ROBOTICS AND ARTIFICIAL INTELLIGENCE ENGINEERING
(INTERNATIONAL PROGRAM)
(B.ENG)

Robotics and artificial intelligence engineering is an interdisciplinary engineering field that combines principles of mechanical, electrical, computer, system, and mechatronics engineering. It covers the advanced machine design with a computer-based controller, which is the mechatronics system concept. The advanced machine design with the advanced automatic control design would increase the system mechanism performance. Moreover, electrical engineering, computer-based automatic control, and artificial intelligence algorithm would enhance the system to be more intelligent and be able to complete complicated tasks.

Robotics and artificial intelligence engineering focuses on the advanced machine design, manufacturing process, and maintenance process consisting of mechanisms and electronic system. Thus, the system can be automatically operated and work with high precision. This system consists of system or plant, actuators, sensors, controllers, and intelligence. Therefore, robotics and artificial intelligence engineer would learn the knowledge on these components as well as industrial standard, industrial safety standard, and management process to effectively use the advanced machines.

Each student is required to accumulate a minimum of 138 credits to graduate for Bachelor of Engineering Program in Automotive Design and Manufacturing Engineering (International Program) which also includes 2 credits of industrial training and 3 credits of senior project.

Curriculum board

Viboon Sangveraphunsiri	Ph.D. (Georgia Tech)
Gridsada Phanomchoeng	Ph.D. (Minnesota)
Ratchatin Chancharoen	Ph.D. (Chula)
Phongsaen Pitakwatchara	Ph.D. (M.S.M.E.)
Attawith Sudsang	Ph.D. (Illinois)
Nattee Niparnan	D.Eng. (Chula)
Paulo Fernando Rocha Garcia	Ph.D. (Portugal)
Jing Tang	D.Eng. (Tokyo Tech)

Professors

Mechanical Engineering

Pramote Dechaumphai	Ph.D. (Old Dominion)
Viboon Sangveraphunsiri	Ph.D. (Georgia Tech)

Associate Professors

Mechanical Engineering

Asi Bunyajitradulya	Ph.D. (UC Irvine)
Kuntinee Maneeratana	Ph.D. (London)
Ratchatin Chanchareon	D.Eng. (Chula)
Witaya Wannasuphoprasit	Ph.D. (Northwestern)
Nopdanai Ajavakom	Ph.D. (UC.Berkeley)
Niphon Wansophark	D.Eng. (Chula)
Alongkorn Pimpin	D.Eng. (Tokyo)
Chanat Ratanasumawong	D.Eng. (Tokyo Tech)
Thanyarat Singhanart	Ph.D. (Tokyo)
Boonchai Lertnuwat	Ph.D. (Tokyo)

Industrial Engineering

Somkiat Tangjitsitchareon	D.Eng. (Kobe Japan)
Oran Kittithreerapronchai	Ph.D. (Georgia)

Metallurgical and materials Engineering

Seksak Asavavisithchai	Ph.D. (Nottingham)

Assistant Professors

Electrial Engineering

Suree Pumrin	Ph.D.(Washington)

Mechanical Engineering

Sunhapos Chantranuwathana	Ph.D. (Michigan)

Lecturer

Electrial Engineering

Boonchuay Supmonchai	M.Eng. (Chula)

Mechanical Engineering

Nuksit Noomwongs	D.Eng. (TUAT)
Tawan Paphapote	Ph.D.C.(USA)

ISE Staffs

Yan Zhao	Ph.D. (London)
Prabhath De Silva	Ph.D. (USA)
Jing Tang	D.Eng. (Tokyo Tech)

Guest lecturer

Kaukeart Boonchukosol	Poitiers (Frence)

Visiting Professor (USA)

Stanley Peter Lynch	Ph.D. (UK)

Curriculum

Total number of credits requirement	138	credits
General Education	30	credits
Core Courses	102	credits
Math & Sciences	30	credits
Basic Engineering	18	credits
Compulsory	37	credits
Concentration	15	credits
Industrial Training	2	credits
Free Electives	6	credits

1. General Education **30 credits**

Social Science	3	credits
Humanity	3	credits
Science and Mathematics	3	credits
Interdisciplinary	3	credits
Foreign Language	12	credits
5501214 Communication and Presentation Skills		3(3-0-6)
5501225 Technical Writing		3(3-0-6)
XXXXXX General Education (Foreign Language)	6	credits
General Education (Special)	6	credits
2147111 Exploring Robotics Engineering		3(3-0-6)
2147104 Engineering Design Thinking		3(3-0-6)

2. Core Course **102 credits**

Science and Mathematics 30 credits

2301107	Calculus I	3(3-0-6)
2301108	Calculus II	3(3-0-6)
2147103	Discrete Mathematics	3(3-0-6)
2304153	Physics for Engineers	3(3-0-6)
2304154	Physics and Electronics for Eng	3(3-0-6)
2304193	Physics Laboratory for Engineers	1(0-3-0)
2304194	Physics and Electronics Laboratory for Engineers	1(0-3-0)
2182203	Probability and Statistics for Eng	3(3-0-6)
2147207	Linear Algebra	3(3-0-6)
2147208	Multivariable Calculus	3(3-0-6)
2147209	Differential Equations for Dynamic Modelling and Numerical Simulation	4(3-3-6)

Basic Engineering 18 credits

2190101	Computer Programming	3(3-0-6)
2147210	Fundamentals of Digital Circuits	3(3-0-6)
2147215	Data Science, Data Visualization And Analytics	3(3-0-6)
2147332	Artificial Intelligence	3(3-0-6)
2183212	Statics	3(3-0-6)
2100227	Project Management	3(3-0-6)

Compulsory 37 credits

2147105	Data Structure and Algorithm	3(3-0-6)
2147311	Digital Logic Design	3(3-0-6)
2183231	Dynamics	3(3-0-6)
2147320	Feedback Control Systems	3(3-0-6)
2147312	Robotics	3(3-0-6)
2183213	Mechanics of Materials	3(3-0-6)
2147313	Design of Machine Elements	3(3-0-6)
2147214	3D CAD Modeling in Mechanical Design	3(2-3-4)
2147216	Sensors, Signaling, and Actuators for Robotics Projects	3(1-6-2)
2147301	Robotics Lab	1(0-3-0)
2147302	Automation, Robotics, and Intelligent System Projects	3(1-6-2)
2147498	Capstone Design Project I	3(0-6-3)
2147499	Capstone Design Project II	3(0-6-3)

Concentration course 15 credits

a) Robotics Systems development and Application

2147319	Mechanics of Machinery	3(3-0-6)
2147321	Modern Control and Digital Control Systems	3(3-0-6)
2147326	Mobile Robot	3(3-0-6)
2147427	Advanced Mobile Robot	3(3-0-6)
2182307	Signals and Systems	3(3-0-6)
2147327	Design of Microprocessor-Based Mechanical Systems	3(3-0-6)
2147309	Mechatronics	3(3-0-6)
2147328	System Identification	3(3-0-6)
2147329	Digital Image Processing and Vision Systems	3(3-0-6)
2147237	Manufacturing Workshop	1(0-3-0)
2147238	Manufacturing Processes	3(3-0-6)
2189101	Engineering Materials	3(3-0-6)
2147239	Materials in Daily Life	3(3-0-6)
2147250	Topics in Robotics and Artificial Intelligence I	3(3-0-6)
2147351	Topics in Robotics and Artificial Intelligence II	3(3-0-6)
2147352	Topics in Robotics and Artificial Intelligence III	3(3-0-6)
2147453	Topics in Robotics and Artificial Intelligence IV	3(3-0-6)
2147480	Independent Study I	1(0-3-0)
2147481	Independent Study II	1(0-3-0)
2147482	Independent Study III	1(0-3-0)

b) Robotics Software and Artificial Intelligence

2147330	Programming methodology	3(3-0-6)
2147331	Perception of Cognitive Robots	3(2-2-5)
2147433	Advanced Artificial Intelligence	3(3-0-6)
2147333	Cyber Physical Robotics	3(3-0-6)
2147334	Machine learning or Depp learning	3(3-0-6)
2147338	Virtual Reality and Augmented Reality	3(3-0-6)
2147336	Internet of Things	3(3-0-6)
2100310	Global Awareness for Technology Implementation	3(3-0-6)
2147337	Database and Simulation	3(3-0-6)
2147250	Topics in Robotics and Artificial Intelligence I	3(3-0-6)
2147351	Topics in Robotics and Artificial Intelligence II	3(3-0-6)

2147352	Topics in Robotics and Artificial Intelligence III	3(3-0-6)
2147453	Topics in Robotics and Artificial Intelligence IV	3(3-0-6)
2147480	Independent Study I	1(0-3-0)
2147481	Independent Study II	1(0-3-0)
2147482	Independent Study III	1(0-3-0)

Industrial Training

2140301	Industrial Training	2(0-12-0)

3. Free Electives **6 credits**

Select 6 credits from any courses offered in English by any International Programs in Chulalongkorn University.

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COURSE NO.	SUBJECT	CREDITS
	FIRST SEMESTER	
2147103	Discrete Mathematics	3
2190101	Computer Programming	3
2301107	Calculus I	3
2304153	Physics for Engineers	3
2304193	Physics Laboratory for Engineers	1
XXXXXX	General Education (Foreign Language)	3
2147111	Exploring Robotics Engineering	3
		19
	SECOND SEMESTER	
2301108	Calculus II	3
2304154	Physics and Electronics for Engineers	3
2304194	Physics and Electronics Laboratory for Engineers	1
2182203	Probability and Statistics for Engineers	3
XXXXXX	General Education (Foreign Language)	3
XXXXXX	General Education	3
		16
	THIRD SEMESTER	
2147207	Linear Algebra	3
2147208	Multivariable Calculus	3
5501214	Communication and Presentation Skills	3
2183212	Statics	3
2147210	Fundamentals of Digital Circuits	3
2147214	3D CAD Modeling in Mechanical Design	3
		18
	FOURTH SEMESTER	
5501225	Technical Writing	3
2183213	Mechanics of Materials	3
2147209	Differential Equations for Dynamics Modelling and Numerical Simulation	4
2147215	Data Science, Data Visualization and Analytics	3
2147216	Sensors, Signaling, and Actuators For Robotics Projects	3
2183231	Dynamics	3
		19

COURSE NO.	SUBJECT	CREDITS
	FIFTH SEMESTER	
2147320	Feedback Control systems	3
2147313	Design of Machine Elements	3
2147105	Data Structure and Algorithm	3
2147104	Engineering Design Thinking	3
2147301	Robotics Lab	1
2147311	Digital Logic Design	3
2147332	Artificial Intelligence	3
		19
	SIXTH SEMESTER	
XXXXXX	Marketing and Management In Engineering	3
2147312	Robotics	3
XXXXXX	Concentration Course	3
XXXXXX	Concentration Course	3
XXXXXX	General Education	3
2147302	Automation, Robotics, and Intelligent System Projects	3
		18
	SUMMER SEMESTER	
2140301	Industrial Training	2
	SEVENTH SEMESTER	
XXXXXX	Concentration Course	3
XXXXXX	Concentration Course	3
XXXXXX	Free Elective	3
XXXXXX	General Education	3
2147498	Capstone Design Project I	3
		15
	EIGHTH SEMESTER	
XXXXXX	Concentration Course	3
XXXXXX	Free Elective	3
XXXXXX	General Education	3
2147499	Capstone Design Project II	3
		12
	TOTAL CREDITS FOR GRADUATION	**138**

COURSES DESCRIPTIONS IN
ROBOTICS AND ARTIFICIAL INTELLIGENCE ENGINEERING
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General Education (Foreign Language)

5501214 Communication and Presentation Skills **3(3-0-6)**
Condition: PRER 5501123

Practice using English for social communication and giving oral presentation on engineering related topics.

5501225 Technical Writing **3(3-0-6)**
Condition: PRER 5501123

Practice in writing summaries composing different types and styles of writing in the field of engineering and writing reports of studies and experiments.

General Education (Special Gened)

2147111 Exploring Robotics Engineering **3(3-0-6)**

Engineering topics related to daily life: energy, resources, environment manufacturing, process, industry, material, automotive, infrastructure, information system and bio engineering

2147104 Engineering Design Thinking **3(3-0-6)**

Principles of Design Thinking; Design thinking process: defining design problems from the real complicated problem, Empathy, product, information, and patent reviews, brain storming, concept generation and evaluation, conceptual design using CAD; Phycology of design; Design Thinking Project to create a real prototype.

Math & Sciences

2301107 Calculus I **3(3-0-6)**

Limits; continuity; differentiation; applications of differentiation; integration; applications of definite integral; transcendental functions; techniques of integration; improper integrals; first-order differential equations.

2301108 Calculus II **3(3-0-6)**
Condition: PRER 2301107

Mathematical induction; sequences and series of real numbers; Taylor series expansion and approximation of elementary functions; numerical integration; vectors, lines and planes in three-dimensional space; calculus of vector valued functions of one variable; calculus of real valued functions of two variables; introduction to differential equations and their applications.

2147103 Discrete Mathematics **3(3-0-6)**

This course covers elementary discrete mathematics for computer science and engineering. It emphasizes mathematical definitions and proofs as well as applicable methods. Topics include formal logic notation, proof methods; induction, well-ordering; sets, relations; elementary graph theory; integer congruence; asymptotic notation and growth of functions; permutations and combinations, counting principles; discrete probability. Further selected topics may also be covered, such as recursive definition and structural induction; state machines and invariants; recurrences; generating functions.

2304153 Physics for Engineer **3(3-0-6)**

Mechanics of particles and rigid bodies, properties of matter, fluid mechanics, heat, vibrations and waves, elements of electromagnetism, optics, modern physics.

2304154 Physics and Electronics for Engineers **3(3-0-6)**

Electricity; DC circuit; AC circuit; basic electronics; solid state devices; electrical actuators.

2304193 Physics Laboratory for Engineers **1(0-3-0)**

Measurement and precision; experiments on simple harmonic motion, radius of gyration, dynamics of rotation, velocity of sound, viscosity of fluids.

2304194 Physics and Electronics Laboratory for Engineers **1(0-3-0)**

Resistance and electromotive force measurements; experiments on amp meter, voltmeter, oscilloscope, AC circuit, transistor, lenses and mirrors, polarization, interference, diffraction.

2182203 Probability and Statistics for Engineers **3(3-0-6)**

Engineering basis in statistics and probability; discrete and continuous probability distribution; joint probability distribution; parameter estimation: estimator, bias, consistency; point estimation; interval estimation; engineering applications in measurement and uncertainty, linear regression, introduction to random process; integration of statistics in engineering applications; case studies.

2147207 Linear Algebra **3(3-0-6)**
CONDITION: PRER 2301108

System of linear algebraic equations; linear spaces; inner products; eigenvalues and eigenvectors; principal axis theorem; higher-order linear differential equations; method of variation of parameters; system of first-order linear differential equations; qualitative analysis and dynamical system

2147208 Multivariable Calculus **3(3-0-6)**
CONDITION: PRER 2301108

Vector; curves, planes and surfaces; derivatives of vector-valued functions; partial, total and directional derivatives; implicit differentiation; maxima-minima; gradient, divergence, curl; scalar and vector fields; line integral; surface integral and volume integral; integral theorems of vector analysis.

2147209 Differential Equations for Dynamics Modelling and Numerical Simulation **4(3-3-6)**
CONDITION: Corequisite 2183231

Differential Equations; Mechanical background; mathematical modeling and numerical solution of engineering problems; modeling of mechanical systems; model representation and response; modeling of electrical, hydraulic

and thermal system; modeling of mixed systems; time response analysis of linear dynamic systems; introduction to optimization and numerical solution; solution techniques for nonlinear systems; signal processing.

Basic Engineering

2190101 Computer Programming 3(3-0-6)

Computer concepts, computer system components, hardware and software interaction, electronic information and data processing concepts; programming: data types, operators, statements, control structures; programming tools; programming styles and conventions; debugging; program design and development with applications to engineering problems using a high-level language.

2147210 Fundamentals of Digital Circuits 3(3-0-6)

Number systems; logic gates and logic expressions; Boolean algebra: Karnaugh map and tabulation method; combination logic circuit and applications: adder, subtractor, multiple outputs circuit, decoder, encoder, multiplexer and demultiplexer; gate implementation: tristate; speed and delay in logic circuits; sequential circuits and design; flip-flop, and counter; register.

2147215 Data Science, Data Visualization And Analytics 3(3-0-6)

Probability and Statistics (do not require the coding skill) To learn the essential fundamental exploratory techniques for analyzing and visualizing data, and to gain hands-on experience of using software tools for data analytics. The following topics are covered: overview of exploratory data analysisytics, data acquisition, data analytic tools, data pre-processing, pattern discovery, graphical visualization, data forecasting, storytelling with data, and case studies.

2147332 Artificial Intelligence 3(3-0-6)

Definitions and application of artificial intelligence; knowledge representation; Prolog programming; natural language processing; machine learning techniques.

2183212 Statics 3(3-0-6)

Force-couple system; resultants; equilibrium; factor of safety; frames and machines; truss; Pappus theory; distributed forces; fluid statics; flexible cable; friction, friction in machines; principle of virtual work; stability.

2100227 Project Management (3-0-6)

Concept of technopreneurship, characteristics and motivation for technopreneurs, intrapreneurship, entrepreneurial mindset and process, opportunity analysis of technology business, technology business model design, sources of fund for technology business.

Compulsory

2147105 Data structure and algorithm 3(3-0-6)
Condition: PRER 2190101

Linear allocation: array, stack, queue, dequeues; linked allocation: singly linked lists, and doubly linked lists; trees: binary tree, traversal, representation, AVL-tree; heap storage, hash coding

2147311 Digital Logic Design 3(3-0-6)

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

2183231 Dynamics 3(3-0-6)
Condition: Corequisite 2183212

Kinematics and kinetics of particles and planar rigid body; Newton's second law; equations of motion; work and energy; impulse and momentum of particles and planar rigid body.

2147320 Feedback Control Systems 3(3-0-6)
Condition: PRER 2147209

Introduction to control system; mathematical models of systems; state-space description; dynamics simulation; feedback control system characteristics; the performance of feedback control systems; the stability of linear feedback systems; essential principles of feedback, the root-locus method; frequency response methods; stability of the frequency domain, time-domain analysis of control systems; the design and compensation of feedback control systems.

2147312 Robotics 3(3-0-6)
Condition: PRER 2183231

Introduction to Industrial Robots; robot reference frames; manipulator kinematics; inverse manipulator kinematics; Jacobian; manipulator dynamics; introduction to robot controls; trajectory generation; mechanism design; introduction to hybrid force/position control

2183213 Mechanics of Materials I 3(3-0-6)
Condition: PRER 2183212

Concept of stress and strain; stress and strain components; plane stress and plane strain; Mohr's circle of plane stress; Hooke's law and modulus of elasticity; engineering stress-strain diagrams; working stress; factor of safety; problems in axial loading including statically indeterminate problems and temperature changes; thin-walled pressure vessel; torsion of circular shaft; statically indeterminate shaft; beam; stress in beam; deflection of beam; statically indeterminate beam; Euler's formula; combined stress.

2147313 Design of Machine Elements 3(3-0-6)

Design machine concept; design of robotics components; joints and transmission system design of robots; link and joint connection design, design standard; materials used in robots, design for manufacturing.

2147214 3D CAD Modeling in Mechanical Design 3(2-3-4)

Engineering design process for product development; conceptual design; detail design; introduction to computer aided design, computer aided manufacturing, and computer aided engineering; 3D solid modeling, design concepts and implementation; link to manufacturing.

2147216 Sensors, Signaling, and Actuators For Robotics Projects **3(1-6-2)**
Condition: 2nd Student

Conduct and complete a engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

2147301 Robotics Lab **1(0-3-0)**
Condition: 3rd Student

Conduct and complete a engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

2147302 Automation, Robotics And Intelligent System Projects **1(1-6-2)**
Condition: PRER 2147301, 3rd year project I

Conduct and complete a engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

2147498 Capstone Design Project I **1(0-6-3)**
Condition: 4th student

Conduct and complete a engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

2147499 Capstone Design Project II **1(0-6-3)**
Condition: PRER 2147498

Conduct and complete a engineering project in a team such that the processes comply with prescribed design processes as well as documenting and presenting the project in a professional manner.

Concentration Course

(a) Robotics Systems Development and Application

2147319 Mechanics of Machinery **3(3-0-6)**
Condition: PRER 2183231

Basic Mechanisms; Position, velocity and acceleration of Linkages, Graphical linkage synthesis; Linkage synthesis; Static and dynamic force analysis; Static and dynamic balancing of a simple rotating and reciprocating machine.

2147321 Modern Control and Digital Control Systems **3(3-0-6)**
Condition: PRER 2147320*

Describing-function analysis of non-linear control systems, phase-plane analysis, state-space analysis of control system; linear dynamical equations and impulse-response matrices; controllability and observability of linear dynamical equations, irreducible realizations: strict system, equivalence and identification; digital control design

2147326 Mobile Robots **3(3-0-6)**

Types and application of mobile robots, control of mobile robots

2147427 Advanced Mobile Robots **3(3-0-6)**
Condition: PRER 2147326

Types and application of mobile robots, control of mobile robots

2182307 Signals and Systems **3(3-0-6)**

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

2147327 Design of Microprocessor-Based Mechanical Systems **3(3-0-6)**

Fundamentals of embedded system hardware and firmware, real-time processing, feedback loop control, communication protocols, transistor logic, memory circuits, interfacing logic families, standard bus interfaces, interrupt, boot-loading stages and direct-memory access (DMA); microprocessors related to problems in mechanical systems

2147309 Mechatronics **3(3-0-6)**

Introduction to mechanical system interfacing; combinational digital logic; industrial electronic components; industrial sensors; simple computer structure; low level programming techniques; embedded control computers; microcontroller; stepping motors; DC motors; analog/digital conversion; position and velocity measurement; amplifiers; projects related to mechatronics.

2147328 System Identification **3(3-0-6)**
Condition: PRER 2147321

Models for linear time-invariant and time-varying systems; nonparametric time- and frequency-domain methods; parameter estimation methods; convergence and consistency; asymptotic distribution of parameter estimates; computing the estimate; recursive identification methods; experiment design; choice of identification criterion; model structure selection and model validation.

2147329 Digital Image Processing and Vision Systems **3(3-0-6)**

Visual perception, digitization and coding of images, converting pictures to discrete(digital) forms; image enhancement; image restoration including improving degraded low-contrast, blurred, or noisy pictures; image compression: data compression used in image processing; image segmentation referred to as first step in image analysis.

2147237 Manufacturing Workshop 1(0-3-0)

Manufacturing process: casting, turning, milling, welding, heat treatment; manufacturing process selection for materials and shapes; manufacturing process selection for linear tolerance and geometric tolerance; surface roughness; metrology and examination techniques.

2147238 Manufacturing Processes 3(3-0-6)

Manufacturing process; casting, plastic processing, metal forming, sheet metalworking, turning, milling, welding and assembly process; Manufacturing process selection for materials and shapes; dimensions, tolerances, surfaces and their measurement.

2189101 Engineering Materials 3(3-0-6)

Crystal structure of solids. Crystal defects. Mechanical properties of materials. Dislocation and strengthening mechanism of metals. Mechanical failure of materials. Phase diagram and solid state reaction. Fabrication and applications of metals. Structure, properties, and applications of ceramic. Structure, properties, and applications of polymers. Structure, properties, and application of composite materials. Corrosion and degradation of materials. Properties and applications of electronic materials. Electrical properties of materials. Magnetic properties of materials. Innovation in material technology.

2147239 Materials in Daily Life 3(3-0-6)

Learn different aspects of materials as found in daily life, in various occupations and in suitable applications. Environmentally friendly materials. Full utilization of materials in both efficient sense and aesthetic sense. Topics include materials for design and 126 architecture, fashion, arts and craft materials, biomedical materials and biomaterials, automotive materials and household materials.

(b) <u>Robotics Software and Artificial Intelligence</u>

2147330 Progrmming Methodology 3(3-0-6)
Condition: PRER 2190101

Programming methodology: object-oriented programming, event-driven programming, concurrent programming; error and exception handling; application programming interface (API); programming tools; programming styles and practice.

2147331 Perception of Cognitive Robots 3(2-2-5)

Programming of robots to enable the achievement of goals in environments, cognitive capabilities such as perception, attention, anticipation, planning, memory, learning, and reasoning. social capabilities, such as communication, collaborative task execution, and reasoning about the mental states of other agents. artificial intelligence techniques, as well as insights from cognitive science.

2147433 Advanced Artificial Intelligence 3(3-0-6)
Condition: PRER 2147332

Definitions and application of artificial intelligence; knowledge representation; Prolog programming; natural language processing; machine learning techniques.

2147333 Cyber Physical Robotics 3(3-0-6)

The mathematics of complex networks/systems in natural and man-made environments; bacteria swarms; smart grid; social media; models for network design; control and optimization, identifying their limitations in relation to the actual characteristics of physical processes; developing advanced mathematical models of CPR based on actual measurements; overview of network theory and research in applied mathematics, physics, and engineering.

2147334 Machine Learning or Deep Learning 3(3-0-6)

Computing with logic; using logic set theory, number theory, algebras graph theory, automata; language of first order logic, model theory and logic programming; problems of inductive inference in the framework of first-order predicate calculus and the probability calculus; introduction of computational learning theory.

2147338 Virtual Reality and Augmented Reality 3(3-0-6)

Theory, development, and applications of virtual reality (VR) technology for the generation of the virtual environments (VE); human-computer interaction based on
the 5 basic senses of human perception; use of 3D software and some scripting language to generate models in the CAVE system; application of VR technology in product and production design and others.

2147336 Internet of Things 3(3-0-6)

This course covers the topics of smart things network and communication: architectures, services and protocols; privacy and security; enabling technologies of
IoT; IoT and smart system applications: smart cities, smart energy, smart transportation and mobility, smart home and building, smart factory and manufacturing, smart health and up-to-date applications related to RAI; smart things networks for data management; IoT related standardization. The course also includes a substantial group design project.

2100310 Global Awareness for Technology Implementation 3(3-0-6)

Global awareness; current mainstream technologies; understanding of a variety of cultures, traditions, laws and regulations, beliefs, concepts, practices, values in each
society technology implementation in various societies; important factors for success in technology implementation.

2147337 Database and Simulation 3(3-0-6)

Introduction of database management; data models (ER, rational, and others); SQL (Structured Query Language); databases in applications; data warehousing; distributed
and no SQL databases; introduction of modeling and simulation; discrete event simulation; system dynamics simulation; agent-based simulation.

Approved Elective Course

2147250 Topics in Robotics Engineering and Artificial Intelligence I **3(3-0-6)**

Selected technical topics in robotics engineering

2147351 Topics in Robotics Engineering and Artificial Intelligence II **3(3-0-6)**

Selected technical topics in robotics engineering

2147352 Topics in Robotics Engineering and Artificial Intelligence III **3(3-0-6)**

Selected technical topics in robotics engineering

2147453 Topics in Robotics Engineering and Artificial Intelligence IV **3(3-0-6)**

Selected technical topics in robotics engineering

2147480 Independent Study I **1(0-3-0)**

Independent study and investigation, theoretically and practically, in robotics and artificial intelligence engineering topics according to each student's interest under the supervision and guidance of the instructor.

2147481 Independent Study II **1(0-3-0)**

Independent study and investigation, theoretically and practically, in robotics and artificial intelligence engineering topics according to each student's interest under the supervision and guidance of the instructor.

2147482 Independent Study III **1(0-3-0)**

Independent study and investigation, theoretically and practically, in robotics and artificial intelligence engineering topics according to each student's interest under the supervision and guidance of the instructor.

2140301 Industrial Training **2(0-12-0)**

Industrial Training in related areas under supervision of experience experienced engineers in private sectors or government agencies.