of Electronics and Communications Engineering (B.S. ECE) program trains engineers who analyze, plan, design, measure, and operate electronic and communication devices and systems. The Bachelor of Science in Electrical Engineering (B.S. EE) program produces engineers who model, analyze, plan, design, measure, operate, and control electric power systems. These three undergraduate programs work closely together to provide students a unique opportunity for cross-curricular learning from all of these areas while pursuing specific undergraduate degrees, enabling them to understand new, complex and hybrid systems, and allowing graduates to rapidly adapt to the continuously-changing technology landscape.

The curricula for the B.S. CoE, B.S. ECE, and B.S. EE programs may be found in Section 5.8 of this Catalogue, while undergraduate course offerings may be found in Section 5.11.

### 5.4 GRADUATE PROGRAMS

The graduate programs of the Institute provide advanced training and specialization in a broad range of areas in electrical and electronics engineering and its allied fields to prepare students to solve complex technological problems and to contribute new knowledge to the field. Our graduate programs provide the country with a pool of highly qualified electrical and electronics engineers who carry out creative and challenging work in research, development, design, technology management and university instruction.

#### Master of Science in Electrical Engineering

The Master of Science (M.S.) program is a research-oriented degree program targeted primarily at academics and researchers. Prospective students in this program intend to undertake research towards enhancing the delivery of higher education in academic institutions or the development of new technology in government and industry research institutions. M.S. students undergo coursework and get trained in research through immersion in research laboratories, and write a thesis documenting the findings and contributions from their research work.

### **Master of Engineering in Electrical Engineering**

The Master of Engineering (M.Eng.) program offers an advanced professional degree targeted primarily at industry practitioners and professionals. Prospective students in this program seek enhance their skills and knowledge for career advancement and towards supporting higher value engineering activities in their respective institutions. As such, the program supports the development of local engineering industry by enhancing the capability of its workforce to undertake higher value engineering work. M.Eng. students may flexibly tailor their coursework based on their learning or professional objectives: they may even opt to engage in research work, directed study, or project work within their program of study.

### **Doctor of Philosophy in Electrical Engineering / Doctor of Engineering in Electrical Engineering**

The Doctor of Philosophy (Ph.D.) and Doctor of Engineering (D.Eng.) programs produce experts capable of conducting independent investigation and study, producing original contributions to the fundamental knowledge in the field (Ph.D.), or solving engineering problems of substance and developing solutions in a creative and distinguished manner (D.Eng.). Doctoral students undergo an intensive program of study and research in exciting, cutting-edge areas of technology, and write a dissertation documenting their journey and findings from their investigation. Although the typical entrance credential for admission into the doctoral programs is a master's degree in a relevant field, admission is also possible for exceptional candidates who possess a relevant bachelor's degree.

Curricula for the graduate programs may be found in Section 5.9 of this Catalogue, while graduate course offerings may be found in Section 5.12.

## **5.5. RESEARCH AREAS AND LABORATORIES**

Research is an important component of the Institute's work. Our research laboratories provide venues for students to engage in creative work and cutting-edge research to provide electrical and electronic solutions to real-world problems, to advance the state of technology, and to contribute to the body of knowledge in the field. Currently we have the following research laboratories:

### **UP-Analog Devices Microelectronics Laboratory (MicroLab)**

Lab head: Dr. Louis P. Alarcon

and

### **UP-Intel Microprocessors Laboratory (IML)**

Lab head: Dr. Ma. Theresa G. de Leon

The IML and MicroLab are used for research in the design and development of radio-frequency CMOS integrated circuits, analog/mixed signal systems, and low-power microprocessors.

### **UP-Artсын Power Electronics Laboratory (PEL)**

Lab head: Engr. Gaudan Albert Chekov L. Castillo

This laboratory serves as a training ground to expose students to the various fields of power electronics. PEL research areas include power supplies and converters, electric vehicle charging, electric motor drives, LED lighting, power amplifiers, battery technology, and electromagnetic compatibility.

### **Computer Networks Laboratory (CNL)**

Lab head: Dr. Roel M. Ocampo

Researches under this laboratory cover various rapidly-evolving aspects and applications of communications networks including but not limited to mobile systems mobile systems, social networks, application-layer overlays, novel link/routing/ transport protocols, cooperative community networks, low-overhead computing and networking, smart grids and smart homes, sensor networks, the Internet of Things (IoT), and big data.

### **Digital Signal Processing (DSP) Laboratory**

Lab head: Engr. Michael Gringo Angelo R. Bayona

Research in the DSP Laboratory is geared towards DSP algorithm development and implementation. Areas of concentration include software and hardware embedded systems for real-time and non-real-time applications in audio, image, video and speech signal processing.

### **Electric Power Research Laboratory (EPRL)**

Lab head: Dr. Allan C. Nerves

The EPRL is dedicated to research aimed at providing a safe, reliable, and optimum generation, distribution, conversion, measurement, and control of electric energy. Areas of concentration include modeling and simulation of electricity markets and power system dynamics; security assessment and stability enhancement for power systems in the restructured environment; and power system planning and optimal operation that ensure supply security, market competitiveness, and environmental sustainability.

### **Mobile Robotics (Mobot) Laboratory**

Lab head: Engr. Percival D.C. Magpantay

This laboratory focuses on mobile robots and intelligence agents. Research thrusts include almost every aspect of electrical engineering, e.g. power electronics, instrumentation and control

communications, embedded systems, artificial intelligence, and operating systems; and a little of computer science, mechanics, biology, and philosophy.

### **Innovation Research Center (IRC)**

Lab head: Dr. Luis G. Sison

The research facility provides technology solutions in managing production resources, health care, and education. Its research thrusts are biomedical engineering; traffic, structural, and environmental monitoring; wireless sensor networks; and embedded systems and mechatronics; and hardware interfaces for interactive learning.

### **Power Simulations Systems Laboratory (PSSL)**

Lab head: Dr. Jordan Rel C. Orillaza

Research areas include modeling, simulation, and optimization of electric power systems (reliability); and planning, protection, automation, control and power quality. The lab is equipped with power system simulation software and hardware simulators such as power system micro-models fitted with protective relays, remote terminal units (RTUs), and supervisory control and data acquisition (SCADA).

### **Robotics Automation Laboratory (RAL)**

Lab head: Dr. Manuel C. Ramos, Jr.

This laboratory focuses on robotic manipulators, bipeds, and autonomous navigation. Research topics under RAL may include, but not limited to manipulator dynamics, motor drives, sensor development, and autonomous vehicles.

### **Smart Grid Research Center (SGRC)**

Lab head: Dr. Michael Angelo A. Pedrasa

Research areas include design and implementation of smart grid building blocks; control and communication solutions for smart grids; demand side management; integration of renewable and distributed energy resources to electric power systems; microgrids; virtual power plants; smart buildings and smart homes; and regulatory aspects and market operations for smart grid.

### **Solar Photovoltaics Laboratory (SPL)**

Lab head: Prof. Miguel T. Escoto, Jr.

As one of the leading research institutions for renewable energy research in the country, the SPL is continuously striving to develop, innovate, and promote novel energy technologies in order to uplift the quality of life for Filipino society and to safeguard the environment. Since its inception, the SPL has continually developed its expertise in many fields of renewable energy, advocates sustainable development, and the judicious use of

energy resources through the implementation of its projects and programs.

### **Ubiquitous Computing Laboratory (UCL)**

Lab head: Dr. Rowel O. Atienza

The UCL focuses on mobile, wearables and Internet of Things (IoT) research. UCL innovates on areas such as educational games (eg Animated Star Gram), human-device interaction (Slash the Fruit, Alien Antics and Holy Sheep!), virtual reality, animation, IoT protocols, and smart apps.

### **Wireless Communications Engineering Laboratory (WCEL)**

Lab head: Engr. Miguel Carlo L. Purisima

The WCEL was established to provide instructional and training support, as well as to spearhead the research and development efforts of the Institute in the area of wireless communications technology. The lab primarily engages in the design, integration, analysis, and testing of wireless communication devices, circuits, and systems for various applications such as rural connectivity, emergency response, and public safety.

## **5.6 INSTRUCTIONAL FACILITIES**

The Institute provides a wide range of facilities to support the instructional and research needs of its students, ranging from the 240-seater PLDT Multimedia Lecture Hall, numerous lecture rooms of various sizes, all the way down to meeting facilities for small group discussions. Students are also provided a number of areas for their own use where they can study, relax, or hold small discussions. Graduate students are also provided dedicated office spaces in addition to their work spaces in the laboratories.

The EEI complements solid theoretical training with exposure and actual hands-on work in instructional laboratories on electronic components and circuits, embedded systems, communication systems, electric machines and motor drives, power system simulation, robotics and automation, prototyping, computer programming and computer networks. Many of these facilities are supported and endowed with state-of-the-art and industry-grade equipment by partners such as Alexan, Analog Devices, Artesyn, Intel, IXYS-Zilog, Meralco, PLDT, and Nokia, to name a few. These facilities ensure that students acquire sufficient practical skills in the design, implementation, operation and management of similar components or systems, making them "industry-ready" and well-prepared to solve engineering challenges out in the real world.

## 5.7 FACULTY AND STAFF

To date, the Institute has 48 full-time faculty members (10 on study leave), 16 lecturers, and 6 regular staff.

### Institute Director

**Dr. John Richard E. Hizon**

### **Professors**

**Miguel T. Escoto, Jr.**

M.S. Electrical Engineering  
Worcester Polytechnic Institute, 1982  
*Power Electronics, Electric Motor Drives,  
Renewable Energy Systems*

**Rowena Cristina L. Guevara**

Ph.D. Electrical Engineering (Systems)  
University of Michigan, 1997  
*Digital Signal Processing for Audio, Music and  
Speech Signals*

**Joel Joseph S. Marciano, Jr.**

Ph.D. Electrical Engineering  
University of New South Wales, 2002  
*Wireless Communications, RF and  
Microwave Engineering*

**Allan C. Nerves**

Ph.D. Electrical Engineering  
Virginia Polytechnic Institute and State University,  
1996  
*Power and Energy Systems, Electricity Markets*

**Manuel C. Ramos, Jr.**

Ph.D. Electrical Engineering  
Purdue University, 2002  
*Control Systems, Nonlinear Control,  
Robotics, Fuzzy Systems*

**Luis G. Sison**

Ph.D. Electrical Engineering  
Purdue University, 1999  
*Biomedical Engineering, Wireless Sensor Networks*

### **Associate Professors**

**Rowel O. Atienza**

Ph.D. Information Sciences Engineering  
Australian National University, 2008  
*Human-Machine Interface*

**Anastacia B. Alvarez**

Ph.D. Electrical Engineering  
National University of Singapore (in progress)  
*Microelectronics, Computer Architecture,  
Digital Design and HDLs, Memory and Cache Design*

**Rhandley D. Cajote**

Ph.D. Electrical Engineering  
Chulalongkorn University, 2011  
*Image and Video Processing, Handwriting  
Recognition, Machine Vision, Stereo Imaging, Pattern  
Recognition*

**Rowaldo D. Del Mundo**

M.S. Electrical Engineering  
University of the Philippines Diliman, 1991  
*Power Systems, Electricity Markets and  
Regulation, Energy Planning*

**Roel M. Ocampo**

Ph.D. Electrical and Electronics Engineering  
University College London, 2007  
*Computer Networks*

**Jordan Rel C. Orillaza**

Ph.D. Electrical Engineering  
University of Canterbury, 2012  
*Electric Power Quality, Power System Modeling  
and Analysis, Electrical Machines*

**Michael Angelo A. Pedrasa**

Ph.D. Electrical Engineering  
University of New South Wales, 2011  
*Smart Grids, Power Systems Operation  
and Control, Energy Systems Modeling*

**Nestor Michael C. Tiglao**

Ph.D. Electrical and Computer Engineering  
Universidade Tecnica de Lisboa, 2013  
*Wireless Sensor Networks, Internet of Things*

### **Assistant Professors**

**Louis P. Alarcon**

Ph.D. Electrical Engineering and Computer Science  
University of California, Berkeley, 2010  
*Microelectronics, Integrated Circuits, RF IC Design,  
Low-Power Processor Design*

**Adelson N. Chua**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2014  
*Microprocessor Design, Digital Systems Design*

**Paul Jason R. Co**

Ph.D. International Development Engineering  
Tokyo Institute of Technology (in progress)  
*RF and Antennas, Wireless Communications*

**Ivan Benedict Nilo C. Cruz**

Ph.D. Electrical and Electronics Engineering  
University of the Philippines Diliman (in progress)  
*Power System Planning, Energy System Planning*

**Franz A. De Leon**

Ph.D. Electrical and Electronics Engineering  
University of Southampton, 2014  
*Audio and Communications Signal Processing,  
Music Information Retrieval*

**Ma. Theresa G. De Leon**

Ph.D. Electrical and Electronics Engineering  
University of Southampton, 2014  
*Microelectromechanical Systems, Energy Harvesting,  
Microfabrication Techniques, RF and Analog ICs,  
On-Wafer Device Characterization*

**John Richard E. Hizon**

Ph.D. Electrical Engineering  
Imperial College London, 2011  
*RF IC Design, RISC Processors, Mixed Signal Circuits*

**Joy Alinda R. Madamba**

Ph.D. Electrical and Electronics Engineering  
University of the Philippines Diliman (in progress)  
*Computer Architecture, Digital IC Design*

**Rico Jossel M. Maestro**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2015  
*Microelectronics*

**Percival D.C. Magpantay**

Ph.D. Electrical and Electronics Engineering  
University of the Philippines Diliman (in progress)  
*Microcontrollers, Sensors, Mobile Robotics  
Power Electronics, Electric Motor Drives*

**Bienvenido M. Malquisto, Jr.**

Ph.D. Electrical and Electronics Engineering  
University of the Philippines Diliman (in progress)  
*Power System Protection, Automation and Control,  
Power System Planning, Power Systems Simulations*

**Carl Michael F. Odulio**

Ph.D. Electrical and Electronics Engineering  
University of the Philippines Diliman (in progress)  
*Power Electronics, Electric Motor Drives*

**Jhoanna Rhodette I. Pedrasa**

Ph.D. Electrical Engineering  
University of New South Wales, 2010  
*Computer Networks, Mobile Systems,  
Smart Grid Communications*

**Miguel Carlo L. Purisima**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2014  
*Wireless Communications, RF and Microwave  
Engineering, Signal Processing for Communications*

**Niño Christopher B. Ramos**

Ph.D. Electrical Engineering  
Osaka University (in progress)  
*Power Electronics, Renewable Energy Systems*

**Mark D. Rosales**

Ph.D. Electrical Engineering,  
University of Paris - Est Marne-la-Vallee', 2014  
*RFIC Design, Electronic Prototyping*

**Marc Caesar R. Talampas**

Ph.D. Electrical and Electronics Engineering  
Nanyang Technological University (in progress)  
*Wireless Sensor Networks, Localization*

**Wilbert Rey D. Tarnate**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2013  
*Power Systems Reliability, Electricity  
Markets and Regulation*

**Adonis Emmanuel D.C. Tio**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2013  
*Power System Reliability, Energy Systems Modeling*

**Lew Andrew R. Tria**

Ph.D. Electrical Engineering  
University of New South Wales (in progress)  
*Power Electronics, Magnetic Design,  
Photovoltaic Systems*

**Instructors**

**Nicolette Ann A. Arriola**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2015  
*Power Electronics, Solar Power*

**Michael Gringo Angelo R. Bayona,**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2014  
*Speech Signal Processing, Synthesis and  
Recognition, Natural Language Processing*

**Neil Irwin M. Bernardo**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)  
*Wireless Communications*

**Gaudan Albert Chekov L. Castillo**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2014  
*Power Electronics, Linear and Switched Mode  
Power Supplies, Electronic Motor Drives*

**Jaybie A. De Guzman**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2013  
*Computer Networks, Communications  
and Embedded Systems*

**Dale Joshua R. Del Carmen**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)  
*Digital Image Processing*

**Jasmin C. Del Rosario**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)  
*Power Electronics, Solar Photovoltaic Systems*

**Chris Vincent J. Densing**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2013  
*Digital VLSI Circuits and Systems,  
Computer Architecture*

**Russel John D.C. Gallano**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2014  
*Power System Dynamics and Stability,  
System Optimization, Microgrids*

**Paul Leonard Atchong C. Hilario**

Ph.D. Physics  
University of the Philippines Diliman, 2014  
*Photonics, Wavefront Engineering,  
Instrumentation Physics*

**Crisron Rudolf G. Lucas**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)  
*Speech Signal Processing*

**Patth Rick L. Ramirez**

M.S. Electrical Engineering,  
University of the Philippines Diliman (in progress)  
*Wireless Communications, RF and Microwave  
Engineering, Antennas and Radio Propagation*

**Adrian C. Salces**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)  
*Wireless Communications, Microwave  
Engineering and Antenna Design*

**Christopher G. Santos**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)  
*Microelectronics, Mixed Signal Circuits*

**Adjunct Professors**

**Raymond C. Nuñez**

Ph.D. Computer Science  
University of the Philippines Diliman (in progress)  
*Computer and Network Security*

**Dwight David M. Simon**

Ph.D. Electrical and Electronics Engineering  
University of the Philippines Diliman, 2007  
*Computer Networks and Telecommunications*

**Lecturers**

**Luis M. Alarilla**

Ph.D. Electrical Engineering  
Iowa State University, 1974

**Sukarno A. Ali**

M. Community Development  
University of the Philippines Diliman, 2001

**Christiensen D.C. Arandilla**

M.S. Electrical Engineering,  
University of the Philippines Diliman (in progress)

**Bryan Edward R. Ayson**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)

**Sherry Joy Alvionne S. Baquiran**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2014

**Steven Matthew Cheng**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)

**Mary Ann Z. Constante**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)

**Calvin Artemis G. Hilario**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)

**David Roman E. Kayanan**

B.S. Electrical Engineering  
University of the Philippines Diliman, 2015

**Wilbert Jethro R. Limjoco**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)

**Aristotle D. Lopez**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)

**Romarie U. Lorenzo**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2009

**Aurelia C. Mechilina**

Ph.D. Materials Science and Engineering  
University of the Philippines Diliman (in progress)

**Miro Jan Benedict G. Navarro**

M.S. Electrical Engineering  
University of the Philippines Diliman (in progress)

**Leonard Bryan B. Paet**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2011

## ELECTRICAL AND ELECTRONICS ENGINEERING INSTITUTE

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### **Christian Raymund K. Roque**

M.S. Electrical Engineering  
University of the Philippines Diliman, 2005

### ***Support Staff***

Sukarno A. Ali  
Precision Instrument Technician

Rogelio M. Lagahit, Jr.  
Precision Instrument Technician

Ma. Dolores C. Pernia  
University Research Associate

Cesar U. Regidor  
Administrative Officer

Amelia M. Yanzon  
Administrative Officer

Veronica B. Centeno  
Administrative Assistant

## **CONTACT INFORMATION**

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# ELECTRICAL AND ELECTRONICS ENGINEERING INSTITUTE

## 5.8 UNDERGRADUATE PROGRAMS CURRICULA

### BACHELOR OF SCIENCE IN COMPUTER ENGINEERING, 2015<sup>†</sup>

First Year								
First Semester			Second Semester			Lect	Lab	Units
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
GE (AH 1) Eng 10 (College English)	3	0	3	GE (AH 2) Comm 3 (Pract Speech Fund)	3	0	3	
GE (SSP 1) Philo 1 (Philosophical Analysis)	3	0	3	Physics 71 (Elementary Physics I)	4	0	4	
GE (SSP 2) Kas 1 <sup>1</sup> (Kasaysayan ng Pil)	3	0	3	Math 53 (Elementary Analysis I)	5	0	5	
Math 17 (Algebra and Trigonometry)	5	0	5	EEE 11 (Programming Fundamentals)	2	3	3	
Chem 16 (General Chemistry)	3	6	5	EEE 31 (Introduction to EEE)	3	0	3	
PE <sup>4</sup> (Physical Education)			(2)	PE <sup>4</sup> (Physical Education)			(2)	
	17	6	19		17	3	18	
Second Year								
First Semester			Second Semester			Lect	Lab	Units
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
Math 54 (Elementary Analysis II)	5	0	5	Math 55 (Elementary Analysis III)	3	0	3	
Physics 72 (Elementary Physics II)	4	0	4	Math 114 (Linear Algebra)	3	0	3	
EEE 13 (Programming Appl in EEE)	2	3	3	ES 1 (Engineering Design)	0	6	2	
EEE 21 (Switching Theory & Dig Log Des)	3	0	3	ES 11 (Statics of Rigid Bodies)	2	3	3	
EEE 33 (Electric Circuit Theory)	4	0	4	EEE 23 (Electromagnetic Fields I)	4	0	4	
EEE 34 (Electrical Measurements Lab)	0	3	1	EEE 35 (Signals and Systems)	3	3	4	
PE <sup>4</sup> (Physical Education)			(2)	PE <sup>4</sup> (Physical Education)			(2)	
NSTP <sup>5</sup> (National Service Training Program)			(3)	NSTP <sup>5</sup> (National Service Training Program)			(3)	
	18	6	20		15	12	19	
Third Year								
First Semester			Second Semester			Lect	Lab	Units
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
GE (MST1) STS (Science, Tech & Society)	3	0	3	GE (AH3) Fil 40 <sup>1</sup> (Wika, Kultura, at Lipunan)	3	0	3	
ES 12 (Dynamics of Rigid Bodies)	2	3	3	EEE 51 (Electronic Circuits I)	3	0	3	
EEE 25 (Probability & Stat for E&E Engrs)	3	0	3	EEE 52 (Electronic Circuits Lab I)	0	3	1	
EEE 41 (Intro to Semicon Devices & Cir)	3	0	3	EEE 53 (Electronic Circuits II)	3	0	3	
EEE 42 (Semicon Devices & Circuits Lab)	0	3	1	EEE 100 (Elect Circuits Proto Lab)	0	3	1	
EEE 43 (Electromechanical Energy Conv)	3	0	3	EEE 101 (Control Systems Theory)	3	0	3	
CoE 23 (Synthesis of Sequential Circuits)	2	3	3	EEE 105 (Computer Organization)	3	3	4	
	16	9	19		15	9	18	
Fourth Year								
First Semester			Second Semester			Lect	Lab	Units
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
GE (MST 2) <sup>3</sup> Free Choice	3	0	3	GE (SSP 3) Free Choice	3	0	3	
EEE 54 (Electronic Circuits Lab II)	0	3	1	CoE 113 (Advanced Computer Org)	3	3	4	
EEE 107 (Intro to Communication Systems)	2	3	3	CoE 115 (Introduction to Embedded $\mu$ C)	2	3	3	
CoE 111 (Advanced Digital Design)	2	3	3	CoE 134 (Computer Systems Engg II)	1	3	2	
CoE 133 (Computer Systems Engg I)	2	0	2	CoE 151 (Computer Networks)	3	3	4	
CoE 135 (Operating Systems)	2	3	3					
Elective			3					
	11	12	18		12	12	16	
Fifth Year								
First Semester			Second Semester			Lect	Lab	Units
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
GE (AH 4) Free Choice <sup>2</sup>	3	0	3	GE (SSP 5) Free Choice	3	0	3	
GE (SSP 4) Free Choice	3	0	3	GE (AH 5) Free Choice <sup>2</sup>	3	0	3	
PI 100 (The Life and Works of Jose Rizal)	3	0	3	GE (MST 3) Free Choice <sup>3</sup>	3	0	3	
CE 22 (Engineering Economy)	3	0	3	CoE 198 (Special Problems in CoE)	2	9	5	
EEE 190 (Project Proposals)	1	3	2	Elective			3	
Elective			3					
	13	3	17		11	9	17	

Total Number of Units = 181

#### Notes:

<sup>†</sup> Effective AY 2010-2011. Total number of units = 181

<sup>1</sup> Kas 1 and Fil 40 satisfy the 6-unit Philippine Studies requirement

<sup>2</sup> Nine (9) units of GE (AH) courses must be in Communication in English

<sup>3</sup> Except for Math 1, GE (MST) Math, Physics, Chem, ES, and EEE cannot be credited as GE courses

<sup>4</sup> For physical education (PE), the student is required to complete any 4 physical education (PE) courses

<sup>5</sup> As a requirement for graduation, all students must take six (6) units in one of the National Service Training Program (NSTP) components:

Civic Welfare Training Service (CWTS), Literacy Training Service (LTS), and Reserved Officer's Training Corps Military Science (ROTC Mil Sci)



**ELECTRICAL AND ELECTRONICS ENGINEERING INSTITUTE**

**BACHELOR OF SCIENCE IN ELECTRICAL ENGINEERING, 2015<sup>†</sup>**

First Year								
First Semester			Second Semester			Lect	Lab	Units
	(hrs/wk)	(hrs/wk)		(hrs/wk)	(hrs/wk)			
GE (AH 1) Eng 10 (College English)	3	0	3	GE (AH 2) Comm 3 (Pract Speech Fund)	3	0	3	
GE (SSP 1) Philo 1 (Philosophical Analysis)	3	0	3	Math 53 (Elementary Analysis I)	5	0	5	
GE (SSP 2) Kas 1 <sup>1</sup> (Kasaysayan ng Pil)	3	0	3	Physics 71 (Elementary Physics I)	4	0	4	
Chem 16 (General Chemistry)	3	6	5	EEE 11 (Programming Fundamentals)	2	3	3	
Math 17 (Algebra and Trigonometry)	5	0	5	EEE 31 (Introduction to EEE)	3	0	3	
PE <sup>4</sup> (Physical Education)			(2)	PE <sup>4</sup> (Physical Education)			(2)	
	17	6	19		17	3	18	
Second Year								
First Semester			Second Semester			Lect	Lab	Units
	(hrs/wk)	(hrs/wk)		(hrs/wk)	(hrs/wk)			
EEE 21 (Switching Theory & Dig Log Des)	3	0	3	EEE 23 (Electromagnetic Fields I)	4	0	4	
EEE 13 (Programming Appl in EEE)	2	3	3	EEE 35 (Signals and Systems)	3	3	4	
EEE 33 (Electric Circuit Theory)	4	0	4	ES 11 (Statics of Rigid Bodies)	2	3	3	
EEE 34 (Electrical Measurements Lab)	0	3	1	Math 55 (Elementary Analysis III)	3	0	3	
Physics 72 (Elementary Physics II)	4	0	4	Math 114 (Linear Algebra)	3	0	3	
Math 54 (Elementary Analysis II)	5	0	5	ES 1 (Engineering Drawing)	0	6	2	
PE <sup>4</sup> (Physical Education)			(2)	PE <sup>4</sup> (Physical Education)			(2)	
NSTP <sup>5</sup> (National Service Training Program)			(3)	NSTP <sup>5</sup> (National Service Training Program)			(3)	
	18	6	20		15	12	19	
Third Year								
First Semester			Second Semester			Lect	Lab	Units
	(hrs/wk)	(hrs/wk)		(hrs/wk)	(hrs/wk)			
GE (MST1) STS (Science, Tech & Society)	3	0	3	GE (AH 3) Fil 40 <sup>1</sup> (Wika, Kultura, at Lipunan)	3	0	3	
GE (SSP 3) Free Choice	3	0	3	EE 143 (Electrical Machine Dyn & Ctrl)	3	0	3	
EEE 25 (Probability & Stat for E&E Engrs)	3	0	3	EEE 44 (Electrical Machine Op & Ctrl)	0	3	1	
EEE 41 (Intro to Semicon Devices & Cir)	3	0	3	EEE 53 (Electronic Circuits II)	3	0	3	
EEE 42 (Semicon Devices & Circuits Lab)	0	3	1	EEE 54 (Electronic Circuits Lab II)	0	3	1	
EEE 43 (Electromechanical Energy Conv)	3	0	3	EEE 100 (Electronic Circuits Proto Lab)	0	3	1	
ES 12 (Dynamics of Rigid Bodies)	2	3	3	EEE 101 (Control Systems Theory)	3	0	3	
	17	6	19	EEE 103 (Intro to Electric Power Systems)	3	0	3	
					15	9	18	
Fourth Year								
First Semester			Second Semester			Lect	Lab	Units
	(hrs/wk)	(hrs/wk)		(hrs/wk)	(hrs/wk)			
GE (AH 4) Free Choice <sup>2</sup>	3	0	3	EE 121 (Intro to Power Electronics)	2	3	3	
EE 145 (Electrical Equipment & Devices)	3	0	3	EE 153 (Electric Power Distn Systems)	3	0	3	
EE 146 (Electrical Power Measurement)	0	3	1	EEE 51 (Electronic Circuit I)	3	0	3	
EEE 152 (Adv Power Systems Analysis)	2	3	3	EEE 52 (Electronic Circuit Lab I)	0	3	1	
EE 158 (Electrical System Design)	2	3	3	EEE 105 (Computer Organization)	3	3	4	
EEE 107 (Intro to Communication Systems)	2	3	3	ME 63 (Thermodynamics)	3	0	3	
Elective			3					
	12	12	19		14	9	17	
Fifth Year								
First Semester			Second Semester			Lect	Lab	Units
	(hrs/wk)	(hrs/wk)		(hrs/wk)	(hrs/wk)			
GE (SSP 4) Free Choice	3	0	3	GE (AH 5) Free Choice <sup>2</sup>	3	0	3	
GE (MST 2) Free Choice <sup>3</sup>	3	0	3	GE (SSP 5) Free Choice	3	0	3	
CE 22 (Engineering Economy)	3	0	3	GE (MST 3) Free Choice <sup>3</sup>	3	0	3	
Physics 73 (Elementary Physics III)	4	0	4	EE 198 (Special Problems in EE)	2	9	5	
EEE 190 (Project Proposals)	1	3	2	PI 100 (The Life and Works of Jose Rizal)	3	0	3	
Elective			3					
	14	3	18		14	9	17	
Total Number of Units = 184								

**Notes:**

<sup>†</sup> Effective AY 2010-2011. Total number of units = 184

<sup>1</sup> Kas 1 and Fil 40 satisfy the 6-unit Philippine Studies requirement

<sup>2</sup> Nine (9) units of GE (AH) courses must be in Communication in English

<sup>3</sup> Except for Math 1, GE (MST) Math, Physics, Chem, ES, and EEE cannot be credited as GE courses

<sup>4</sup> For physical education (PE), the student is required to complete any 4 physical education (PE) courses

<sup>5</sup> As a requirement for graduation, all students must take six (6) units in one of the National Service Training Program (NSTP) components:

Civic Welfare Training Service (CWTS), Literacy Training Service (LTS), and Reserved Officer's Training Corps Military Science (ROTC Mil Sci)

**ELECTRICAL AND ELECTRONICS ENGINEERING INSTITUTE**

**BACHELOR OF SCIENCE IN ELECTRONICS AND COMMUNICATIONS ENGINEERING, 2015<sup>†</sup>**

First Year								
First Semester			Second Semester			Lect	Lab	Units
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
GE (AH 1) Eng 10 (College English)	3	0	3	GE (AH 2) Comm 3 (Pract Speech Fund)	3	0	3	
GE (SSP 1) Philo 1 (Philosophical Analysis)	3	0	3	Math 53 (Elementary Analysis I)	5	0	5	
GE (SSP 2) Kas 1 <sup>1</sup> (Kasaysayan ng Pil)	3	0	3	Physics 71 (Elementary Physics I)	4	0	4	
Chem 16 (General Chemistry)	3	6	5	EEE 11 (Programming Fundamentals)	2	3	3	
Math 17 (Algebra & Trigonometry)	5	0	5	EEE 31 (Introduction to EEE)	3	0	3	
PE <sup>4</sup> (Physical Education)			(2)	PE <sup>4</sup> (Physical Education)			(2)	
	17	6	19		17	3	18	
Second Year								
First Semester			Second Semester			Lect	Lab	Units
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
GE (MST 1) STS (Science, Tech & Society)	3	0	3	EEE 23 (Electromagnetic Fields I)	4	0	4	
EEE 13 (Programming Appl in EEE)	2	3	3	EEE 35 (Signals and Systems)	3	3	4	
EEE 33 (Electric Circuit Theory)	4	0	4	ES 11 (Statics of Rigid Bodies)	2	3	3	
EEE 34 (Electrical Measurements Lab)	0	3	1	Math 55 (Elementary Analysis III)	3	0	3	
Physics 72 (Elementary Physics II)	4	0	4	Physics 73 (Elementary Physics III)	4	0	4	
Math 54 (Elementary Analysis II)	5	0	5	PE <sup>4</sup> (Physical Education)			(2)	
PE <sup>4</sup> (Physical Education)			(2)	NSTP <sup>5</sup> (National Service Training Program)			(3)	
NSTP <sup>5</sup> (National Service Training Program)			(3)		16	6	18	
	18	6	20					
Third Year								
First Semester			Second Semester			Lect	Lab	Units
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
EEE 21 (Sw Theory & Dig Log Des)	3	0	3	GE (AH) Fil 40 <sup>1</sup> (Wika, Kultura, at Lipunan)	3	0	3	
EEE 25 (Prob & Stat for E&E Engrs)	3	0	3	EEE 51 (Electronics Circuits I)	3	0	3	
EEE 41 (Intro to Semicon Devices & Cir)	3	0	3	EEE 52 (Electronic Circuits Lab I)	0	3	1	
EEE 42 (Semicon Devices & Circuits Lab)	0	3	1	EEE 107 (Intro to Comm Systems)	2	3	3	
EEE 43 (Electromechanical Energy Conv)	3	0	3	Math 114 (Linear Algebra)	3	0	3	
EEE 44 (Electrical Machine Op & Ctrl)	0	3	1	ES 1 (Engineering Design)	0	6	2	
ES 12 (Dynamics of Rigid Bodies)	2	3	3	ME 63 (Thermodynamics)	3	0	3	
	14	9	17		14	12	18	
Fourth Year								
First Semester			Second Semester			Lect	Lab	Units
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
ECE 141 (Digital Communications)	2	3	3	GE (SSP 3) Free Choice	3	0	3	
EEE 53 (Electronics Circuits II)	3	0	3	ECE 113 (Communication Electronics)	2	3	3	
EEE 54 (Electronics Circuits Lab II)	0	3	1	CoE 115 (Introduction to Embedded $\mu$ C)	2	3	3	
EEE 100 (Elect Circuits Proto Lab)	0	3	1	ECE 117 (Instrumentation Electronics)	2	3	3	
EEE 105 (Computer Organization)	3	3	4	ECE 151 (Communication Networks)	3	0	3	
EEE 101 (Control System Theory)	2	3	3	EEE 103 (Intro to Electric Power Systems)	3	0	3	
Elective			3		15	9	18	
	10	15	18					
Fifth Year								
First Semester			Second Semester			Lect	Lab	Units
	Lect (hrs/wk)	Lab (hrs/wk)	Units		Lect (hrs/wk)	Lab (hrs/wk)	Units	
GE (SSP 4) Free Choice	3	0	3	GE (SSP 5) Free Choice	3	0	3	
GE (AH 4) Free Choice <sup>2</sup>	3	0	3	GE (AH 5) Free Choice <sup>2</sup>	3	0	3	
GE (MST 2) Free Choice <sup>3</sup>	3	0	3	GE (MST 3) Free Choice <sup>3</sup>	3	0	3	
CE 22 (Engineering Economy)	3	0	3	ECE 198 (Special Problems in ECE)	2	9	5	
EEE 190 (Project Proposals)	1	3	2	PI 100 (The Life and Works of Jose Rizal)	3	0	3	
Elective			3		14	9	17	
Elective			3					
	13	3	20					

Total Number of Units = 183

**Notes:**

<sup>†</sup> Effective AY 2010-2011. Total number of units = 183.

<sup>1</sup> Kas 1 and Fil 40 satisfy the 6-unit Philippine Studies requirement

<sup>2</sup> Nine (9) units of GE (AH) courses must be in Communication in English

<sup>3</sup> Except for Math 1, GE (MST) Math, Physics, Chem, ES, and EEE cannot be credited as GE courses

<sup>4</sup> For physical education (PE), the student is required to complete any 4 physical education (PE) courses

<sup>5</sup> As a requirement for graduation, all students must take six (6) units in one of the National Service Training Program (NSTP) components: Civic Welfare Training Service (CWTS), Literacy Training Service (LTS), and Reserved Officer's Training Corps Military Science (ROTC Mil Sci)

5.9 GRADUATE PROGRAMS CURRICULA

**Master of Engineering in Electrical Engineering (M.Eng. EE)**

PROGRAM CHECKLIST

A. Required Major Courses <sup>1</sup>	15 units
B. Elective Courses <sup>2</sup>	14 units
C. Comprehensive Examination	
D. Seminar Course	
• EE 296 Seminar	1 unit

**Notes:**

1. Major Subject: Any creditable graduate-level EE course offered by the EEE Institute that is relevant to the area of specialization.
2. Elective: Any creditable graduate-level course that has been recommended for approval by the adviser and Institute graduate program committee; provided that all course prerequisites have been satisfied.

**Master of Science in Electrical Engineering (M.S. EE)**

PROGRAM CHECKLIST

A. Required Major Courses <sup>1</sup>	14 units
B. Elective Courses <sup>2</sup>	9 units
C. Thesis	
• EE 300	6 units
D. Seminar Course	
• EE 296 Seminar	1 unit

**Notes:**

1. Major Subject: Any creditable graduate-level EE course offered by the EEE Institute that is relevant to the area of specialization.
2. Elective: Any creditable graduate-level course that has been recommended for approval by the adviser and Institute graduate program committee; provided that all course prerequisites have been satisfied.

**Doctor of Engineering in Electrical and Electronics Engineering (D.Eng. EEE)**  
**Doctor of Philosophy in Electrical and Electronics Engineering (Ph.D. EEE)**

**For M.S. / M.Eng. Degree Holders**

PROGRAM CHECKLIST

A. Major <sup>1</sup> or Specialization <sup>2</sup> Courses	24 units
B. Dissertation <sup>3</sup>	
• EE 400	12 units

**Notes:**

- <sup>1</sup> Major Course: Any creditable Electrical and Electronics Engineering graduate course relevant to the field / area of specialization
- <sup>2</sup> Specialization Course: Any creditable graduate course relevant to the field of specialization, pre-approved by the adviser and for which all prerequisites have been satisfied
- <sup>3</sup> The student must submit a 12-unit dissertation where s/he makes an original contribution to the fundamental knowledge in the field (Ph.D.) or addresses an engineering problem of substance and develops a solution in a creative and distinguished manner (D.E.)

**Doctor of Engineering in Electrical and Electronics Engineering (D.E. EEE)**  
**Doctor of Philosophy in Electrical and Electronics Engineering (Ph.D. EEE)**

**For B.S. Degree Holders**

PROGRAM CHECKLIST

A. Major <sup>1</sup> Courses	24 units
B. Specialization Courses <sup>2</sup>	12 units
C. Applied Mathematics	9 units
D. Dissertation <sup>3</sup>	
• EE 400	12 units

**Notes:**

- <sup>1</sup> Major Course: Any creditable Electrical and Electronics Engineering graduate course relevant to the field / area of specialization
- <sup>2</sup> Specialization Course: Any creditable graduate course relevant to the field of specialization, pre-approved by the adviser and for which all prerequisites have been satisfied
- <sup>3</sup> The student must submit a 12-unit dissertation where s/he makes an original contribution to the fundamental knowledge in the field (Ph.D.) or addresses an engineering problem of substance and develops a solution in a creative and distinguished manner (D.E.)

### 5.10 UNDERGRADUATE PROGRAM RETENTION RULES

Students who wish to study and pursue careers in electrical and electronics engineering and any of its allied fields need to acquire a strong background in the fundamentals of mathematics, physics, and other engineering sciences, in addition to courses in their chosen field. To ensure that student aptitudes and interests match the rigors and demands of the program, and that graduates consistently meet the high quality standards expected of products of our programs, the Institute enforces academic retention rules that EEE undergraduate students must satisfy, in addition to existing College and University academic rules and regulations, in order to remain in good academic standing.

A student will be permanently dismissed from any EEE undergraduate program if he or she:

1. Incurs a grade other than a passing grade twice in any of these mathematics courses: (Math 17, Math 53, Math 54, Math 55);
2. Accumulates three or more grades other than passing grades in any combination of these mathematics courses (Math 17, Math 53, Math 54, Math 55);
3. Incurs a grade other than a passing grade twice in any of these basic EEE courses (EEE 23, EEE 31, EEE 33, EEE 35, EEE 41);
4. Accumulates three or more grades other than passing grades in any combination of these basic EEE courses (EEE 23, EEE 31, EEE 33, EEE 35, EEE 41)

For purposes of this retention rule, a 'grade other than a passing grade' includes the following: a 5.00, an unremoved 4.00, an unremoved 'Inc', or a 'DRP' recorded at the end of the semester or semesters under evaluation.

### 5.11 UNDERGRADUATE PROGRAMS COURSE DESCRIPTIONS

#### ***Computer Engineering (CoE)***

**CoE 23 Synthesis of Sequential Circuits.** Minimization of synchronous sequential circuits; synthesis of synchronous sequential circuits using structured techniques; delays and hazards; asynchronous Huffman circuits; physical characteristics of logic gate implementations. Prereq: EEE 11, EEE 21, EEE 34. 5 h (2 lec, 3 lab) 3 u.

**CoE 111 Advanced Digital Design.** Combinational and sequential circuits; structured design; digital design using programmable devices; hardware description language (HDL)-based digital design; simulation; testing of digital circuits. Coreq: EEE 105. 5 h (2 lec, 3 lab) 3 u.

**CoE 113 Advanced Computer Organization.** Instruction sets. Central processor implementations. Hardwired and micro-programmed control. Reduced instruction set computer (RISC) processors. Datapaths. Arithmetic and logic units (ALUs). Distributed systems. Performance enhancements. Prereq: CoE 111, EEE 105. 6 h (3 lec, 3 lab) 4 u.

**CoE 115 Introduction to Embedded Microcontrollers.** Introduction to embedded microcontrollers in electronic and electromechanical systems. Hardware and software design techniques. System interfaces, data acquisition and control. High speed design techniques. Prereq: EEE 105. 5 h (2 lec, 3 lab) 3 u.

**CoE 121 Introduction to Digital Signal Processing.** Discrete-time systems in frequency domain; digital filter design; linear prediction and optimum linear filters. Prereq: EEE 25, EEE 35. 6 h (3 lec, 3 lab) 4 u.

**CoE 123 Introduction to Digital Image and Video Processing.** Digital image fundamentals; introduction to two-dimensional digital signal processing (DSP); image enhancements and restoration algorithms; image filters; image coding and compression; video coding and standards; some applications of video and image processing. Prereq: EEE 35. 6 h (3 lec, 3 lab) 4 u.

**CoE 127 Audio and Speech Signal Processing.** Fundamental audio synthesis concepts; advanced techniques of audio signal processing, analysis and modeling; engineering models for speech signal analysis, synthesis and recognition. Prereq: CoE 121. 5 h (2 lec, 3 lab) 3 u.

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**CoE 129 Real-Time Digital Signal Processing.** Digital signal processor architectures; data converters; real-time concepts and programming; digital filtering; real-time spectral analysis. Prereq: CoE 121, EEE 105. 5 h (2 lec, 3 lab) 3 u.

**CoE 133 Computer Systems Engineering I.** History and overview of computer systems engineering. Computer engineering ethics. Software risks and reliability. Life cycles. Project management. Prereq: EEE 105. 2 u.

**CoE 134 Computer Systems Engineering II.** Requirements analysis and elicitation. Architectural design. Implementation, testing and maintenance issues. Prereq: CoE 133. 4 h (1 lec, 3 lab) 2 u.

**CoE 135 Operating Systems.** Overview and examples of operating systems. System calls. Process management. Threads. Scheduler. Interprocess communication and synchronization. Deadlock and starvation. Memory management. Virtual memory. I/O systems. File system. Prereq: EEE 13. 5 h (2 lec, 3 lab) 3 u.

**CoE 141 Introduction to Digital Integrated Circuit Design.** Concepts, economics and trends of integrated circuits (IC); MOS transistor characteristics and models; basic digital building blocks; structured digital circuits and systems. Prereq: EEE 21, EEE 41. 6 h (3 lec, 3 lab) 4 u.

**CoE 143 Introduction to Analog Integrated Circuit Design.** IC fabrication processes; analog device modeling; circuit simulation; amplifiers, comparators and other analog systems. Prereq: EEE 51. 6 h (3 lec, 3 lab) 4 u.

**CoE 151 Computer Networks.** Principles and practices of computer networking. Structures and components of networks. Packet switching. Layered architectures. Open systems interconnect (OSI) reference model. Transmission Control Protocol / Internet Protocol (TCP/IP). Prereq: EEE 13, 107. 6 h (3 lec, 3 lab) 4 u.

**CoE 153 Advanced Computer Networks.** Advanced topics in computer networks, including Internet architecture and design, multicast and advanced routing. Quality of service and congestion control. Network measurement and modeling. Mobile and ad-hoc networks. Web technologies and the Semantic Web. Application-layer overlay networks. Security and privacy. Emerging applications. Prereq: CoE 151. 5 h (2 lec, 3 lab) 3 u.

**CoE 197 Special Topics in Computer Engineering.** Prereq: COI. 2-4 u. (any combination of lec or lab); may be repeated for additional credit provided that the special topic should be indicated for record purposes.

**CoE 198 Special Problems in Computer Engineering.** Prereq: Approved project proposal from EEE 190, research laboratory affiliation. 11 h (2 lec, 9 lab) 5 u.

### ***Electronics and Communications Engineering (ECE)***

**ECE 113 Communication Electronics.** Resonant circuits and filters. Analog modulation and demodulation circuits. Frequency synthesis and phase locked loops. Basic concepts in radio frequency (RF) circuit design. Other communications circuits. Prereq: EEE 53, EEE 54, EEE 100, EEE 107. 5 h (2 lec, 3 lab) 3 u.

**ECE 117 Instrumentation Electronics.** Sensors in control systems; signal conditioning; data acquisition systems; actuators and controllers; industry standards. Prereq: EEE 34, EEE 51. 5 h (2 lec, 3 lab) 3 u.

**ECE 123 Digital Instrumentation and Control Techniques.** A/D-D/A conversion; process control; fundamentals of robotics; data acquisition; real time applications. Prereq: EEE 101. 3 u.

**ECE 129 Simulation and Control Laboratory.** System modeling; computer-aided control system design and computer simulation; op amps as feedback compensators; DC motor dynamics and control; closed-loop control and responses to step and ramp inputs. Prereq: EEE 52/COI, EEE 101. 5 h (2 lec, 3 lab) 3 u.

**ECE 131 Introduction to Robotics.** Coordinate transformations; forward and inverse kinematics; manipulator dynamics; control of manipulators; path planning. Prereq: EEE 101, ES 12, ES 21/COI. 3 u.

**ECE 133 Introduction to Mobile Robotics.** Mobile robot control. Software architectures. Interoceptive and exteroceptive sensors. Sensor interpretation. Map building and navigation. Mobile robot construction. Prereq: EEE 35, ES 12 and EEE 11 or COI. 5 h (2 lec, 3 lab) 3 u.

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**ECE 141 Digital Communications.** Sampling and quantization; baseband pulse transmission; multiplexing; digital modulation techniques; bit error rates and spectral efficiency; clock recovery; information theory and error control coding; spread spectrum modulation. Prereq: EEE 107. 5 h (2 lec, 3 lab) 3 u.

**ECE 151 Communication Networks.** Telephony; telephone traffic, switching and signaling systems; multiplexing; trunking theory; modem standards; optical communication systems; open systems interconnect (OSI) layers for communication systems. Prereq: EEE 107. 3 u.

**ECE 153 Wireless Communications.** Radiowave propagation; antenna basics; large-scale path loss models; small-scale fading; cellular and satellite communication systems; multiple access techniques; current topics of interest in wireless communications. Prereq: EEE 23; Coreq: ECE 141. 3 u.

**ECE 155 Modern Audio Engineering.** Fundamentals of sound and hearing; audio tests and measurements; electrical and environmental noise and noise reduction in audio systems; microphones and loudspeakers; audio processing electronics and acoustics; practical audio systems. Prereq: EEE 107. 5 h (2 lec, 3 lab) 3 u.

**ECE 157 Microwave Engineering I.** Review of electromagnetics; transmission line theory and wave-guides; the Smith chart; network analysis and port parameters; impedance matching; passive and active microwave circuits. Coreq: EEE 23, EEE 107. 3 u.

**ECE 159 Microwave Engineering II.** Microwave materials and processes; laminates; metals; solders; packaging; connectors; resistance, inductance, and capacitance (RLC) measurements; transmission lines; microstrip circuits; test and measurement equipment and software for microwave communication systems. Prereq: ECE 157, EEE 100. 5 h (2 lec, 3 lab) 3 u.

**ECE 197 Special Topics in Electronics and Communications Engineering.** Prereq: COI. 2-4 u. (any combination of lec or lab); may be repeated for additional credit provided that the special topic should be indicated for record purposes.

**ECE 198 Special Problems in Electronics and Communications Engineering.** Prereq: Approved project proposal from EEE 190, research laboratory affiliation. 11 h (2 lec, 9 lab) 5 u.

### *Electrical Engineering (EE)*

**EE 121 Introduction to Power Electronics.** Switching converter principles, harmonics, pulse-width modulation, phase control and phase modulation. Single-phase and three-phase rectifiers. AC voltage controllers, DC/DC converters and DC/AC inverters. Converter transfer functions. Prereq: EEE 42, EEE 53. 5 h (2 lec, 3 lab) 3 u.

**EE 123 Electric Motor Drives.** Electric drive systems; steady-state analysis of direct current, induction, synchronous, and reluctance motor drives; efficiency, harmonics, and converter-motor interaction. Prereq: EE 121, EEE 43. 3 u.

**EE 143 Electrical Machine Dynamics and Control.** Dynamic models and characteristics of electrical machines. Applications and control of direct-current, synchronous, induction and reluctance machines. Prereq: EEE 43. 3 u.

**EE 145 Electrical Equipment and Devices.** Operating principles, characteristics and applications of transformers, switchgear, and other electrical equipment and devices used for power system protection and control. Prereq: EEE 43, EEE 103. 3 u.

**EE 146 Electric Power Measurements and Equipment Characterization.** Power measurements. Performance evaluation and parameter measurement of electrical machines and transformers. Prereq: EEE 43, EEE 44, EEE 103. 3 h (3 lab) 1 u.

**EE 147 Energy-Efficient Lighting Systems.** Fundamentals of lighting, vision, and color. Electric light source and ballast technologies. Luminaires and optical control. Light loss factors. Average illuminance calculations. Calculation of illuminance at a point. Lighting quantity and quality assessment. Design of energy-efficient lighting for interiors. Design of energy-efficient lighting for exteriors. Strategies and technologies for control of energy-efficient lighting. Daylighting. Building energy codes and standards. Lighting economics. Prereq: EEE 41, EEE 101. 3 u.

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**EE 148 Electrical Machine Design.** Design of transformers, rotating machines, and selected electrical equipment and devices. Prereq: EEE 143. 3 u.

**EE 151 Power System Operation.** Philippine Grid Code. Voltage and frequency control. Operating reserve. Unit commitment. Economic dispatch. Optimal power flow. Energy interchange. System security and reliability. Transmission network operations in competitive electricity markets. Prereq: EEE 103. 5 h (2 lec, 3 lab) 3 u.

**EE 152 Advanced Power Systems Analysis.** Large-scale power system studies using computer methods: matrix techniques and numerical methods. Network building. Load flow studies, fault studies and rotor angle stability. Electromagnetic transients analysis. Prereq: EEE 13, EEE 103. 5 h (2 lec, 3 lab) 3 u.

**EE 153 Electric Power Distribution Systems.** Substation, subtransmission and distribution system design. Distribution system models and load flow, short-circuit, reliability, and system loss analysis. Distribution planning. Distribution automation. Prereq: EE 103, EEE 145. 3 u.

**EE 157 New Energy Systems.** Non-conventional energy resources and conversion technologies; new energy systems for off-grid applications; grid integration issues of non-conventional and new energy systems; planning and operations of electric power systems with intermittent energy systems. Prereq: EEE 103. 3 u.

**EE 158 Electrical System Design.** Choice of systems and selection, arrangement and protection of components for power, lighting and auxiliary systems of residential, institutional, commercial, and industrial power systems; illumination design. Prereq: EEE 103. 5 h (2 lec, 3 lab) 3 u.

**EE 159 Industrial Power Systems.** Selection and arrangement of electrical equipment for distribution, control, protection and metering in industrial plants, substations and modern power plants. Prereq: EEE 158. 5 h (2 lec, 3 lab) 3 u.

**EE 197 Special Topics in Electrical Engineering.** Coreq: COI. 2-4 u. (any combination of lec or lab); may be repeated for additional credit provided that the special topic should be indicated for record purposes.

**EE 198 Special Problems in Electrical Engineering.** Prereq: Approved project proposal from EEE 190, research laboratory affiliation. 11 h (2 lec, 9 lab) 5 u.

### ***Electrical and Electronics Engineering (EEE)***

**EEE 1 Essentials of Electrical and Electronics Engineering.** Analysis of alternating current (AC) and direct current (DC) circuits; motors and generators, characteristics and methods of control; diode and transistor circuits; current digital circuits and logic gates; transducers and transducer circuits; operational amplifiers; motor control; feedback control systems; introduction to digital control; programmable logic controllers. Prereq: ES 21/Math 121.1/equiv., Physics 72/102. 6 h (3 lec, 3 lab) 4 u.

**EEE 3 Elementary Electrical Engineering.** Fundamentals of electric and magnetic circuits; transformers; direct and alternating current machinery; elementary distribution systems and electrical wiring. Prereq: Math 54, Physics 72. 3 u.

**EEE 4 Industrial Electronics and Equipment.** Electrical measurements and some of their industrial applications. Operating principles, characteristics and application of electrical equipment. Equipment and devices used for system protection and control. Applications in power and industrial systems. Modern control devices in industry. Prereq: EEE 1 or EEE 3. Credits: 5 h (2 lec, 3 lab) 3 u.

**EEE 5 Introduction to Semiconductor Devices and Circuit Theory.** Elementary circuit analysis; semiconductor devices; introduction to transducers, operational amplifiers, and digital design. Prereq: Math 54, Physics 72, Physics 72.1. 6 h (3 lec, 3 lab) 4 u.

**EEE 7 Microcontroller-Based Data Acquisition Systems.** Analog-to-digital conversion. Digital-to-analog conversion. Sensors and transducers. Signal conditioning. Data acquisition systems. Microcontroller programming and interfacing. Data transfer and visualization. Prereq: EEE 1 or EEE 3. 5 h (2 lec, 3 lab) 3 u.



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**EEE 11 Programming Fundamentals.** Programming fundamentals. Data types. Control loops. Fundamental principles of software engineering. Functions. Standard libraries. Arrays and strings. Structure and union. File I/O. Fundamental data structures. Pointers. Prereq: Math 17. 5 h (2 lec, 3 lab) 3 u.

**EEE 13 Programming Applications in Electrical and Electronics Engineering.** Data structures. Algorithm performance. System calls. Fundamental database concepts. Graphical user interface principles. Fundamental network programming. Prereq: EEE 11 or equiv. 5 h (2 lec, 3 lab). 3 u.

**EEE 21 Switching Theory and Digital Logic Design.** Combinational logic analysis and design. Digital integrated circuit building blocks. Design of digital subsystems. Analysis and synthesis of sequential circuits. Introduction to hardware description languages. Prereq: Math 17. 3 u.

**EEE 23 Electromagnetic Fields I.** Vector analysis; steady electric and magnetic fields; dielectric and magnetic materials; time-varying fields. Maxwell's equations; introduction to uniform plane waves and transmission lines; applications to electrical engineering. Coreq: Physics 72; Prereq: Math 55. 4 u.

**EEE 25 Probability and Statistics for Electrical and Electronics Engineers.** Review of descriptive statistics; combinatorial probability; single and bivariate random variables; expectation; sum of two independent random variables; introduction to estimation; introduction to random processes. Prereq: Math 55. 3 u.

**EEE 31 Introduction to Electrical and Electronics Engineering.** Fundamental concepts and laws in electrical and electronics engineering. Magnetism. Electrical and electronic devices. DC analysis of resistive networks. Overview of different fields in electrical and electronics engineering. Demonstration of basic concepts. Prereq: Math 17. 3 u.

**EEE 33 Electric Circuit Theory.** Network theorems. AC circuit analysis. Equilibrium equations for resistance-inductance-capacitance (RLC) networks. Transient analysis of first-order and higher-order networks. Sinusoidal steady-state analysis. Polyphase circuits. Prereq: Math 53, EEE 31. 4 u.

**EEE 34 Electrical Measurements Laboratory.** Laboratory procedures and practice; data collection and analysis; laboratory documentation; standard electric instruments and circuits; basic electric circuit behavior; transducers. Coreq: EEE 33. 3 h (3 lab) 1 u.

**EEE 35 Signals and Systems.** Mathematical modeling of signals and systems. Continuous- and discrete-time signals. System analysis techniques and their applications to electric and electronic circuits, filter design, communications, control and signal processing. Linear time-invariant (LTI) systems. Frequency domain representation of signals and system transfer functions. Two-port networks. Fourier-, Laplace- and Z-transforms. Prereq: Math 54, EEE 11, EEE 33. 6 h (3 lec, 3 lab) 4 u.

**EEE 41 Introduction to Semiconductor Devices and Circuits.** Semiconductor devices: diodes, bipolar junction transistors, field effect transistors; device models and circuit applications; regions of operation; large and small signal modeling and analysis; semiconductor theory. Prereq: EEE 23, EEE 33. 3u.

**EEE 42 Semiconductor Devices and Circuits Laboratory.** Characteristics, parameters, and non-idealities of actual diodes, bipolar junction transistors (BJTs) and field effect transistors (FETs); basic circuit applications. Prereq: EEE 34; Coreq: EEE 41. 3 h (3 lab) 1 u.

**EEE 43 Electromechanical Energy Conversion.** Basic principles; generalized machine model; direct current, synchronous and induction machines. Prereq: EEE 23, EEE 33. 3 u.

**EEE 44 Electrical Machine Operation and Control.** Operation and control of rotating machines. Motor and generator control devices and circuits. Programmable logic controllers. Prereq: EEE 34, Coreq: EEE 43. 3 h (3 lab) 1 u.

**EEE 51 Electronic Circuits I.** Transistor amplifiers. Feedback amplifiers. Operational amplifiers. Linear regulators. Prereq: EEE 41. 3 u.

**EEE 52 Electronic Circuits Laboratory I.** Performance measurements and behavior analysis of analog circuits. Prereq: EEE 42; Coreq: EEE 51. 1 u.

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**EEE 53 Electronic Circuits II.** Active switching circuits. Waveshaping circuits. Pulse and digital circuits. Analog and digital circuit building blocks. Linear and switch-mode regulators. Prereq: EEE 21, EEE 41. 3 u.

**EEE 54 Electronic Circuits Laboratory II.** Construction, performance measurements and behavior analysis of pulse, wave-shaping, timing and digital circuits. Prereq: EEE 42; Coreq: EEE 53. 3 h (3 lab) 1 u.

**EEE 100 Electronic Circuits Prototyping Laboratory.** Basic prototyping skills for electronic circuits including soldering, schematic design entry, printed circuit board (PCB) layout and routing, PCB fabrication. Safe laboratory practices. Computer aided design tools. Overview of industrial prototyping processes and standards. Prereq: ES 1, EEE 42. 3 h (3 lab) 1 u.

**EEE 101 Control Systems Theory.** Continuous and discrete systems; open and closed loop systems; transfer functions; block diagrams. Signal flow graphs; state variables; state transition matrix; stability; controllability and observability. Prereq: ES 12, EEE 35; Coreq: EEE 41. 3 u.

**EEE 103 Introduction to Electric Power Systems.** Electric power industry. Power system components and system modeling. Per unit system. Symmetrical components. Load flow analysis. Short circuit analysis. Prereq: EEE 23, EEE 33. 3 u.

**EEE 105 Computer Organization.** Instruction sets. Computer arithmetic. Datapath and control. Memory system organization and architecture. Interfacing and communication. Assembly language programming. Prereq: EEE 11, EEE 21, EEE 41. 6 h (3 lec, 3 lab) 4 u.

**EEE 107 Introduction to Communication Systems.** Signals and spectra; noise and distortion; transmission, reception, and detection; continuous-wave modulation and baseband digital pulse modulation; examples of practical communication systems. Prereq: EEE 25, EEE 34, EEE 35. 5 h (2 lec, 3 lab) 3 u.

**EEE 190 Project Proposals, Inspection Trips, and Seminars.** Project proposal documentation and presentation; visits to companies, factories, and electrical power plants; seminars on topics such as research, technical writing, presentation skills, career planning, engineering ethics, and technopreneurship. Prereq: SS, research laboratory affiliation. 4 h (1 lec, 3 lab) 2 u.

### *REVITALIZED GENERAL EDUCATION COURSE*

#### ***Electrical and Electronics Engineering (EEE)***

**EEE 10 Everyday EEE: Kuryente, Radyo, atbp.** Electrical and electronics engineering in everyday life. 3 u.

## 5.12 GRADUATE PROGRAMS COURSE DESCRIPTIONS

### ***Electrical Engineering (EE)***

**EE 212 Linear System Theory.** Theory and application of discrete and continuous-time linear dynamical systems. Review of applied linear algebra; least-norm and least-squares methods. Autonomous linear dynamical systems; interpretations of eigenvalues, eigenvectors, matrix exponential, and invariant sets. Singular value decomposition with applications. Linear dynamical systems with inputs and outputs; transfer matrices. Observability and state estimation; controllability and state transfer. Examples and applications from digital filters, circuits, signal processing, and control systems. Prereq: EEE 35 and Math 114 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 214 Probability and Random Processes in Electrical Engineering.** Review of combinatorial probability. Random variables and vectors. Discrete and continuous distributions. Conditional and multivariate probabilities. Functions of random variables. Mathematical expectations. Autocorrelation and power spectral density. Stochastic models. Stationarity and cyclostationarity. Higher order statistics, cumulants and polyspectra. Spectral-correlation density. Prereq: EEE 25 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 217 Electromagnetic Fields II.** Review of Maxwell's equations. Propagation phenomena of plane waves in dielectric and conducting media. Transmission lines, waveguides and resonators. Antennas and radiation. Fiber optics and optoelectronic systems. Prereq: EEE 23 or equiv. 3 u.

**EE 218 System Identification.** Introduction to point estimation, least squares, Bayes risk, and maximum likelihood. Optimum mean-square recursive estimation for non-dynamic stochastic systems. State estimation for discrete-time and continuous-time dynamic systems. Parameter identification of stochastic systems using maximum likelihood. Stochastic approximation, least squares, and random search algorithms. Applications to controls, communication, and signal processing. Prereq: EE 212 and EE 214. 3 u.

**EE 220 Analog Integrated Circuits.** Integrated circuit devices and modeling. Noise analysis and modeling. Review of basic operational amplifier design and compensation. Advanced current mirrors and operational amplifiers. Operational transconductance amplifiers. Common-mode feedback circuits. Comparators. Sample and holds. Voltage references and translinear circuits. Discrete-time signals. Switched-capacitor circuits. Coreq: CoE 143 or equiv. 6 h (3 lec, 3 lab) 4 u.

**EE 221 Electronic Amplifier Design.** Linear and non-linear models of field-effect and bipolar junction transistors at low and high frequencies; theory, design and application of class A, B, C, D, E, F amplifiers, wide band low-pass amplifiers, distributed amplifiers, power amplifiers, tuned amplifiers, feedback amplifiers, operational amplifiers, parametric amplifiers, sense amplifiers, and other special amplifiers; biasing; gain-bandwidth; noise mechanisms and low-noise design; passive components; performance evaluation and optimization; integrated circuit implementations; design projects. Prereq: COI. 4 u.

**EE 223 Design of Signal Processing Systems.** System modeling. Computational algorithms. Architecture mapping. Hardware optimizations. SoC applications. Prereq: EE 227 and EE 274. 3 u.

**EE 224 Mixed Signal Systems.** Signals and filters. Sampling and aliasing. Analog and digital filters. Analog-to-digital converters. Digital-to-analog converters. Sample/hold amplifiers. Mixed-signal applications. Prereq: EE 220. 5 h (2 lec, 3 lab) 3 u.

**EE 225 Solid State Electronics and Semiconductor Devices.** Conduction mechanisms in semiconductors and metals. Physics, characteristics and models of p-n junction diode. Bipolar junction transistors. Junction and MOS field-effect transistors. Trends in scaled MOSFETs. Short channel MOSFETs. Prereq: EEE 41 or equiv. 4 u.

**EE 226 Digital Integrated Circuits.** Fundamentals of MOSFETS. Technology and modeling. Scaling and limits of scaling. Design for deep-submicron CMOS- high speed. Design techniques for low power. Arithmetic circuits. Driving interconnect, high-speed signaling. Timing. Memory design. Design for testability. Prereq: COE 141 or equiv. 6 h (3 lec, 3 lab) 4 u.

**EE 227 Modern VLSI Design.** Digital systems and VLSI. Transistors and layout. Logic functions. Combinational logic networks. Sequential machines. Systems architecture design and HDLs. Subsystem design and IP components. CAD systems and algorithms. Prereq: EEE 21 or equiv. 3 u.

**EE 229 RF Integrated Circuit Design.** Introduction to RF and wireless technology. Characteristics of passive devices at RF. High-frequency amplifier design. Analysis of distortion in amplifiers. Low-noise amplifiers and mixers. Oscillators. Frequency synthesizers. Power amplifiers. Phased-locked loops. Modulators and demodulators. Transceiver architectures. Prereq: EE 220. 3 u.

**EE 231 Advanced Feedback Control Systems.** Transfer functions. Block diagrams. Signal flow graphs. Root locus, Bode, Nyquist and polar plots. Sensitivity. Stability. Compensation techniques. Multivariable systems. Disturbance rejection. Robust control. Adaptive control. state-variable representation and feedback; state-space design; optimal control, computer simulations; design projects. Prereq: EEE 101 or equiv. 3 u.

**EE 233 Digital Control Systems Design.** Z-transforms and state variable representation of discrete-time systems; models for mixed continuous and discrete-time systems; modeling asynchronous sampling; analysis and design by root locus, frequency response, and state-space techniques; controllability, observability and observer design; linear quadratic optimal control and state estimation; optimization and design issues of mixed continuous and discrete-time systems; inter sample behavior; robust control; sampling rate selection; effects of quantization and finite precision errors ; multi-variable control and optimization; multirate systems; computer simulations; design projects. Prereq: EEE 101 or equiv. 5 h (2 lec, 3 lab) 3 u.

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**EE 234 Advanced Data Acquisition Systems.** Sensors and industrial standards. Storage and display devices. Sensor networks. Prereq: COI. 5 h (2 lec, 3 lab) 3 u.

**EE 235 Nonlinear Control Theory.** Introduction to nonlinear control with emphasis on differential geometric methods. Linear and nonlinear dynamical systems analysis methods. Describing functions. Lyapunov theory. Popov and the circle criteria. Bifurcation analysis. Controllability, accessibility and observability of nonlinear systems. Differential geometry and nonlinear control from the geometric point of view. Prereq: EE 212. 3 u.

**EE 236 Principles of Robotics.** Definition of robots and manipulators. Different transformations involved in the study of manipulators. Kinematics and dynamics. Trajectory planning. Prereq: COI. 3 u.

**EE 237 Advanced Robotics.** Dynamical models for manipulator in Lagrange and Newton-Euler formulations. Controller design based on manipulator dynamics. PID-controllers, eigenvalue assignment and adaptive self-tuning control. Controllers for compliant motion. Prereq: ECE 131. 3 u.

**EE 238 Mobile Robotics.** Locomotion. Robot kinematics. Perception. Navigation and planning. Map-building. Mobile robot localization. Prereq: COI. 5 h (2 lec, 3 lab) 3 u.

**EE 240 Power Electronics I.** Application of semiconductor devices and circuits to power systems; power control, conditioning, processing and switching. Prereq: EEE 53 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 241 Linear and Switching Power Supplies.** Linear converters. Switchmode topologies. DC/DC, AC/DC, DC/AC converters. Applications. Power supply simulation. Prereq: EEE 53 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 242 Industrial Electronics.** Electrical transients. Three phase circuits. Fourier series. Transformers. Rectification. AC/DC thyristor converters. Forced Commutation. PWM motor control. AC power control. Applications. Prereq: EEE 101 and EEE 103 or equiv. 3 u.

**EE 243 Electromagnetic Compatibility.** Transmission lines. Emissions. Modeling. Susceptibility. PCB Design. Shielding. Grounding. Prereq: EEE 23 and EEE 53 or equiv. 3 u.

**EE 245 Advanced Theory of Electrical Machines.** Reference frames and generalized machine theory. Modeling and analysis of rotating machines during steady state, transient, and dynamic conditions. Prereq: EEE 43 or equiv. 3 u.

**EE 246 Dynamics and Control of Electric Motor Drives.** Phase- and chopper-controlled DC motor drives. Dynamic modeling of AC machines. Frequency-, phase-, and vector-controlled induction motor drives. Permanent magnet AC, brushless DC, and switched-reluctance motor drives. Simulation of electric drive systems. Prereq: EEE 43 and EEE 51 or equiv. 3 u.

**EE 248 Power Amplifiers.** Linear amplification. Voltage and current mode amplifiers. Amplifier classes A, B, AB, C. Trans-conductance amplifiers. Composite amplifiers. Resonant and switchmode amplifiers. Prereq: EEE 53 or EE 121 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 249 Power Electronics II.** Principles of steady state converter analysis. Steady state equivalent circuit modeling. Converter circuits. AC circuit modeling. Converter transfer functions. Prereq: EE 240 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 251 Fault Studies.** Symmetrical components. Sequence impedances of transmission lines, synchronous machines and transformers. Phase-domain and sequence-domain analysis of unbalanced and simultaneous faults. Prereq: EEE 103 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 252 Load Flow Analysis.** System modeling and matrix analysis of balanced and unbalanced three-phase power systems. Solution of a system of linear and nonlinear equations. Sparsity techniques and optimal ordering. Load flow of balanced and unbalanced three-phase power systems. Prereq: EEE 103 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 254 Surge Protection in Power Systems.** Electrical surges including traveling waves due to lightning and switching. Principles of lightning protection. Multi-velocity waves. Electromagnetic transient simulations. Insulation coordination. Application of surge protection devices. 5 h (2 lec, 3 lab) 3 u.

**EE 255 Electric Power Transmission and Distribution System Planning.** Forecasting models for network planning. Cost models for transmission and distribution facilities. Technical and economic evaluation. Optimization in transmission and distribution planning. Reliability evaluation of transmission and distribution networks.

Prereq: EEE 103 or equiv. 3 u.

**EE 256 Power System Protection.** Fundamental principles. Selection and application of protective devices and protection algorithms. Protection of transmission lines, transformers, generators, motors, buses, and other equipment. Phase and ground fault protection. Coordination of protective devices. Testing of relays and protection algorithms.

Prereq: EEE 103 or equiv. 5 h (2 lec, 3 lab) 3u.

**EE 257 Electric Power Transmission and Distribution Network Automation.** Transmission and distribution (T&D) system automation requirements. Sensors, actuators, and controllers. T&D automation equipment. Remote Terminal Units (RTUs). Distribution Management Systems. Supervisory Control and Data Acquisition Systems (SCADA). Decision Support Applications. Communications options and communications for T&D utility automation. Design of transmission, substation, and distribution feeder automation. Case studies and applications. Prereq: EEE 103 or equiv. 3 u.

**EE 258 Electric Power Quality.** Modeling for power quality analysis. Harmonics. Time and frequency domain methods of analysis. Grounding. Voltage sags and swells. Electrical transients. Measurement techniques. Mitigation techniques. Power quality standards. Prereq: EEE 103 and EEE 51 and EEE 35 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 260 Embedded Systems Hardware I.** Design of 8, 16, 32-bit microprocessor-based systems using microprocessor integrated circuits and softcores (system-on-a-programmable-chip). Advanced microprocessor features and peripherals. Memory technologies. Interfacing using simple bus protocols. Prereq: EE 227. 5 h (2 lec, 3 lab) 3 u.

**EE 261 Embedded Systems Hardware II.** Complex bus protocols. Video. Mass storage. Circuit board-level design of embedded systems. High speed circuit board design techniques. Signal integrity issues. Prereq: EE 260. 5 h (2 lec, 3 lab) 3 u.

**EE 263 Finite State Machines.** Review of clocked sequential circuits. State minimization. State assignment. Pulsed sequential circuits. Fundamental mode sequential circuits. Delays and hazards. Timing driven analysis. State identification. State Machine Testing. Prereq: EEE 21 or equiv. 3 u.

**EE 264 Computer Architecture.** Evolution of computer architecture. Principles of computer system design. Computer system components. Instruction set design. Processor micro-architecture. Pipelining. Cache and virtual memory organizations. I/O structures. Instruction level parallelism. Prereq: EEE 105 or equiv. 3 u.

**EE 265 Advanced Computer Architecture.** Vector machines. Out-of-order execution. Dynamic scheduling. Thread level parallelism. VLIW machines. Speculation techniques. Compiler support. Multiprocessor architectures. Multicore architectures. Coherency issues. Interconnection networks. Prereq: EE 264. 3 u.

**EE 267 Embedded Software and Operating Systems.** Overview of embedded systems. Kernel. Bootlander. Toolchain. Root Filesystems. Memory Technology Devices. I/O Subsystem. Device Driver. Introduction to Applications Programming. Prereq: EE 260 and EEE 13 or equiv. 3 u.

**EE 268 Embedded Software Applications Development.** Software engineering methodologies applied to embedded systems program development. Quality Assurance techniques. Software maintenance issues. Functional and non-functional software properties. Prereq: COI. 5 h (2 lec, 3 lab) 3 u.

**EE 269 Digital Systems Testing.** Test economics and motivation. Fault models and simulation. Test pattern generation. Measures for testability. Design for testability. Memory testing. Prereq: EEE 21 and EEE 41 or equiv. 3 u.

**EE 270 Digital Communications I.** Methods of digital modulation and demodulation. Signal space methods in digital communications. Communication over AWGN and band-limited channels, including channel capacity. Carrier and symbol synchronization. Source coding and lossless compression. Channel coding, including block codes, convolutional codes and Viterbi decoding. Current topics of interest. Prereq: EEE 107 and EE 214 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 271 Microwave Theory and Techniques.** Analysis and synthesis of transmission lines and waveguides. Microwave resonators. Microwave network analysis. Analysis and design of passive and active microwave devices. Noise in microwave circuits. Circuit models of active devices. Magnetic materials and their applications. Microwave test and measurement principles. Prereq: EE 217. 3 u.

**EE 272 Radiowave Propagation and Radio Link Design.** Transmission loss. Free-space propagation. Propagation at low and high frequencies. Microwave propagation. Propagation over plane and spherical surfaces. Propagation in the ionosphere, troposphere and near-earth. Antennas. Design considerations for noise, diffraction, refraction, absorption, multipath interference, and scattering in wireless communications, including mobile communications and satellite links. Prereq: EEE 23 or equiv. 3 u.

**EE 273 Antenna Engineering.** Radiation from simple and extended sources and arrays. Antenna theorems. Scattering concepts. Analysis and design of wire, aperture, traveling wave, reflector, microstrip and miniaturized antennas. Modern antenna systems. Receiving antenna considerations. Prereq: EEE 23 or equiv. 3 u.

**EE 274 Digital Signal Processing I.** Sampling theorem. Discrete time signals and LTI systems. Discrete convolution. Z-transform. FIR and IIR digital filters. Discrete Fourier transform. Fast Fourier Transform. State-space analysis. Prereq: EEE 35 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 275 Networking Technologies I.** Layered network architecture. Link layer protocols. Packet switching. LAN and WAN routing. Transport protocols. Applications. Prereq: EEE 13 and EEE 107, or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 276 Statistical Communication Theory.** Principles and applications of detection and estimation theories in communication systems. Bayes and the Neyman-Pearson criteria. Cramer-Rao bound. Minimum variance unbiased estimation, maximum likelihood, EM, MAP, linear MMSE estimation. Hypothesis testing. Applications in modern digital communications, radar and sonar signal processing. Prereq: EE 214 and EE 274. 3 u.

**EE 277 Coding and Information Theory.** Error detecting and error correcting codes. Block codes and convolutional codes. Analysis and design of error-control channel codes. Modeling of information sources, including zero-memory and Markov models. Construction of compact source codes. Entropy, mutual information and channel capacity. Shannon's noiseless and noisy coding theorems. Examples of modern source and error control codes. Prereq: EEE 25 or equiv. 3 u.

**EE 279 Networking Technologies II.** Distributed systems and applications. Network architectures and technologies. Network protocols. Routing and congestion control. Modeling, simulation, and performance analysis. Emerging applications. Prereq: COI. 5 h (2 lec, 3 lab) 3 u.

**EE 280 Wireless Communication Systems.** Radio propagation and antennas. Large-scale and small-scale propagation models. Performance of wireless communication systems in fading channels. Coding, equalization and diversity. TDMA, FDMA, CDMA, SDMA and random access protocols. Examples of modern and practical systems, including cellular systems, wireless local area networks, wireless personal area networks and broadband wireless access systems. Coreq: EE 270 or equiv. 3 u.

**EE 281 Optical Communications Systems.** Optical fiber fundamentals. Single mode and multimode fibers. Optical fiber bandwidth. Optical sources, light-emitting diodes and lasers. Optical detectors, modulators, switches and directional couplers. Optical communications systems design. Wavelength division multiplexing and other topics of interest. Prereq: EEE 41 or equiv. 3 u.

**EE 282 Adaptive Filtering and Array Processing.** Theory and applications of adaptive filtering in systems and signal processing. Iterative methods of optimization and their convergence properties. Transversal filters. LMS and gradient-search algorithms. Kalman filtering and least-squares algorithms. Array fundamentals. Optimum array processing. Adaptive beam forming. Space-time processing and space-time coding. MIMO. Current topics of interest. Prereq: EE 274 or equiv. 5 h (2 lec, 3 lab) 3 u.

**EE 283 Digital Image Signal Processing.** Digital image fundamentals. Introduction to two-dimensional digital signal processing. Image enhancements in spatial and frequency domain. Image transforms. Image restoration. Color image processing. Wavelets and image compression. Morphological image processing. Image segmentation, representation, and description. Introduction to object recognition and computer vision. Advanced topics and applications of image processing and analysis. Prereq: CoE 121 or EE 274, or COI. 3 u.

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**EE 284 Speech Signal Processing.** Feature Extraction. Speech Recognition. Hidden Markov Modeling. Speech production models. Pitch detection. Prosody. Speech Synthesis. Speech coding. Prereq: EEE 35 or equiv. 3 u.

**EE 285 Digital Video Signal Processing.** Digital video fundamentals. Video formation, perception, and representation. Fourier analysis of video signals. Frequency response of the human visual system. Video sampling and rate conversion. Video modeling. 2-D and 3-D motion estimation. Video coding: waveform-based coding and content-dependent coding. Scalable video coding. Stereo and multi-view sequence processing. Video compression standards. Error control in video communications. Advanced topics and applications of video analysis, processing, streaming, compression, error control, and transmission. Prereq: CoE 121 or EE 274, or COI. 5 h (2 lec, 3 lab) 3 u.

**EE 286 Digital Audio Signal Processing.** Digital audio signal analysis and manipulation. Speech and musical instrument synthesis. Digital audio recording and reproduction. Prereq: EEE 35 and EEE 11, or COI. 5 h (2 lec, 3 lab) 3 u.

**EE 290 Directed Studies.** Independent study or investigation of directed, current research areas in electrical and electronics engineering. Collaborative peer discussion of study results and findings. Prereq: COI. 3 u.

**EE 296 Seminar.** 1 u. per sem; max. of 3 u.

**EE 298 Special Problems.** 3 u.; Course may be repeated for credit, up to a maximum of 12 units, provided that topics are different; topics to be indicated for record purposes.

**EE 299 Electrical Engineering Project.** Prereq: COI. 3 u.

**EE 300 Thesis.** 3 u. to 6 u.

**EE 317 Mathematical Methods for Electromagnetics I.** Analytical and numerical methods of solving practical problems in electromagnetics, including fundamental theorems, plane wave functions, cylindrical wave functions, variational techniques, geometric theory of diffraction, method of moments, finite difference time domain method and Galerkin's method. Computer programming exercises. Prereq: EE 217 and ES 204. 3 u.

**EE 318 Mathematical Methods for Electromagnetics II.** Variational techniques, geometric theory of diffraction, Galerkin's method, finite difference time domain method, method of moments; recent topics of interest; computer programming exercises. Prereq: EE 317. 3 u.

**EE 320 Analysis and Design of High Performance Digital Integrated Circuits.** Parasitic models and second Order effects of field-effect and bipolar transistors, and interconnects; clock skew and other timing issues; design of high-performance combinational and sequential logic circuits; arithmetic and memory structures and devices; charge-coupled device circuits; signaling, synchronization, noise and clock and power distribution issues; extraction of circuit parameters from process parameters; optimization at the device and circuit levels; circuit-systems issues; design projects. Prereq: EE 226 Coreq: EE 325. 4 u.

**EE 322 Analysis and Design of Monolithic Information Processing and Communication Circuits.** Small and large-signal models of field-effect and bipolar transistors; amplifiers, switched capacitor networks, sample and hold, multiplexers, analog to digital and digital to analog converters, active filters, comparators, analog multipliers, relaxation oscillators, phase detectors, phase-locked loops, voltage-controlled oscillators, mixers, sampled-data filters, digital decimation and interpolation filters; charge-coupled device circuits; architectural and circuit level performance evaluation; design projects. Prereq: EE 220. Coreq: EE 325. 4 u.

**EE 325 Semiconductor Devices II.** Compound semiconductors and hetero-junctions; dielectric and optical properties; optical processes; physics and models of high-frequency, high-speed and optoelectronic devices including HFET, HBT, MESFET, quasi-ballistic transistors and other sub-micron transistor concepts, and charge-coupled devices. Prereq: EE 225. 3 u.

**EE 326 Optoelectronic Devices.** Optical properties and processes; optical detectors, light-emitting diodes, solar cells, modulators, switches, directional couplers, lasers and others of interest. Prereq: EE 325. 3 u.

**EE 327 Advanced VLSI Design.** Advanced VLSI technologies; system architecture; system behavior modeling in VHDL or C; CAD tools for standard cell, custom design or hybrid techniques; integration of heterogeneous CAD tools; automated and manual synthesis; advanced circuit design and testing methods; synthesis of the different levels of design hierarchy; design projects. Prereq: EE 227. 3 u.

**EE 330 Optimal Control.** Theoretical methods in optimal control theory. Topics include the review of the optimality conditions: Lagrange and Kuhn-Tucker. The calculus of variations and the Pontryagin minimum principle with applications to minimum energy problems. Geometric methods will be applied to the solution of minimum time problems. Computational methods, singular problems, observer theory, and sufficient conditions for existence of solutions are also discussed. Prereq: EE 212. 3 u.

**EE 353 Power System Reliability.** Basic reliability concepts. Methods for reliability modeling and evaluation. Reliability measures. Reliability of generation, transmission, distribution, composite, and interconnected systems. Prereq: EEE 25 or equiv. 3 u.

**EE 355 Power System Planning.** Financial modeling. Load forecasting. Production simulation. Generation planning. Network planning. System planning in a competitive electricity industry. Prereq: EEE 103 or equiv. 3 u.

**EE 357 Power System Dynamics and Stability.** Modeling, analysis, and simulation of power systems subjected to small and large disturbances. Steady state, transient, and dynamic stability assessment and enhancement. Multi machine studies. Recent developments. Prereq: EEE 103 or equiv. 3 u.

**EE 358 Economic Operation of Power Systems.** Economics of energy generation and operation. Optimization methods. Mixed-generation dispatch. Unit commitment. Optimal load flow. Competitive markets for electricity generation. Recent developments. Prereq: EEE 103 or equiv. 3 u.

**EE 359 Power Systems Operation and Control.** Modern power system operational and control problems and solution techniques, including load frequency control, automatic generation control, system voltage control, security assessment, state estimation, and contingency analysis. System control centers. Interconnected systems. Prereq: EEE 103 or equiv. 3 u.

**EE 370 Digital Communications II.** Communication over band-limited and fading channels. Multipath propagation. Channel equalization and adaptive techniques. Fractionally-spaced equalizers. Decision feedback equalization. Spread spectrum systems, multiuser access and detection. Current topics of interest. Computer exercises. Prereq: EE 270. 3 u.

**EE 371 Microwave Integrated Circuits I.** Computer-aided analysis and design of distributed circuit structures and their applications in passive and active microwave circuits including dividers, directional couplers, circulators, filters, transistor amplifiers, attenuators; experimental characterization; design projects. Prereq: EE 271 and EE 325. 3 u.

**EE 372 Microwave Integrated Circuits II.** Computer-aided analysis and design of distributed circuit structures and their applications in passive and active microwave circuits including transistor amplifiers, mixers, modulators, demodulators, oscillators, frequency converters, phase shifters, harmonic generators; noise models and low-noise design; monolithic MIC; fabrication processes of monolithic circuits; experimental characterization; design projects. Prereq: EE 371. 3 u.

**EE 374 Digital Signal Processing II.** Multirate processing. Optimal methods in filter design. Superior filter structures. Advanced finite word length effects. Non-parametric and parametric spectrum estimation. Adaptive filters, Wiener filters and algorithms. Time-frequency analysis and wavelets. Linear prediction. Current topics of interest. Computer exercises. Prereq: EE 214 or equiv. and EE 274. 5 h (2 lec, 3 lab) 3 u.

**EE 398 Special Problems.** 3 u.

**EE 400 Dissertation.** 12 u.