

DEFENSE ENGINEERING AND TECHNOLOGY

This curriculum was created according to Her Royal Highness Princess Sirindhorn's wish to establish the academic collaborations between Chulachomkloa Royal Military Academy and Chulalongkorn University. The Memorandum of Understanding between two institutes was signed on September 23th, 2013 with 5-year duration. The Faculty of Engineering has initiated the academic collaborations by co-developing Master Program in Defense Engineering and Technology which is the result of merging engineering and military defense technologies. Now, the program is open in 7 majors; Civil Engineering and Explosives, Electrical Engineering for Defense, Mechanical Engineering for Defense, Metallurgy Engineering for Defense, Computer Engineering for Defense, Environment Engineering for Defense, and Nuclear Engineering for Defense.

HEAD:

Withit	Pansuk,	Ph.D. (Hokkaido)
Col.Chuan	Chuntavan	Ph.D. (Cincinnati)

ASSOCIATE PROFESSORS:

Withit	Pansuk,	Ph.D. (Hokkaido)
Sunchai	Nilsuwankosit,	Ph.D. (Wisconsin)

ASSISTANT PROFESSORS:

Col.Chuan	Chuntavan	Ph.D. (Cincinnati)
Widhyakorn	Asdornwised	Ph.D. (Chula)
Suebskul	Phiphobmongkol	Ph.D. (AuBurn)
Chaodit	Aswakul	Ph.D. (London)
Alongkorn	Pimpin	D.Eng. (Tokyo)
Pichaya	Rachdawong	Ph.D. (Wisconsin-Milwaukee)
Panyawat	Wangyao	Ph.D. (Kosice)
Krerk	Piromsopa,	Ph.D. (Michigan)
Col.Phaderm	Nangsue	Ph.D. (Clarkson)
Col.Anotai	Suksangpanomrong	Ph.D. (Victoria)
Col.Preecha	Apiwantragoon	Ph.D. (Wisconsin)
Col.Nuthaporn	Nittayasakol	Ph.D. (Virginia Polytechnic)

INSTRUCTORS:

Kanok	Weerawong	Ph.D. (Purdue)
Maj.Banchachit	Saensunon	Ph.D. (New South Wales)

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

ADMISSION

The applicants must hold a Bachelor degree in Engineering, Science, or equivalent and also passed the

requirements of the Graduate School or got approval from the program committee for admission.

DEGREE REQUIREMENTS

1. **Pattern 1(1)** program consists of
 - 1.1 Thesis 36 credits
 - 1.2 2120601 Defense Engineering and Technology Principles S/U
 - 1.3 Seminar (2 credits) S/U

2. **Pattern 1(2)** program consists of

2.1	Core course	3
credits	2120601 Defense Engineering and Technology Principles	3(3-0-9)

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|-------------------------|--|-----------------------------|
| 2.2 | Approve elective course | credits |
| 0-9 | | |
| civil engineering | 1) Explosive and | 6 credits |
| Engineering for Defense | 2) Nuclear | 9 credits |
| | Engineering | |
| | 3) Electrical Engineering for Defense/
Mechanical Engineering for Defense/
Metallurgy Engineering for Defense/
Computer Engineering for Defense/
Environment Engineering for Defense | No prerequisite requirement |

- | | |
|---------------------------------------|---|
| 2.3 Free Elective | 6-15 credits |
| civil engineering | 1) Explosive and
9 credits |
| Engineering for Defense | 2) Nuclear
6 credits |
| | Engineering |
| 3) Defense | Electrical Engineering for
15 credit |
| | Engineering |
| 4) for Defense 15 | Mechanical Engineering
credit |
| | Engineering |
| 5) Engineering for | Environmental
15 credit |
| | Defense Engineering |
| 6) Metallurgy Engineering for Defense | 15 credit |
| | Engineering |
| 7) Defense | Computer Engineering for
15 credit |
| | Engineering |

Students in Electrical Engineering for Defense/Mechanical Engineering for Defense/Metallurgy Engineering for Defense/Computer Engineering for Defense/Environment Engineering for Defense must take signified course for their major at least 9 credits and take other course this program for 6 more credits.

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|--------------------------------|-------------------|
| 2.4 Thesis | 18 credits |
| 2.5 Seminar (2 credits) | S/U |

COURSE REQUIREMENTS

1. Required Courses	
1) Pattern 1(1)	
2120601	Defense Engineering and Technology S/U Principles
2120603	Defense Engineering and Technology S/U Seminar I
2120604	Defense Engineering and Technology S/U Seminar II
2) Pattern 1(2) 3 credits	
2120601	Defense Engineering and Technology 3(3-0-9) Concept
2120603	Defense Engineering and Technology S/U Seminar I
2120604	Defense Engineering and Technology S/U Seminar II
2. Approve Elective course 0-9 credits	
1.1) Explosive and civil engineering 6 credits	
2101607	Advanced Mechanics of Materials 3(3-0-9)
2121677	Principles of Explosives Engineering 3(2-3-7)
1.2) Nuclear Engineering for Defense 9 credits	
	Engineering
2111610	Nuclear Security 3(3-0-9)
2111651	Weapon Mass Destruction 3(3-0-9) Nonproliferation
2131501	Nuclear Technology for Military 3(3-0-9)
1.3) Electrical Engineering for Defense/ Mechanical Engineering for Defense/ Metallurgy Engineering for Defense/ Computer Engineering for Defense/ Environment Engineering for Defense	
No prerequisite requirement	
3) Free Elective Courses 6-15 credits	
2.1) Explosive and civil engineering 9 credits	
2101535	Tunnel Engineering 3(3-0-9)
2101566	Dynamics of Structures 3(3-0-9)
2101567	Rail Transport System 3(3-0-9)
2101615	Advanced Prestressed Concrete Structures 3(3-0-9)
2101617	Structural Building Components 3(3-0-9)
2101619	Seismic Design of Structures 3(3-0-9)
2121670	Explosives Handling and safety 3(3-0-9)
2121671	Blasting Design and Technology 3(2-3-7)
2121672	Demolition of Building and Structures 3(2-3-7)
2121673	Scientific Instrumentation for Explosives Testing & Blasting 3(2-3-7)
2121674	Theory of High Explosive 3(3-0-9)
2121675	Advanced Explosives Engineering 3(3-0-9)
2121676	Exterior Ballistics 3(3-0-9)
2.2) Nuclear Engineering for Defense Engineering 6 credits	
2111613	Radiation Safety and Shielding 3(3-0-9)
2111642	Nuclear Reactor Engineering 3(3-0-9)
2111646	Radioactive Waste Management 3(3-0-9)
2111653	Nuclear Safeguards 3(3-0-9)
2111654	Nuclear Fuel Cycle and Environmental Impacts 3(3-0-9)
2111656	Physical Protection of Nuclear Materials

	and Facilities I 3(3-0-9)
2111657	Advanced Detection Technologies of Radioactive and Nuclear materials 3(3-0-9)
2111658	Methods and Instrumentation for Nuclear Security and Safeguards 3(3-0-9)
2111678	Nuclear Materials Engineering 3(3-0-9)

2.3) Students in Electrical Engineering for Defense/Mechanical Engineering for Defense/Metallurgy Engineering for Defense/Computer Engineering for Defense/ Environment Engineering for Defense must take signified course for their major at least 9 credits and take other course this program for 6 more credits.

2.3.1) Electrical Engineering for Defense Engineering 15 credits	
2102505	Introduction to Optimization Techniques 3(3-0-9)
2102531	System Identification 3(3-0-9)
2102544	Advanced Embedded Systems 3(3-0-9)
2102571	Multimedia Communication 3(3-0-9)
2102601	Electrical Power and Energy Technogy in Smart Grids 3(3-0-9)
2102602	Information and Communication Technologies in Smart Grids 3(3-0-9)
2102620	Electromagnetic Theory 3(3-0-9)
2102623	Antennas and Rader Systems 3(3-0-9)
2102627	Reliability and Survivability of Communication Networks and Systems 3(3-0-9)
2102631	Optimal Control Systems 3(3-0-9)
2102635	Control System Theory 3(3-0-9)
2102642	Computer Vision and Video Electronics 3(3-0-9)
2102645	Embedded System Design 3(3-0-9)
2102668	Biosensors 3(3-0-9)
2102675	Pattern Recognition 3(3-0-9)
2102676	Digital Image Processing 3(3-0-9)

2.3.2) Mechanical Engineering for Defense 15 credits	
Engineering	
2103510	Mechanics of Composite Materials 3(3-0-9)
2103511	Introduction to Continuum Mechanics 3(3-0-9)
2103532	Computer Aided Design and Computer Aided Manufacturing 3(2-3-7)
2103535	Mechatronics 3(3-0-9)
2103540	Failure Analysis and Nondestructive Testing 3(2-3-7)
2103566	Compressible Fluid Dynamics 3(3-0-9)
2103571	Micro and Nano Electromechanical Systems 3(3-0-9)
2103601	Advanced Engineering Mathematic 3(3-0-9)
2103625	Advanced Finite Element Method 3(3-0-9)
2103631	Control of Dynamic Systems 3(3-0-9)
2103664	Design of Thermal Systems 3(3-0-9)
2103665	Advanced Computational Fluid Dynamics 3(3-0-9)

2.3.3) Environmental Engineering for Defense Engineering 15 credits	
2107607	Environmental Analysis 3(3-0-9)
2107616	Air Quality Management 3(3-0-9)

2107630	Treatment and Disposal of Industrial Wastes	3(3-2-7)
2107641	Air Pollution Control Technology	3(3-0-9)
2107642	Engineering Practices for Solid Wastes Disposal	3(3-0-9)
2107657	Energy and Environment	3(3-0-9)
2107658	Theory and Design of Advanced Water Treatment Processes	4(3-3-10)
2107659	Theory and Design of Advanced Wastewater Treatment Processes	4(3-3-10)
2107661	Fundamental Chemistry for Environmental Engineering	3(3-2-7)
2127675	Military Waste Management	3(3-0-9)
2107676	Management of Environmental Emergencies	3(3-0-9)

2.3.4) Metallurgy Engineering for Defense 15 credits Engineering

2109509	Stainless Steel Technology	3(3-0-9)
2109510	Instrumental Analysis	3(2-3-7)
2109516	Advanced Topics in Physical Metallurgy	3(3-0-9)
2109517	Composite Materials I	3(3-0-9)
2109518	Surface Technology	3(3-0-9)
2109519	Solidification of Casting	3(3-0-9)
2109525	Welding Engineering	3(3-0-9)
2109527	High Temperature Materials	3(3-0-9)
2109533	Powder Metallurgy	3(3-0-9)
2109535	Cellular Metal	3(3-0-9)
2109536	Advanced Topics in Production Metallurgy	3(3-0-9)
2109537	Tribology of Materials	3(3-0-9)

2.3.5) Computer Engineering for Defense

15 credits

2108532	Satellite Surveying and Modern Techniques	3(2-3-7)
2108556	Online Spatial Information Technologies	3(2-3-7)
2108557	Spatial Data Structure and Models	3(3-0-9)
2108558	Spatial Data Handling and Analysis	3(2-3-7)
2108627	Geospatial Processing	3(2-3-7)
2108628	Radar Remote Sensing	3(2-3-7)
2108632	Advanced GNSS Surveying	3(2-3-7)
2110622	Data Management	3(3-0-9)
2110639	Computer System Security	3(3-0-9)
2110661	Computer Network	3(3-0-9)
2110678	Mobile Computing	3(3-0-9)
2110681	Computer Algorithm	3(3-0-9)
2110682	Embedded and Real-time Systems	3(3-0-9)
2110741	Robotics	3(3-0-9)
2110743	Machine learning	3(3-0-9)
2110745	Cryptography	3(3-0-9)

Other Free Elective Courses

2120602	Advanced Topics in Defense Engineering and Technology	3(3-0-9)
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In addition, students may take other additional course which the curriculum allows or which is opened in graduate program in Chulalongkorn University. The course must be corresponding to the thesis and consented by the academic advisor.

3) Thesis

Pattern 1(1)		
2120816	Thesis	36 credits
Pattern 1(2)		
2120813	Thesis	18 credits

STUDY PROGRAM

Pattern 1(1)

The First Semester

2120601	Defense Engineering and Technology Principles	S/U
2120603	Defense Engineering and Technology Seminar I	S/U
2120816	Thesis	9 9

The Second Semester

2120604	Defense Engineering and Technology Seminar II	S/U
2100829	Thesis	9 9

The Third Semester

2120816	Thesis	9 9
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The Fourth Semester

2120816	Thesis	9 9
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Remarks:

* No credit will be granted, Evaluation will be only S/U

Pattern 1(2)

The First Semester

2120601	Defense Engineering and Technology Principles	3
2120603	Defense Engineering and Technology Seminar I	S/U
210XXXX	Approve Elective and/or Free Elective	6 — 9

The Second Semester

2120604	Defense Engineering and Technology Seminar II	S/U
210XXXX	Approve Elective and/or Free Elective	9 — 9

The Third Semester

2120813	Thesis	9 — 9
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The Fourth Semester

2120813	Thesis	9 — 9
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COURSE DESCRIPTIONS IN DEFENSE ENGINEERING AND TECHNOLOGY ENGINEERING (M.Eng.)

2120601 Defense Engineering and Technology Principles 3(3-0-9)

Principles of defense and military development; national security and national strategy; organization, responsibilities, management and work operation of the Royal Thai Armed Forces; military standards, and national disaster relief and prevention.

2120602 Advanced Topics in Defense Engineering and Technology 3(3-0-9)

Recent interesting topics and technology development in various field of defense and engineering technology.

2120603 Defense Engineering and Technology Seminar I 1(1-0-3)

Analysis of research products or quality research papers; presentation of research papers or research findings of individual researchers, and discussions.

2120604 Defense Engineering and Technology Seminar II 1(1-0-3)

Analysis of research products or quality research papers; presentation of research papers or research findings which are parts of students' thesis, and discussions.

2121670 Explosive Handling and Safety 3(3-0-9)

Basic handling and safety of explosives; laboratory handling; testing; manufacturing and storage of explosive instruments and weapons used in both the civil and the military sectors.

2121671 Blasting Design and Technology 3(2-3-7)

Advanced theory and application of explosives in excavation; detailed underground blast design; specialization in blasting, including blast casting, construction and pre-splitting; introduction to blasting research and examination of applications in other fields.

2121672 Demolition of Building and Structures 3(2-3-7)

Basic knowledge about the equipment, techniques and processes required for the demolition and remediation of mine plants and mining equipment sites and non-mining structures.

2121673 Scientific Instrumentation for Explosives Testing and Blasting 3(2-3-7)

Application of scientific principles, details of the equipment and the use of instruments for explosives including blasting; related topics: blast chamber design, equipment set up, high-speed photography, motion detection and measurement, explosives sensitivity testing, explosives properties testing, vibration measurement and analysis, destruction in both the civil and the military sectors.

2121674 Theory of High Explosive 3(3-0-9)

Applications of chemical thermodynamics and the hydrodynamics theory to determine properties of high explosives; kinetics and reaction rate; application of the above theory to the blasting of explosives.

2121675 Advanced Explosives Engineering 3(3-0-9)

Detonation of non-ideal explosives; equation of the state of porous media; explosively driven mechanical systems; shock compaction of powders and desensitization and experimental methods used in the evaluation of explosives and their applications.

2121676 Exterior Ballistics 3(3-0-9)

Benefits and uses of exterior ballistics; related background theories; trajectory; forces and moments acted on the projectile; projectile coefficients; various trajectory models; wind effect; mass asymmetries and swerve motion.

2121677 Fundamental Principles of Explosive Engineering 3(2-3-7)

Theory and application of explosives in the mining industry: explosives, initiating systems, characteristics of explosive reactions and rock breakage, fundamentals of blast design, drilling and blasting, regulatory and safety considerations.

2121535 Tunnel Engineering 3(3-0-9)

History of tunneling; soil tunneling methods; types of linings and face support; stand-up times and tunnel man's ground classification; groundwater control and soil modification methods; lining behavior and design; ground movements and changes of pore water pressure caused by tunnel construction; field observations, monitoring, and instrumentation; building distortion/damage and relation to ground movements; fundamentals of tunnel engineering related to soil types and construction techniques; design of tunnel lining in various subsoil conditions; applications and techniques of tunnel construction for infrastructure system.

2101566 Dynamics of Structures 3(3-0-9)
Condition: Consent of Faculty

Analysis of structural systems with single and multi-degree of freedom; equations of motions; free and forced vibrations; vibration natural frequencies and mode shapes of systems; numerical evaluation of dynamic response; response spectrum; modal response history and response spectrum analysis; response of inelastic SDF system; building codes on seismic design of structures.

2101567 Rail Transport System 3(3-0-9)

This course covers the following topics: History of Rail Transport Development, Fundamental and Characteristics of Rail Operation, Rules of Safety, Composition of Rail System: Infrastructure, Rolling Stocks, Signaling and Communication, Case Studies of Rail Transport Development in Thailand and Neighboring Countries.

2101607 Advanced Mechanics of Materials 3(3-0-9)

Stress, strain, and displacement relationship; energy theorems; equilibrium and compatibility conditions; plane stress and plane strain problems; beams on elastic foundation; beam-columns, flexure of curve members; torsion of non-circular and thin-walled members; shear center; shear flow; introduction to theorems of limit analysis.

2101615 Advanced Prestressed Concrete Structures 3(3-0-9)

Prestressing systems; behavior of prestressed concrete beams; moment curvature relationship; load deflection curves, ductility and fatigue, analysis and design of composite members, continuous flexural members, prestressed frames and segmental bridges.

2101617 Structural Building Components 3(3-0-9)

Analysis and design of structural components for buildings considering various types of construction materials: timber, metal, concrete and synthetics; the components include floor systems, roof member, tilt-up walls, sandwich panels, precast, precast member, bearing walls, shear walls and light-gauge steel members.

2101619 Seismic Design of Structures 3(3-0-9)

Elementary engineering seismology; seismic waves; intensity and magnitude; response spectrum and design earthquakes; earthquake codes and analysis; response spectrum analysis; random vibrations; artificial generation of earthquake records; structural design and detailing for earthquake resistance; special structures: bridges, dams, nuclear power plants.

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

Condition: PRER 2102205 or Consent of Faculty

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

quadratic; solutions of linear programming by the simplex method.

2102531 System Identification 3(3-0-9)

Condition: PRER 2102332 or Consent of Faculty

Models for linear time-invariant and time-varying system; 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.

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

Condition: Consent of Faculty

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

2102571 Multimedia Communication 3(3-0-9)

Condition: Consent of Faculty

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

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

Condition: Consent of Faculty

Introduction to Smart Grids; fundamentals of power system operation and control; distributed generation, microgrid and active networks; introduction to wide area monitoring and wide area protection systems; renewable energy generation; grid connection codes; renewable energy policy and regulation; energy storage; electric vehicle.

2102602 Information and communication technologies in Smart Grids 3(3-0-9)

Condition: Consent of Faculty

Substation operation and related communication within substation; equipment in distribution system; communication between control center Architecture and components of AMI/AMR including phasor measurement unit, digital fault recorder and interoperability. Energy efficiency within home, building and factory. Communication channels in smart grid: wire, wireless, optical fiber, including network layer, sensing/control and control protocol. Database management and cyber security.

2102620 Electromagnetic Theory 3(3-0-9)

Maxwell's equations; theorem of electromagnetic energy and power; properties of materials in electromagnetic fields; boundary conditions; theorems of electromagnetic fields, duality principle, uniqueness, image theory, equivalence principle, induction theorem, reciprocity; potential functions; electromagnetic wave equations, plane wave functions, cylindrical wave functions, spherical wave functions mathematical tools for electromagnetic fields, separation of

variables technique, transverse resonance method, perturbation and variational techniques, Green's functions, geometric algebra; solution methods for electrostatic, magnetostatic, for electrostatic, magnetostatic, and quasi-static fields problems; plane wave propagation problems, propagation in unbounded medium, multilayered medium, and anisotropic medium; wave guidance problems, field analysis in typical waveguides, modal expansion method; resonators and filters; radiation problems, radiation from current sources and apertures; scattering problems, scattering by cylinder, wedge, and sphere; optical waves, optical waveguides, optical wave propagation in photonic crystal.

2102623 Antennas and Radar Systems 3(3-0-9)
Condition: Consent of Faculty

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

2102627 Reliability and Survivability of Communication Networks and Systems 3(3-0-9)
Condition: Consent of Faculty

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

2102631 Optimal Control Systems 3(3-0-9)
Condition: PRER 2102505 or Consent of Faculty

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

2102635 Control System Theory 3(3-0-9)
Condition: Consent of Faculty

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

2102642 Computer Vision and Video Electronics 3(3-0-9)
Condition: Consent of Faculty

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

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

Condition: Consent of Faculty

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

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

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

2102675 Pattern Recognition 3(3-0-9)
Condition: PRER 2102282 or Consent of Faculty

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

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

2103511 Introduction to Continuum Mechanics 3(3-0-9)

Introduction to continuum mechanics; essential mathematics: notations, tensor and operations, transformation, equation and symbol presentation; Kinematics of motion and small deformation; engineering stress; governing equations; constitutive equations; applications: setting and interpretation of heat conduction, solid mechanics and fluid mechanics.

2103510 Mechanics of Composite Materials 3(3-0-9)

Basic concepts of fiber reinforced composite materials and their application, stress and strain analysis of continuous fiber composite materials; Hooke' law and hygrothermal behavior of orthotropic lamina; classical lamination theory, failure criterion, and design concepts, as applied to composite structures; analysis of composite beams and plates; introduction to material fabrication and testing.

2103532 Computer Aided Design and Computer Aided Manufacturing 3(2-3-7)

Introduction to CAD/CAM; Basic Concept of CAD/CAM/CAE; Product Design and Strategy; 3D Modeling Concept; Techniques for Geometry Modeling; Surface Design, Design Analysis; Mechanism Design and Animation; Computer Aided Manufacturing Concept; The Design and Manufacturing Interface; The Total Approach to Product Development; NC Programming.

2103535 Mechatronics 3(3-0-9)

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

2103540 Failure Analysis and Nondestructive Testing 3(2-3-7)

Stress at crack tip and related parameters; failure phenomena; crack propagation creep; corrosion; failure surface; life assessment; case studies; nondestructive testing; practice in NDT techniques.

2103566 Compressible Fluid Dynamics 3(3-0-9)

Thermodynamics of motion; physical acoustics; wave equation; speed of sound; quasi-one dimensional flow with friction and heat addition; shock dimensional steady flow; method of characteristics; nozzle design; linearized flow visualization using optical techniques.

2103571 Micro and Nano Electromechanical Systems 3(3-0-9)

Overview of MENS-NEMS, review of engineering mechanics and thermo-fluid engineering, electromechanics and light phenomena, micro system design, scaling of micromechanical devices, MEMS materials, review of micro fabrication, applications of MEMS, and future trends in technology development.

2103601 Advanced Engineering Mathematics 3(3-0-9)

Numerical and graphical methods of approximate solution; finite difference methods; calculus of variations, solution of classical partial differential equations of mathematical physics including application of conformal mapping and the Laplace transformation.

2103625 Advanced Finite Element Method 3(3-0-9)

Procedures of the finite element method for structural, thermal and fluid differential equations; nonlinear structural static and dynamic problems with discrete and continuum structures; transient nonlinear heat transfer problems with conduction, and radiation; and radiation; steady and unsteady nonlinear heat transfer problems with conduction, and radiation; steady and unsteady nonlinear incompressible and compressible fluid flow problems.

2103631 Control of Dynamic Systems 3(3-0-9)

Introduction; Mathematical Representation of Dynamic Systems; Response of Linear Systems; Stability of Linear Systems; System Theory, Control of Linear Systems: Root-Locus Design, Frequency Response analysis and design, State Variable Feedback, Observer Design; Multivariable Control Systems.

2103664 Design of Thermal Systems 3(3-0-9)

Engineering design, design of a workable system, consideration; Equation fitting and mathematical modeling,

system simulation, optimization, Lagrange multipliers search methods, dynamic programming, linear programming.

2103665 Advanced Computational Fluid Dynamics 3(3-0-9)

Mathematical and numerical aspects of heat transfer and fluid mechanics, finite difference and finite volume methods for solving basic governing equations of fluid flow and heat transfer: continuity, momentum and energy, discretization methods for two and three dimensional problems, boundary conditions, numerical schemes and solvers, consistency stability and convergence, advanced numerical techniques for CFD, application of the methods to some engineering problems.

2107607 Environmental Analysis 3(3-0-9)

Procedures and details of environmental sample analysis; methods of sample collection, sample handling; analytical method selection; details of analysis and data presentation.

2107616 Air Quality Management 3(3-0-9)

Interaction among air, water and land pollutions, effects of air pollutants, standards and regulations, technical aspects of air pollution control programs, the organization and management of control programs in governmental and private sectors.

2107630 Treatment and Disposal of Industrial Wastes 3(2-3-7)

Industrial waste problems; categories of waste; nature and characteristics of liquid waste; effect of waste on environment; laws for disposal of waste in Thailand and other countries; method of treatment of various kinds of waste; preventive measures.

2107641 Air Pollution Control Technology 3(3-0-9)

Overview of air pollution control methods. Control of particulates and gaseous emissions by settling chambers, cyclones, scrubbers, filters and electrostatic precipitators. Design of equipment, maintenance and evaluation of control efficiency.

2107642 Engineering Practices for Solid Wastes Disposal 3(3-0-9)

Municipal and industrial solid wasters, their volume and characteristics; heat value, methods of handling, storage and disposal. Size and volume reduction. Separation of components. Landfill and leachate effects. Ocean disposal. Incineration.

2107657 Energy and Environment 3(3-0-9)

Energy resources and utilization in the global context and a case studies in Thailand; fossil-based energy, environmental impact of mining and fuel processing; air pollution, greenhouse gas, and global warming from fuel utilization; energy conservation and renewable energy technologies; hydro energy harnessing and its environmental impact and mitigation; other non-fossil fuel options: biomass, solar, and wind energy; synthetic fuel conversion technology including pyrolysis and gasification; biogas from fermentation; prospect of hydrogen economy.

2107658 Theory and Design of Advanced Water Treatment Processes 4(3-3-10)

Water sources; water chemistry and quality, aeration, coagulation, sedimentation, filtration, ion exchange, membrane processes, disinfection absorption, neutralization and stabilization; water conditioning for boiler and cooling system; design criteria for water sources, lines distribution and storage facilities, water treatment and softening, engineering design of water distribution system, functional and hydraulic design of complete water treatment.

2107659 Theory and Design of Advanced Wastewater Treatment Processes 4(3-3-10)

Development of wastewater technology; wastewater collection and transportation; design of sewers and appurtenances; advanced wastewater treatment by microbial and biological control techniques, law related to effluent disposal; wastewater law relating to effluent disposal, wastewater treatment plant organization and management; combined and separate system pumping stations; functional and hydraulic design of complete wastewater treatment system.

2107661 Fundamental Chemistry for Environmental Engineering 3(2-3-7)

Chemical and physical characteristics of water and wastewater, general considerations, methods for determination and application of data to environmental engineering practice; instrumentation; sample collection and preservation; laboratory analysis of water; interpretation of water analysis results as related to their treatment; neutralization, precipitation, coagulation, water softening, ion exchange, corrosion, absorption, chlorination; determinations of solids, Do, BOD, COD, nitrogen (in all forms related to environmental engineering practice), phosphorus and phosphates, grease and oil, volatile acids, sulfides and gas analysis.

2127675 Military Waste Management 3(3-0-9)

Management of solid and hazardous wastes from military activities; waste reuse and recycling; characteristics of wastes from military activities; site remediation; site remediation; environmental impact assessment.

2107676 Management of Environmental Emergencies 3(3-0-9)

Classification and identification of susceptible sites for environmental emergencies; protection of important infrastructures in industries, in industrial estates, in fuel distribution and storage and in water supply from terrorist activities in the form chemical or biological threats; planning for emergency handling; public handling; coordinating with various work units, and training related people.

2108532 Satellite Surveying and Modern Techniques 3(2-3-7)

Satellite datum, coordinate systems, concept of satellite positioning, global positioning system, observable in GPS, errors in GPS measurements, survey planning, field procedures, data processing, principles of inertial navigation system (INS), practical applications of GPS, principles of electronics, electronic surveying systems and basic

components, geometry of electronic surveying, instrumentation and modern surveying technology.

2108556 Online Spatial Information Technologies 3(2-3-7)

Introduction to GIS; and internet GIS; fundamental of computer networking; client/server computing; technology evolutions of web GIS; standards for distributed geospatial services (ISO & OGC), XML, GML and SVG, mobile GIS case studies and web GIS applications.

2108557 Spatial Data Structure and Models 3(3-0-9)

Conceptual model of space: entities and fields; vector data model, raster data model; data organization in raster: chain, block, run length, quadtrees, binary; data organization in vector: point, line, network, polygon, topology; comparisons of vector and raster data; database structure; file and data access; hierarchical structure; network structure, relational structure, object-oriented structure; introduction to geo-spatial relational database system, graph theory; optimal path.

2108558 Spatial Data Handling and Analysis 3(2-3-7)

Data capture techniques, coordinate systems, data quality; intersections of lines and curves, calculation of length and area, coordinate adjustment, geometric searching; range searching; proximity searching; buffering; rubber sheeting, edge matching, image warping, conflation, feature editing; feature alignment; generalization; densification; topology construction; surface modeling; viewsheds; intervisibility; contouring.

2108627 Geoimage Processing 3(2-3-7)

Concepts of digital image: air borne, space borne; electromagnetic wave; optical and microwave sensor; digital image processing; classification; image coordinate and photo coordinate; sensor orientation; stereo-photogrammetry; photogrammetric triangulation; orthorectification.

2108628 Radar Remote Sensing 3(2-3-7)

Characteristics of microwave, microwave interaction with atmosphere and target, radar equation and radar section, principles of imaging radar, measureable phase/amplitude/polarization in radar imagery, geometric and radiometric properties of radar imagery, synthetic Aperture Radar, airborne/spaceborne SAR systems, interferometric SAR, processing stages in interferogram generation, differential interferometric SAR, In SAR/DInSAR as measurement tools, geodetic and geophysical applications of InSAR/DInSAR, polarimetric SAR, classification and analysis of polarimetric SAR, landuse/landcover mapping applications using polarimetric SAR.

2108632 Advanced GNSS Surveying 3(2-3-7)

GPS system, coordinate and reference system, GPS observations and equations, GPS error mitigation techniques, computation of GPS satellite positions, principles of least-squares estimation, mathematical models for GPS positioning, standard format of GPS data, GPS data processing by least-squares method, interpretation of

baseline results, GPS network adjustment, quality control for GPS surveying, GPS heighting, trends and applications of GNSS technology.

2109509 Stainless Steel Technology 3(3-0-9)

Stainless steel development; stainless steel grades; phase equilibrium diagram; microstructure and metallography; passive film; martensitic, ferritic, austenitic, duplex and precipitation hardening stainless steels; production technology; improvement of mechanical and corrosion properties and selection.

2109510 Instrumental Analysis 3(2-3-7)

Operation principles of transmission electron microscopy and scanning electron microscopy, X-ray diffraction, X-ray fluorescence, atomic absorption and spectro analysis, ESCA and Auger electron spectrometer; interpretation of instrumental results in terms of mechanical properties.

2109516 Advanced Topics in Physical Metallurgy 3(3-0-9)

Advanced topics of current research interests in physical metallurgy.

2109517 Composite Materials I 3(3-0-9)

Properties of engineering composite materials; types of composite materials; fiber and their interfaces; geometrical properties; elasticity; case studies.

2109518 Surface Technology 3(3-0-9)

Carburizing, nitriding, flame hardening, diffusion hardening; chemical vapor deposition and physical vapor deposition; electro-plating; hot dip coating; metal spraying and ion implantation.

2109519 Solidification of Casting 3(3-0-9)

Study of solidification of metal in molds; characteristics of liquid-solid phase transformations; Sand and metal thermal behavior; macroscopic structures; mechanical properties, and casting defects.

2109525 Welding Engineering 3(3-0-9)

Type and process of welding; mass and heat flow during welding; metallurgical effects of heat thermal cycle; solid-phase welding and joining of ceramic; welding of ferrous and non-ferrous metals; behavior of welds in service.

2109527 High Temperature Materials 3(3-0-9)

Theory of alloying and relationship among temperature, structure, and mechanical properties in nickel, cobalt, and iron base alloys; effect of thermomechanical processing; analysis of microstructures by transmission electron microscopy, scanning electron microscopy, X-ray diffraction, and X-ray microprobe.

2109533 Powder Metallurgy 3(3-0-9)

Preparation and fabrication of metal powder; engineering properties and industrial uses; theory of compaction and sintering.

2109535 Cellular Metal 3(3-0-9)

The structure, manufacturing methods, characterization techniques, mechanics. Physical and mechanical properties

of cellular metals; energy absorption; sandwich structures and case studies.

2109536 Advanced Topics in Production Metallurgy 3(3-0-9)

Advanced topics of current research interests in production metallurgy.

2109537 Tribology of Materials 3(3-0-9)

Solid lubrication and surface treatment; fundamentals of contacts between solids; abrasive, erosive, and cavitation wear; adhesion and adhesive wear, corrosive and oxidative wear; fatigue wear; fretting and minor wear mechanism; wear of non-metallic materials; case study.

2110622 Data Management 3(3-0-9)

List structures: list, stacks, queues; table and hash in tree structures: binary search trees, AVL trees, B-trees, heaps; searching and sorting; fundamental of file structures.

2110639 Computer System Security 3(3-0-9)

Security system planning and administration; access control; data encryption; computer crime protection; disaster recovery planning; security models; including Orange book, and RACF.

2110661 Computer Network 3(3-0-9)

Introduction to network and network components; transmission links and protocols; design and analysis of network; WAN; IMP; to pology; network protocols; flow control and routing techniques.

2110678 Mobile Computing 3(3-0-9)

Principles, technologies and applications of mobile computing and wireless networks; mobile and wireless environment; protocols and architecture of mobile computing; mobile device technology; mobile computing security; application of distributed system in mobile computing; mobile middleware; mobile information and database access; mobile platforms; Web-based mobile application development.

2110681 Computer Algorithm 3(3-0-9)

Analysis and design of efficient algorithms; divide and conquer, recursion, dynamic programming and greedy algorithm; selection of appropriate data abstraction; analysis and correctness of algorithms; algebraic algorithms; combination problems; providing techniques for complexity analysis.

2110682 Embedded and Real-Time Systems 3(3-0-9)

Microcontroller architecture (RAM, ROM, CPU), I/O, and peripheral devices, I/O interfacing, real-time operating systems, real-time constraints, scheduling theory, real-time system design methodology, case studies.

2110741 Robotics 3(3-0-9)

A broad view of robotics: robot control, sensors and interfacing, robot intelligence and programming; a broad spectrum of disciplines: mechanical, electrical, industrial, and computer engineering; current topics: planning, subsumption architecture, reactive systems.

2110743 Machine Learning 3(3-0-9)

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.

2110745 Cryptography 3(3-0-9)

Introduction; symmetric encryption; block ciphers; block ciphers; pseudorandom permutations and pseudorandom functions; one-way functions; pseudorandom generators; hash functions; message authentication; authenticated encryption; asymmetric encryption; digital signatures; authenticated key exchange; interactive proofs and zero knowledge.

2131501 Nuclear Technology for Military 3(3-0-9)

Radioactive and nuclear materials; measurement of nuclear radiation; principles of radiation safety, detection of radioactive and nuclear materials; radiation imaging; elemental analysis using nuclear techniques, nuclear techniques for explosive detection; other uses of radioactive and nuclear materials; nuclear non-proliferation.

2111610 Nuclear Security 3(3-0-9)

Nuclear security; overview of related legal framework; interrelationships between nuclear safety, security and safeguards; nuclear and radiation threat by non-State actors; counterterrorism; chemical biological, radiological and nuclear (CBRN) weapons; basic elements of nuclear security; planning nuclear security at the state level; planning nuclear security of nuclear and radiological facility; introduction to detection of and response to, crimes and unauthorized acts involving nuclear material and other radioactive material outside regulatory control; information security; security culture.

2111613 Radiation Safety and shielding 3(3-0-9)

Definition and basic concepts in radiation safety; biological effects of radiation; basic radiation protection, dose limits; regulation concerning radioactive materials; transportation of radioactive materials; accidents and emergency procedure; gamma radiation and x-ray shielding; radiation shielding from nuclear reactor.

2111642 Nuclear Reactor Engineering 3(3-0-9)

Production and characteristics of neutrons; the fission process; neutron diffusion theory; slowing-down theory; Fermi theory of the bare thermal reactor; one-and multi-group diffusion methods; basic principles of nuclear reactor kinetics and nuclear reactor control.

2111646 Radioactive Waste Management 3(3-0-9)

Nature of radioactive wastes; origin of low-high radioactive wastes; characteristics, forms and quantity of radioactive wastes; storage and transportation; waste management technologies; radioactive waste management plans in various countries.

2111651 Weapon Mass Destruction Nonproliferation 3(3-0-9)

Issues concerning the proliferation of nuclear, chemical, and biological weapons; introduction to nuclear and radiological terrorism; international nuclear nonproliferation framework; weapon technologies of mass destruction; nuclear proliferation issues in South Asia.

2111653 Nuclear Safeguards 3(3-0-9)

Safeguarding nuclear material and facilities; monitoring principles and technologies; safeguards issues; international framework of nuclear material safeguard; nuclear material safeguard; nuclear proliferation threat; radiological threat; detecting nuclear and other radioactive materials; roles of intelligence; A Q. Khan's network; counter-proliferation of nuclear weapons; nuclear material safeguard in various countries.

2111654 Nuclear Fuel Cycle and Environmental Impacts 3(3-0-9)

Technology of nuclear fuel cycle; technologies used in manufacturing, safety handling, and disposing of nuclear materials and by-products; social environmental, and health impacts of materials used in each major step in the fuel cycle; potential of nuclear proliferation.

2111656 Physical Protection of Nuclear Materials and Facilities I 3(3-0-9)

Principles of physical protection of nuclear materials and facilities: detection, delay, response; threat identification and analysis; vital area analysis; international physical safeguard framework; internal threats.

2111657 Advanced Detection Technologies for Radioactive and Nuclear Material 3(3-0-9)

Detection and identification of the types of nuclear materials; chemical and radiological characteristics of nuclear materials from raw materials to various finished products; detection technologies; nuclear forensics.

2111658 Method and Instrumentation for Nuclear Security and Safeguards 3(3-0-9)

Counting statistics; radiation detectors; gamma detection; neutron detection; detection of charged particles; gamma spectroscopy; activation analysis; destructive analysis; non-destructive analysis; quantitative nuclear material measurements; survey devices; use of detectors at port.

2111678 Nuclear Materials Engineering 3(3-0-9)

Nuclear fuel cycle; materials and thermal aspects of nuclear reactors; crystal structures of solids; point defects; diffusion in solids; elastic behavior of solids; dislocations in solid and creep deformation; grain and grain boundaries; cavities in solids; fission product behavior in nuclear fuel; radiation damage and fast-neutron irradiation effects in metals; introduction to the High-Temperature Gas-Cooled Reactor Technology.

2120602 Advanced Topics in Defense Engineering Technology 3(3-0-9)

Study of recent topic and technology development in various fields of defense and engineering technology.