

Catalog Description

Basic Mathematics and Sciences

200-112	Fundamental Mathematics for Engineer	3((3)-0-6)
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Mathematics in engineering; mathematical induction; functions and graphs; limit and continuity; derivatives of functions and applications in engineering; integration of functions and applications in engineering

200-113 Fundamental Physics for Engineer 3((3)-0-6)

Physics in engineering; units, physical quantities, and vectors; force system and motions; work and moment; particles and rigid bodies; energy and momentum

200-114 Fundamental Chemistry for Engineer 3((3)-0-6)

Chemical in daily life and safety; physical properties of solid, liquid and gas; gas law; law of mass and stoichiometry; reaction and equilibrium; acid-base; electrochemistry; thermodynamics

200-118 Fundamental Chemistry for Engineer 3((3)-0-6)

Electrostatics; electric current; direct current circuit; capacitor; alternating current circuit; magnetism; electromagnetism; electric induction; inductor; electromagnetic wave; introduction to optics

200-119	Physics Laboratory for Engineer II	1(0-2-1)
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Laboratory experiments in electric field, electrical measurement and electrical instruments, magnetic field, induction, electromagnet, direct current circuit, alternating current circuit and light

212-181	Linear Algebra	3((3)-0-6)
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Introduction to linear algebra; matrices and determinants; system of linear equations and elementary operations; vector space; linear mapping; eigenvalues and eigenvectors; singular value decomposition; applications of linear algebra

212-282 Probability**3((3)-0-6)**

Counting techniques; combinatorial analysis; axioms of probability; conditional probability and independent events; random variables; discrete probability; probability mass function; cumulative distribution function; binomial and multinomial distributions; geometric distribution; uniform distribution; Poisson distribution; Bayes' theorem; expected value; conditional expectation; variance; continuous probability; density functions; distribution functions; uniform distribution; exponential distributions; normal distributions; functions of random variables; joint densities; marginal densities; sum of independent random variables; expectation; variance; correlation; conditional densities; central limit theorem; Markov chain

322-110 Vector Calculus**3((3)-0-6)**

Functions of several variables; derivatives of functions of several variables; multiple integrals; introduction to vector calculus; polar coordinate system; cylindrical coordinate system; spherical coordinate system; line Integrals and surface Integrals

322-111 Differential Equations**3((3)-0-6)**

First-order ordinary differential equations; second-order linear ordinary differential equations with constant coefficients; Laplace transforms and applications; sequences and series; Fourier series; introduction to partial differential equations

333-112 Basic Chemistry Laboratory for Engineers**1(0-2-1)**

Chemical safety; significant figures and glassware selections; chemical reactions of copper; semi-micro qualitative analysis of cations and anions; thermochemistry; freezing point depression; chemical kinetics; volumetric analysis; acids, bases and buffer solutions; electrochemistry

333-112 Fundamental Physics Laboratory for Engineers**1(0-3-0)**

Measurement and errors; graphs and equations; force equilibrium; projectile motion; springs and oscillations; moment of inertia standing waves on a string

347-208 Basic Statistics for Engineers**3((3)-0-6)**

force system; equilibrium of particles and rigid bodies; free body diagrams; analysis of trusses, frames; friction; centres of gravity, centroids; moments of inertia of plane areas; Mohr's circle of moment of inertia; introduction to dynamics

238-111 Engineering Materials

2((2)-0-4)

Study of structures, properties, production processes and applications of engineering materials i.e. metals, polymers, ceramics, composites, electronic materials other materials, phase diagrams, mechanical properties and materials degradation

Electrical Engineering

212-101 Electrical Engineering Laboratory I

1(0-3-0)

Laboratory experiments in basic electrical circuits, electronic and digital circuits, electrical instruments, programming and basic communication systems

212-111 Electric Circuits

3((3)-0-6)

Signals and models; circuit element; Ohm's law and Kirchhoff's laws; resistive circuits; nodal and mesh analyses; linearity and superposition; equivalent circuits and network theorems; energy storage element; first- and second-order circuits; natural and forced responses; transient and steady state; AC steady-state analysis; average and effective values; phasors; impedance and admittance; AC circuit power analysis; power factor improvement; three-phase circuits; coupled inductors and transformers

212-131 Principles of Electronics

2((2)-0-4)

Semiconductor devices; PN junction; diodes; analysis of diode circuits; diode applications; bipolar-junction transistor; field-effect transistors; device current and voltage characteristics; biasing of transistor; basic transistor circuits and its applications; basic operational amplifier circuits and its applications

212-191 Digital Systems

3((3)-0-6)

Number systems and codes; logical operation and logic gates; Boolean algebra; logic simplifications and manipulations; minimization aids, mapping method, tabular

method; combinational logic circuits, encoder and decoder, multiplexer and demultiplexer; sequential logic circuits, flip-flop circuits, counters and transfer registers; state diagram and state table; analysis and design of sequential logic circuits; tri-state devices

212-202	Electrical Engineering Laboratory II	1(0-3-0)
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Laboratory experiments in electronic circuits, digital circuits, electrical measuring instruments, electric machines and communication systems

212-203	Mini Project	1(0-3-0)
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A small electrical engineering team project; practice design process and system thinking; report writing and presentation

212-204	Electrical Instruments and Measurements	3((3)-0-6)
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Units and standards of electrical measurements; instrument classifications and characteristics; measurement analysis; measurement of DC and AC current and voltage using analog and digital instruments; power, power factor and energy measurements; measurements of resistance, inductance, and capacitance; frequency and period/time-interval measurements; noises; transducers; calibration; computer-based measurement systems

212-205	Power Engineering Laboratory I	1(0-3-0)
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Laboratory experiments and simulations on basic electrical machines and power electronics circuits using real work examples

212-206 Electronic Laboratory I 1(0-3-0)

Laboratory experiments and simulations on electronic circuits and digital circuits
using real work examples

212-207 Telecommunication Laboratory I 1(0-3-0)

Prerequisite : 212-292

Laboratory experiments and simulations on telecommunication systems and telecommunication instruments using real work examples

212-212 Network and Linear Systems Analysis**2((2)-0-4)**

Network theorems; Laplace transform and its applications; natural frequencies; natural and forced responses; impulse responses; poles and zeros; state-variable analysis; frequency responses; resonant circuits; two-port networks; Fourier series; Fourier transforms and its applications; network functions

212-221 Electromechanical Energy Conversion**2((2)-0-4)**

Magnetic circuits; principles of electromechanical energy conversion; construction and equivalent circuit of single phase transformers, three phase transformers and autotransformer; principles and construction of DC and AC rotating machines; equivalent circuits and external characteristics analysis of DC generators and DC motors, synchronous generator and motor, three phase and single phase induction motors; methods of starting and speed control; protection of machines

212-222 Electrical Power Generation and Transmission**3((3)-0-6)**

Introduction to power systems; energy sources and reserves; load characteristics; power system devices and components; construction and principles of operation of synchronous machines; interconnected synchronous generators; transient performance and dynamics including models for transient analysis; power transformer characteristics and models; per-unit system; transmission line and cable parameters and model; energy storage system; fundamentals of power flow and fault calculation

212-223 Power Electronics**3((3)-0-6)**

Power electronics and its role in energy conversion; power semiconductor devices; AC-DC converters; AC-AC converters; DC-DC converters; DC-AC converters; power electronics simulation, design and integration; power electronics applications

212-232 Electronic Circuits**2((2)-0-4)**

Transistor parameters; large-signal and small-signal model of transistor amplifier circuits, transistor amplifier analysis and its applications; negative feedback technique,

negative feedback circuits with op-amps and transistors; voltage summing amplifier, voltage difference amplifier; instrumentation amplifier; filter circuits

212-233	Electronic Circuits and Systems	3((3)-0-6)
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Differential amplifiers; waveform generators; astable multivibrator and bistable multivibrator; basic analog-to-digital and digital-to-analog converters; digital system components; datapath, control, memory; shift registers; parallel to serial and serial to parallel circuits; buffers; Finite State Machine (FSM), serial interfaces; digital communication protocol

212-241 Signals and Systems 3((3)-0-6)

Prerequisite : 322-111

Introduction to signals and systems; continuous time signals and systems; time domain analysis of linear time invariant continuous time systems; continuous time convolution; continuous time Fourier series; continuous time Fourier transform; Laplace transform; Introduction to discrete time signals and systems; sampling and quantization; applications for engineering

212-242 Discrete Time Signal Processing 3((3)-0-6)

Prerequisite : 212-241

Time domain analysis of discrete time systems; discrete time convolution; discrete time Fourier series; discrete time Fourier transform; sampling and quantization; Z-transform; numerical simulation and applications for electrical engineering

212-251	Electromagnetic Field Theory	3((3)-0-6)
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Prerequisite : 322-110

Vector calculus; line and surface integral; electrostatic field and electric field intensity; energy and potential; conductors, dielectrics, and capacitance; solutions to electrostatic problems; convection and conduction currents; magnetostatic fields, magnetic forces, electromagnetic induction; Maxwell's equations; static electric fields; steady magnetic fields; time varying field; Faraday's law; Ampere's circuit law; transmission line; the uniform plane waves; Poynting vector and electromagnetic energy radiation; plane wave reflection and dispersion

3((3)-0-6)

Cylindrical dielectric waveguides and propagating conditions; structure and optical fiber; optical transmission parameters; optical fiber production and process; cable types; signal degradations, attenuation, losses and dispersion in optical fibers; transmitters, light sources, LEDs and laser diodes; optical receivers, optical detection; repeaters and amplifiers; link budget calculations; switches and multiplexers; introduction to FTTx networks

2((1)-3-2)

Basic microprocessor programing; digital input; digital output; analog-to-digital conversion; timer and counter; pulse width modulation; introduction to interrupt; mini project with microcontroller

3((3)-0-6)

Introduction to data network; architecture of computer networking on layer; protocol; data transmission; medium access control; encoder; circuit switch and packet switch; local area network; switching network; routing in data networks; network security; cloud network, architecture and system; communication standards

3((2)-3-4)

Different types of Interrupts; multi-processors communication protocols; different serial peripheral interfaces and protocols; mini project with microprocessor system

No less than 320 hours

A minimum of 320-hour summer training in the industry or institutions approved by the Electrical Engineering department

1(0-3-0)

212-205

Laboratory experiments and simulations on electrical machines, electrical power system and power electronics circuits using real work examples

212-302 Power Engineering Laboratory III 1(0-3-0)

Prerequisite : 212-301

Laboratory experiments and simulations on electrical machines, electrical power system, high voltage power equipment and electrical design and installation using real work examples

212-303 Electronics Laboratory II 1(0-3-0)

Prerequisite : 212-206

Laboratory experiments and simulations on electronic circuits and systems; design and measurement of transistor circuits; microelectronic circuit simulations; digital integrated circuit design

212-304 Electronics Laboratory III 1(0-3-0)

Prerequisite : 212-303

Laboratory experiments on electronic circuits and systems; experiments in sampled communication electronics; design of simple model-based control system; experiments in hardware-in-loop

212-305 Telecommunications Laboratory II 1(0-3-0)

Prerequisite : 212-207

Laboratory experiments on wired and wireless communication systems; signals, circuits, electromagnetic wave propagations; network simulations

212-306 Telecommunications Laboratory III 1(0-3-0)

Prerequisite : 212-305

Laboratory experiments on wired and wireless communication systems; signals, circuits, electromagnetic wave propagations, optical fiber, antenna; network configurations

- 212-307 Project Preparation 1(0-2-1)**
Prepare project proposal; technical documentation; preliminary review and research on project's related topics; proposal report writing; project proposal presentation
- 212-312 Illumination Engineering 3((3)-0-6)**
Prerequisite : 212-111
Nature of light and sight; relationship of light and sight; quantity and quality of illumination; characteristics of light sources; light control and luminaires; interior lighting design; industrial lighting; exterior lighting design; street lighting
- 212-313 Electrical System Design and Installation 3((3)-0-6)**
Prerequisite : 212-111
Graphical electrical symbols and one-line diagrams; study of safety codes; electrical power supply and distribution systems; system grounding and equipment grounding; sizing wires, cables, and conduits; short circuit calculation; protective devices and their coordination; lighting and appliances circuit design
- 212-314 High Voltage Engineering 3((3)-0-6)**
Prerequisite : 212-251
Introduction to high voltage engineering; generation of high voltage AC, DC, and impulse; measurement techniques; electrostatic voltmeters; sphere gaps; resistive and capacitive voltage dividers; voltage transformers; non-destructive insulation testing methods; electrical conductivity; dielectric loss and capacitance; partial discharge; electric field distribution and stress control in homogeneous and non-homogeneous materials; mechanisms of electrical breakdown in gases, liquids, and solids; overvoltage protection; lightning phenomena; grounding systems; surge protection
- 212-324 Power System Analysis 3((3)-0-6)**
Prerequisite : 212-222
Transmission line model and performance; power transmission capability; line compensation; single-line diagram and per-unit system; network equations and solutions; power flow studies; control of real power and reactive power; symmetrical three-phase faults; unsymmetrical faults; power system stability; economic load dispatch

212-325 Electric Drive Systems**3((3)-0-6)****Prerequisite : 212-221**

Electric drive components; load characteristics; motor characteristics; power converters; control system; motor-load system; speed-torque equation; power transmission system; braking; operation quadrants of electric drives; dynamic of electric drive system; DC drives; AC drives, servo drives; application of electric drives in industrial applications

212-326 Power System Protection**3((3)-0-6)****Prerequisite : 212-324**

Principles of power system protection; instrument transformer; protective relays; overcurrent protection; earth fault protection; differential protection; motor protection; transformer protection; generator protection; bus bar protection; transmission line protection by distance relaying and pilot relaying; introduction to digital protection devices

212-333 Analog Integrated Circuits**3((3)-0-6)****Prerequisite : 212-233**

Integrated-circuit technologies; fabrication of bipolar junction transistor and MOSFET; amplifiers: class A, B and AB, cascode pair; transconductors; current source and current mirror circuits: cascode and Wilson current mirrors; voltage reference circuits; temperature-variation compensation design technique; feedback amplifiers and their stability; operational amplifier design; single-stage op-amp and two-stage op-amp, Miller compensation; right-half plane zero elimination; simple active filter circuit design; oscillators; phase-locked loop

212-334 Digital Integrated Circuits Design**3((3)-0-6)****Prerequisite : 212-191**

CMOS digital integrated circuit design; nanotechnology fabrication; design tools; static and dynamic circuits; layout techniques; electrical wire and on-chip interconnects; energy and delay optimization; clock system; memory circuits; interconnecting sub-systems and packaging; testing

212-335 Digital Design by HDL 3((3)-0-6)

Prerequisite : 212-191

Theory and methodologies for digital circuit design by Hardware Description Language (HDL); digital circuit design flow; gate-level design; register transfer level (RTL) design; combinational circuit design; sequential circuit design; synchronous control circuit design; asynchronous control circuit design; digital signal processing circuit design; microprocessor design; digital circuit implementation on FPGAs (Field Programmable Gate Arrays); circuit simulation

212-336 Digital Integrated Circuit Testing 3((3)-0-6)

Prerequisite : 212-334

Introduction to digital integrated circuit design verification and testing; defects; fault modeling and simulation; automatic test pattern generation (ATPG); design for testability (DFT); scan and boundary scan architectures; built-in self-test (BIST); tools for testing

212-337 Communication Electronic Circuits and Systems 3((3)-0-6)

Prerequisite : 212-233

Transmission-line principles; impedance transformation and matching; complex-signal analysis; single-sideband generation technique; wireless receiver architectures: IF receiver, low-IF receiver, direct-conversion receiver; oscillators; mixer; power amplifiers; phase-lock loop; delay-locked loop; RF circuits' performances: dynamic range, harmonic distortions, intermodulation distortions

212-338 System on Chip Design 3((3)-0-6)

Prerequisite : 212-191

Introduction to Systems on Chips (SoCs); performance, power and area constraints; building SoCs around Arm processors; FPGAs prototyping platforms; SoC development process; creating high level functional specifications to design, implementation and testing on real FPGA hardware using standard hardware description and software programming languages

212-339 Radio-Frequency Microelectronics 3((3)-0-6)

Prerequisite : 212-233

Basic concepts in radio frequency design; modulation and detection; multiple access techniques and wireless standards; transceiver architectures; modern integrated circuit technologies; low-noise amplifiers; mixers; oscillators; charge-pump phase-locked loop, frequency synthesizers; power amplifiers; channel-select filters, intermediate-frequency filters, noise figure, phase noise; layout for high-speed circuits

212-340 Control Systems Laboratory 1(0-3-0)

Prerequisite : 212-241

Experimental works and computer-based simulation on control systems to reinforce the knowledge in continuous-time control systems

212-342 Continuous-Time Control Systems 3((3)-0-6)

Prerequisite : 212-241

Mathematical modeling of systems; block diagrams; first and second order systems; time domain response; open-loop and closed-loop control; feedback control and sensitivity; disturbances; types of feedback control; concepts and conditions of system stability; methods of stability analysis; root locus; frequency response; Bode plot; Nyquist stability criterion; relative stability; controller design

212-343 Industrial Instrumentation and Process Control 3((3)-0-6)

Prerequisite : 212-131

Introduction to industrial instruments; pressure measurement, level sensing devices, flow measurement instruments, temperature measuring devices, humidity measuring devices, viscosity measuring instruments, pH measurements, position and motion sensing, force sensing device, chemical sensors, sound and light measuring devices; pressure controllers, flow control actuators, power control, signal conditioning, signal transmission; process control; intelligent process decision systems; distribution control system; industrial information technology

212-344	Model-Based Control System Design	3((3)-0-6)
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Prerequisite : 212-241

Introduction to digital control system using model-based design; discrete-time signals; z-transform technique; sampled-data systems; discrete equivalent of continuous transfer functions; stability analysis of discrete-time system; implementation of digital control systems in embedded systems; model-in-loop simulation; hardware-in-loop simulation; processor-in-loop simulation; prototype-in-loop simulation; verification and validation; applications of model-based design via mini project

212-345	Programmable Logic Controllers	3((3)-0-6)
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Hardware of programmable logic controller (PLC); PLC languages; principles of PLC programming; error diagnostics; standard function blocks; analog/digital sensors; applications of PLC; PLC communication networks

212-346	Smart Agriculture and Agritronics	3((3)-0-6)
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Prerequisite : 212-232

Principles and applications of electronic and digital technology in agriculture; increasing the efficiency, accuracy and sustainability of production; components of smart farming systems; sensor systems; automatic control; microcontrollers; data communication; Internet of Things (IoT); artificial intelligence (AI); design of electronic circuits for measurement and control in smart farms

212-352 Principles of Communication Systems 3((3)-0-6)

Prerequisite : 212-241

Summary of signals and linear systems; basic operations of signals; classification of signals; signals and their properties; linear time invariant systems; summary of Fourier series and Fourier transform; power and energy; lowpass and bandpass signals; analog modulation; amplitude modulation; double-sideband modulation; single-sideband modulation; frequency modulation; narrowband frequency modulation; wideband frequency modulation; phase modulation; noise in analog communication; binary baseband modulation; Nyquist's sampling theory and quantization; pulse analog modulation; pulse code modulation; delta modulation; multiplexing techniques

212-353	Transmission Lines and Its Applications in Modern Communication Circuit	3((3)-0-6)
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Prerequisite : 212-251

Definition and importance of S-parameter; transmission-line theory; transmission lines in modern mobile communication, satellite communication and high-speed electronic circuits; incident and reflected waves in a transmission line; effect of reflected wave on electromagnetic compatibility; some techniques for mitigating electromagnetic interferences; effects of reflected wave on signal qualities in a high-speed digital circuit and high-frequency circuit; smith chart and its applications; design of reactive components using transmission line; analysis and design a matching circuit for mitigating reflected wave problem; design and layout microstrip line and coplanar waveguide on a printed circuit board; measurement and test with a microwave network analyzer

212-354 Digital Communications 3((3)-0-6)

Prerequisite : 212-282

Review of probability and random process; signal space; minimum Nyquist bandwidth; signal detections; additive white Gaussian noise; digital modulation techniques; performance analysis; synchronization; introduction to information theory; source coding; channel coding

212-355	Microwave Engineering and Its Applications	3((3)-0-6)
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Prerequisite : 212-353

S-parameter review; definition of microwave and its applications in communication engineering; microwave transceiver architectures; noise and noise factor; sensitivity and selectivity; nonlinearity; harmonic distortion; interference; analysis of signal-to-noise ratio and bit-error-rate in a radio transceiver; small-signal amplifier; some definitions of power gain; transistor biasing; oscillation and stability analysis; stabilizing active circuit using negative feedback technique; amplifier design using a simultaneous conjugated matching technique; layout, fabrication and test small-signal amplifier

212-356 Antenna Engineering 3((3)-0-6)

Prerequisite : 212-251

Basic definitions and theory; isotropic point source; power and field patterns; directivity and gain; efficiency, polarization; input impedance and bandwidth; Friis

transmission equation, radiation from current elements; ground effects; radiation properties of linear wire antenna; array antenna; Yagi-Uda antenna and log-periodic antenna; aperture antenna; microstrip antenna; modern antenna for current applications; antenna characteristics measurement

212-361 Routing and Switching: Entry Level 3((2)-3-4)

Prerequisite : 212-292

Data communication basis for small-sized enterprise networks; network reference model; command-line interface; network layer protocols; IP addressing; IP routing basics; OSPF; ethernet switching; VLAN; STP; ethernet link aggregation

212-362	Routing and Switching: Intermediate Level	3((2)-3-4)
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Prerequisite : 212-361

Review data communication basis for small-sized enterprise networks; network security; ACL; AAA; network address translation; FTP; Telnet; DHCP; HTTP; DNS; NTP; WLAN; WAN technologies; PPP; PPPOE; MPLS; segment routing; network management; IPv6; SDN; NFV; network programmability and automation; network architecture and practice

212-381 Systems Modeling Language 3((3)-0-6)

Prerequisite : 212-116

Introduction to SysML; systems modeling framework; packages and model structure; requirements diagrams; use case diagrams; activity diagrams; block definition diagram; internal block diagrams; state machine diagrams; cross cutting relationships and model analysis; constraints and parametric diagrams; sequence diagrams

212-382 Data Structure and Algorithms 3((3)-0-6)

Prerequisite : 212-116

Introduction to data structure and algorithm; array, stack, queue, sorting algorithms; dynamic sets and searching; divide-and-conquer algorithms; graphs and graph traversals; greedy algorithms; dynamic programming; parallel algorithms; adaptive algorithms; algorithms for electrical engineering; algorithm solving using engineering tool

212-383	Machine Learning in Electrical Engineering	3((3)-0-6)
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Prerequisite : 212-116

Introduction to machine learning; machine learning in electrical engineering; signal processing; data normalization; signal filtering; feature extraction; correlation analysis; feature selection; regression analysis; classification; application of machine learning in electrical engineering; machine learning solving using engineering tool

212-384 Introduction to Data Analysis 3((3)-0-6)

Prerequisite : 212-116

Introduction to data analysis; data collection, loading and storage; data cleaning and preprocessing; data statistics and probability; data manipulation; data visualization; data presentation; dimensionality reduction; principal component analysis; singular value decomposition; data clustering; data classification

212-391 Microcontroller Architecture and Applications 3((3)-0-6)

Prerequisite : 212-291

Microcontroller architecture, central processing unit, memory, input/output systems, register configuration, programming in high-level languages, interfacing with external devices, signal conversion, timer implementation, interrupts, pulse width modulation, serial communication, applications in embedded systems and automatic control systems

212-400 Co-operative Education 6(0-40-0)

Criteria: For students in their 4th year or higher, who have passed the specific professional courses as required by the Electrical Engineering curriculum.

Designing electrical engineering systems to solve problems in workplaces; creating electrical engineering systems in real industries; testing and measuring the efficiency of electrical engineering systems; working with diverse groups of people; analyzing efficiency results and presenting data using statistical principles; writing reports presenting the efficiency of electrical engineering systems; communicating the results of electrical system design to diverse groups.

212-401 Electrical Engineering Capstone Project I 3(0-9-0)

Criteria: For students in their 4th year or higher, who have passed the specific professional courses as required by the Electrical Engineering curriculum.

Electrical engineering problems in real situations; electrical engineering design procedures; policies and laws related to the design of electrical engineering systems; root cause analysis of problems; working together to find alternatives to solve real electrical engineering problems; writing reports and presenting holistic proposals to solve real electrical engineering problems

212-402	Electrical Engineering Capstone Project II	3(0-9-0)
	Prerequisite : 212-401	

Complex electrical engineering problems in real-world situations; policies and legislation related to electrical engineering system design; detailed design of holistic electrical engineering systems; engineering and economic feasibility analysis; collaboration to design detailed electrical engineering systems; writing detailed design reports for solving real electrical engineering problems; result presentation to stakeholders at all levels

212-403	Seminar	1(0-2-1)
	Prerequisite :	212-307

A seminar presentation on various electrical engineering topics; laws, standards, regulations and professional ethics related to electrical engineering; communication and presentation techniques for future works

212-411	Electrical Systems and Signal Systems in Building	3((3)-0-6)
	Prerequisite :	212-313

Emergency power systems; electrical installation system design; lighting system design; electrical protection system design in buildings and industrials; motor circuit design; power factor improvement and capacitor bank circuit design; harmonics in electrical systems; power installation in commercial, industrial, and residential buildings; telephone systems; sound systems; MATV systems; fire alarm systems; lightning protection systems; standby generators; building automation systems; security systems

212-412 Project Planning and Management 3((3)-0-6)

Prerequisite : 212-307

Role of project management and project core team; project launch organization and project core team; managing obligations and requirements; communicating with project stakeholders and project team; project planning; managing schedules and critical path; change management; risk and opportunity in project; monitoring and reporting project progress and project review; project closure and after delivery managing

212-413 Railway Electrification 3((3)-0-6)

Prerequisite : 212-221

Development history of railways; railway energy use; traction motor and drive technology; electric locomotive technology; high speed train technology; maglev train; traction drive and rollingstock; DC railway electrification; AC railway electrification; overhead catenary system and conductor rail system; electrical protection in railway; grounding and bonding in railway electrification; power quality and harmonics in railway; railway condition monitoring

212-414 Railway Signaling Engineering 3((3)-0-6)

Prerequisite : 212-292

Basics of railway signaling; railway signaling products; railway signaling design standards; basic signaling design; Interlocking design; traffic management system and control; ERTMS/ETCS standard

212-415 Module : Battery Management System 4((3)-3-6)

Prerequisite : 212-223

Principles and applications of battery management systems (BMS); emphasis on lithium-ion battery behavior; battery modeling; estimation of state of charge (SOC), state of health (SOH), and state of power (SOP); cell balancing; thermal management; fault detection; safety design and relevant standards; communication protocols; integration with control units

212-416 Electrical Safety 3((3)-0-6)

Prerequisite : 212-111

Prerequisite : 212-324

Potential, importance, and impacts of renewable energy and energy storage technologies in power systems; differences between traditional energy technologies and renewable energy; laws, regulations, policies, and economic analysis related to the development of renewable energy and energy storage technologies; solar energy; wind energy; hydropower; biomass; nuclear energy; tidal energy; wave energy; geothermal energy; energy storage technologies; batteries; supercapacitors; flywheels; compressed air; fuel cells; hydrogen; pumped-storage hydropower systems

212-422	Electric Machine Modeling and Analysis	3((3)-0-6)
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Prerequisite : 212-221

Dynamic model; reference frame transformations; transient state analysis of three-phase ac machines; vector-controlled induction motor drives; permanent-magnet synchronous motor drives

212-423	Power Quality	3((3)-0-6)
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Prerequisite : 212-324

Power quality problems; harmonic sources; effects of harmonic in power systems; review of Fourier series; harmonic current and voltage definition; characteristics of harmonic in power systems; distortion factors; power factor; RMS current and voltage; series and parallel resonances; standards of harmonic; passive power filter design; power quality conditioner technology

212-424 Power Plant and Substation 3((3)-0-6)

Prerequisite : 212-324

Characteristic of various loads; hydro power plant; steam power plant; gas turbine power plant; combined cycle power plant; diesel power plant; nuclear power plant; renewable energy sources; sub-station with air insulation, compressed gas insulation; types and functions of equipment in a sub-station; the pattern of equipment layout; lightning protection; grounding system; security procedures for operator in a sub-station

212-425	Module : Electric Vehicle Technologies	3((2)-3-4)
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Prerequisite : 212-223 and 212-325

Introduction to hybrid and electric vehicles; hybrid and electric vehicle drivetrain; types of electric motors; power electronics for electric vehicles; regenerative braking; battery technologies for electric vehicles; battery management system; charging technologies for electric vehicles; energy management strategies; electric vehicle systems simulation; communication and protocol in electric vehicles

212-431 CMOS Analog Integrated Circuits 3((3)-0-6)

Prerequisite : 212-233

CMOS integrated circuit technologies/process; MOSFET model, body effects; MOSFET as a tunable resistor; common-source, common-drain and common-gate amplifiers, negative feedback, common-mode feedback technique; low-voltage circuit design: MOSFET operation under a sub-threshold voltage region, pseudo-differential amplifier, common-mode rejection techniques; CMOS operational amplifiers, operational transconductance amplifiers; transistor's noise modelling and analysis; distortion analysis; voltage-controlled oscillator; multiplier; current-feedback op-amp; transconductor-capacitor filters, opamp-RC filters; complex filters; analog integrated circuit layout

212-432 Analog MOS Integrated Circuits for Signal Processing 3((3)-0-6)

Prerequisite : 212-241

Discrete-time data signal; MOS transistors, switched-capacitor circuits; switched-current circuits; switched op-amp circuits; comparators; filters; switching noise; simulation techniques; mixed-signal design techniques

212-433	Data Conversion Integrated Circuit Design	3((3)-0-6)
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Prerequisite : 212-241

Sampling circuits, MOSFET switches, sample-and-hold architectures, comparator circuits, resistor-ladder DACs, current-steering DACs, successive approximation register (SAR) ADC, pipeline ADCs, flash ADCs, subranging ADCs, time-interleaved ADCs, delta-sigma analog-to-digital converters

212-434 Analog Integrated Circuits for Biomedical Applications 3((3)-0-6)

Prerequisite : 212-233

Integrated circuit technologies; transistor modeling, weak-inversion CMOS circuits, low-voltage and low-power design techniques; filters; amplifiers; data conversion circuits; biotelemetry techniques, wireless inductive link; wireless architectures, circuits for wireless transmitter and receiver, human-body communications

212-435 Integrated Circuits for Optical Communications 3((3)-0-6)

Prerequisite : 212-233

Integrated circuit technologies for optical communications; fundamentals of optical communications; noise and jitter; laser diodes, optical fibers, photodiodes; transimpedance amplifiers; limiting amplifiers, output buffers; oscillators, inductor-capacitor oscillators; phase-locked loop; clock and data recovery circuits; multiplexers and laser drivers

212-441	Fuzzy Logic Control	3((3)-0-6)
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Introduction to fuzzy sets; operation of fuzzy sets; fuzzy relations; fuzzy rules; fuzzy logic; linguistic variable; fuzzy inference; fuzzy control; applications of fuzzy logic control

212-442 Digital Controller Design 3((3)-0-6)

Prerequisite : 212-342

Introduction to digital control system; discrete-time signals; z-transform technique; sampled-data systems; quantization effects; discrete equivalent to continuous transfer functions; stability analysis of discrete-time system; digital controller design

212-443	Digital Signal Processing	3((3)-0-6)
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Prerequisite : 212-241

Introduction to digital signal processing; FIR and IIR filter design; adaptive filter; introduction to random and statistics signal processing; time series analysis and parameter estimation; DSP applications

212-444 Automotive Embedded Systems 3((3)-0-6)

Prerequisite : 212-291

Introduction to automotive embedded systems; Changes in automotive embedded systems; hardware architecture; software architecture; automotive platform; real-time operating system; real-time scheduling; networks and protocols: CAN, LIN, FlexRay, and TTCAN; functional safety; cyber security; autonomous vehicles; validation and verification

212-445 Embedded System Design

3((3)-0-6)

Prerequisite : 212-291

Introduction to embedded systems; embedded system development on microcontroller; C language for microcontroller; communication buses for devices network; device drivers and interrupt service mechanism; programming for embedded systems; UML program modeling; real-time operating system; design examples; simulation and debugging

212-446 Industrial Robotics and Machine Vision

3((3)-0-6)

Prerequisite : 212-241

Fundamental of robot technology; history of robotics; classification of robots; introduction to industrial robotics; robot physical configuration; basic robot motion control; programming the robot; robot vision systems, machine vision; acquisition of images; lighting techniques; image processing and analysis; 3D machine vision techniques; robot cell design and control; hardware interfacing; graphical simulation of robotic work-cell; robot applications in industrial process

212-451 Mobile Broadband Networks

3((3)-0-6)

Prerequisite : 212-292

Concepts of mobile broadband networks; WiFi (IEEE 802.11 family); network architecture; 4G Communication technology; resource block; Throughput; radio resource management; random access network; local area update; QoS; NB-IoT; 5G communication technology; discuss research issues addressed in the next generations

212-452 Radio Wave Propagation

3((3)-0-6)

Prerequisite : 212-251

Radio frequency allocation; radio system; ground wave propagation; sky wave propagation; space wave propagation in the troposphere; tropospheric scattering propagation; microwave radio relay system; satellite and space communication; radar; fading; outdoor propagation models; indoor propagation models; case study in cellular systems

212-453 Cellular Communications

3((3)-0-6)

Prerequisite : 212-354

Cellular systems; narrowband and wideband Systems, CDMA and OFDM; capacity of wireless and wired channels; wired channel resources; LTI Gaussian channel, SIMO, MISO and frequency-selective channels; capacity of fading channels, capacity of multiuser channels; Uplink and Downlink; frequency-selective fading channels; Multiuser diversity

212-454 Wireless Communications

3((3)-0-6)

Prerequisite : 212-354

Wireless channel; physical modeling for wireless channels; input and output models of the wireless channel; time and frequency coherence; statistical channel models; point-to-point communications; detection in Rayleigh fading channel and static AWGN channel; code design and degrees of freedom; time diversity, antenna or space diversity, frequency diversity

212-455 Satellite Communication

3((3)-0-6)

Prerequisite : 212-292

Principle of satellite communications; structure of satellite; satellite orbits; frequency technic of satellite; technical characteristic of communication satellite; calculation of elevation and azimuth angle of receiving antenna; calculation of satellite signal level; carrier to noise ratio; multiple access; FDMA, TDMA, CDMA and current techniques; earth and space station systems; domestic and international satellite communication systems

212-461 Network Security

3((3)-0-6)

Prerequisite : 212-292

Basic concept of security; mathematics for security; symmetric and asymmetric theory; reduction algorithms; RSA cryptography; network fundamental for security; network security protocols; security tools; security on VPN; firewall on embedded system; hacker techniques; Unix security issues; windows security issues; legal issues in information security

212-462 Cloud Computing Services

3((2)-3-4)

Prerequisite : 212-292

Cloud computing basics; compute cloud service; elastic cloud server; network cloud service; virtual private cloud; elastic IP; virtual private network; NAT gateway; storage cloud service; elastic volume service; database service; security and other services

212-463 Cybersecurity

3((3)-0-6)

Prerequisite : 212-292

Cryptography; public key infrastructure; secure network; secure perimeter; zero trust; SD-WAN; SASE; network segmentation; firewall; security protocols; SSL; TLS, SSH; IPsec; authentication; authorization; network access control; secure remote access; virtual private network; endpoint security; web application firewall; cloud security

212-464 Next-Generation Firewall for Network Security

3((2)-3-4)

Prerequisite : 212-292

Next-generation firewall administration for network security; system and network settings; firewall policies and NAT; routing; firewall authentication; single sign-on; certificates operation; antivirus; web filtering; IPS and application control; SSL VPN; IPsec VPN; SD-WAN; security fabric; high availability; diagnostics and troubleshooting; network security

212-465 Large-Scale Enterprise Networks

3((3)-0-6)

Prerequisite : 212-362

Overview of large-scale enterprise networks; IP routing basics; OSPF; IS-IS; BGP; routing and traffic control; switching; RSTP; MSTP; IP multicast; IGMP; PIM; IPv6; network security; network reliability; network service and management; large-scale wireless LAN architecture; interesting large-scale enterprise network solutions

212-466 Wireless Ad Hoc and Sensor Networks 3((3)-0-6)

Prerequisite : 212-292

Application of wireless ad hoc and sensor networks; architecture of wireless ad hoc and sensor systems; digital communications and radio propagations; self-organization protocols; medium access control; routing; IEEE 802.15.4 and ZigBee standards; IoT network architecture

212-471	Energy Management	3((3)-0-6)
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Prerequisite : 212-221

Fundamental of energy efficiency; principle of energy efficiency in building and industry; load management; laws and regulations of energy conservation; energy management and analysis in building and industrial; technical aspects to use energy efficiently in lighting system, heating ventilating and air-conditioning (HVAC) systems; industrial motor; cogeneration; energy conservations and economics analysis

212-472 Power Electronics in High Voltage Direct Current 3((3)-0-6)

Transmission

Prerequisite : 212-223

Power electronic devices; insulated gate bipolar transistors; power diodes; thyristors; line-commutated converters; voltage source converters; modular multilevel converters; DC link topologies; HVDC economics; HVDC overhead line systems; HVDC cable technologies; HVDC converter transformers; filters; protection systems for HVDC links

212-473	Power System Operation and Economics	3((3)-0-6)
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Prerequisite : 212-324

Utilization of electric power; control of power and frequency; active and reactive power control; power factor and economical power factor; voltage collapse; energy management system; customer power quality; smart meters; smart grid and smart city; power system economics; electricity markets; future power systems.

212-474	Modern Power Distribution Systems	3((3)-0-6)
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Prerequisite : **212-324 and 212-326**

Network planning; network architectures; substation bus layouts; distribution substation sizing methods; overhead lines; underground cables; transformers; circuit breakers; sectionalizers and reclosers; fuses; overcurrent protection schemes; directional and distance protections; differential protections; protection coordination

212-475 Smart Grid

3((3)-0-6)

Prerequisite : **212-292**

Introduction to smart grid and power grid operation; elements of the power grid and measurement technologies: generation, transmission, distribution, and end-user; basic concepts of power, load models, load flow analysis; wide area monitoring system; elements of communication and networking; elements of power networks and data analysis; elements of computation and decision support tools; elements of distributed energy resources (DER) and grid integration: renewable energy, effect of electric vehicles (EVs); elements of management: aspects of energy management in the smart grid; SCADA; microgrids; smart meter; communication technologies; network architectures; Wireless Mesh Network (WMNs); IEC 61850; smart meter communication; communication on intelligent electronic devices; Power Line Communication (PLC); ZigBee protocol; wireless sensor network; policy and economic drives of the smart grid; environmental implications; sustainability issues