

DEPARTMENT OF COMPUTER ENGINEERING

Objectives

1. Graduates have knowledge of basic sciences and engineering sciences necessary to engage in further learning.
2. Graduates have knowledge and skills needed for the engineering profession.
3. Graduates are able to use engineering tools appropriately.

The undergraduate program in Computer Engineering is relatively broad-based. The program covers various aspects in computer science and engineering which includes the design, analysis, organization, and applications of computer system. The department offers courses which can be divided into three major areas.

1. Digital System Engineering : Courses cover the design and analysis of digital computer systems which include logic design, microprocessors, microcomputer systems, assembly language, VLSI design, computer architectures, data communications and computer networks.

2. Systems Software Engineering : Courses cover the principles of design and analysis of algorithms, systems software, programming languages, compilers, and operating systems. The students will, in addition, understand the interactions between software and hardware at various interface levels.

3. Information Processing : Courses cover the design and analysis of information processing systems, information technology, software engineering, artificial intelligence, data base management system, computer graphics, and their applications.

A bachelor degree in Computer Engineering will be awarded upon successful completion of the four year curriculum. Being highly competent in the design, analysis, and applications of systems software, digital systems, and information processing, the graduate will be able to work as a systems programmer, a systems analyst or a system engineer.

The department also offers four additional curriculums leading to the Master Degree in Computer Science, Master Degree in Software Engineering, Master Degree in Computer Engineering, and Doctor of Philosophy in Computer Engineering.

HEAD :

Sartid Vongpradhip, Ph.D. (U.of Tech. Sydney)

ASSOCIATE PROFESSORS :

Boonserm Kijirikul, Ph.D. (Tokyo Institute of Technology)
Mandhana Prakansamut, M.Sc. (Chula)
Prabhas Chongstitvatana, Ph.D. (Edinburgh U.)
Pornsiri Muenchaisri, Ph.D. (Oregon State)
Sartid Vongpradhip, Ph.D. (U.of Tech. Sydney)

Somchai Prasitjutrakul, Ph.D. (U. of Illinois)
Wanchai Rivepiboon, Dr.-Univ. (Grenoble 1)

ASSISTANT PROFESSORS :

Boonchai Sowanwanichakul, B.Eng. (Chula)
Chucheep Shimwong, M.Sc. (Chula)
Matee Srisangwan, M.Sc. (Chula)
Nongluk Covavisaruch, M.S. in E.E. (Missouri Columbia)
M.A. (Languages & International Trade) (Eastern Michigan)
Sumet Vacharachaisurapol, M.Sc. (Chula)
Taratip Suwannasart, Ph.D. (Illinois Institute of Technology)
Thanawan Chantaratanapibul, M.Sc. (Chula)
Twittie Senivongse na ayudhaya, Ph.D. (U. of Kent)
Wichan Lertwipatrakul, M.Sc. (Chula)
Wiwat Vatanawood, Ph.D. (Chula)
Yachai Limpiyakorn, Ph.D. (Illinois Institute of Technology)
Chalermek Intanagonwiwat, Ph.D. (U of Southern California)

LECTURERS :

Arthit Thongtak, D.Eng. (Tokyo Institute of Technology)
Atiwong Suchato, Ph.D. (M.I.T.)
Athasit Surarerks, Ph.D. (U. of Pierre et Marie Curie)
Attawith Sudsang, Ph.D. (U. of Illinois)
Chai Phongphanphane, Ph.D. (U. of Southampton)
Chaisiri Pantitanonta, M.Sc. (Chula)
Charumatr Pinthong, M.Sc. (Chula)
Chate Patanothai, M.Sc. in EE. (U. of Miami)
Chotirat Ratanamahatana, Ph.D. (California)
Daricha Sutivong, Ph.D. (Stanford)
Krerka Piromsopa, Ph.D. (Michigan St.)
Nakornthip Prompoon, M.S. (George Wash.U.)
Natawut Nupairoj, Ph.D. (Michigan St.)
Pizzanu Kanongchaiyos, Ph.D. (U. of Tokyo)
Proadpran Punyabukkana Pitsatorn, Ph.D. (Claremont)
Setha Pan-Ngum, Ph.D. (U. of Warwick)
Suebskul Phiphobmongkol, Ph.D. (Auburn)
Thit Siriboon, Ph.D. (Oregon State)
Thongchai Rojkangsadan, M.Sc. (Chula)
Veera Muangsin, Ph.D. (U. of Manchester)
Vishnu Kotrajaras, Ph.D. (Imperial College)
Yunyong Teng-amnuay, Ph.D. (Iowa State)

**COMPUTER ENGINEERING CURRICULUM
FIRST YEAR CURRICULUM
COMMON TO ALL ENGINEERING STUDENTS**

COURSE NO.	SUBJECT	CREDITS	COURSE NO.	SUBJECT	CREDITS
THIRD SEMESTER			SIXTH SEMESTER		
2103213	ENG MECH I	3	2110317	FUND DIST SYS	3
2110200	DISCRETE STRUC	3	2110332	SYS ANA DESIGN	3
2110210	PROGRAMMING METH	2	2110422	DB MGT SYS DESIGN	3
2110250	COMP ORG	3	2110472	COMP NETWORK	3
2110251	DIG COMP LOGIC	3	2301366	NUMERICAL ANALYSIS	3
2110261	DIG COMP LOGIC LAB	2	xxxxxxx	GENERAL EDUCATION	<u>3</u>
xxxxxxx	GENERAL EDUCATION	<u>3</u>			
		19			18
FORTH SEMESTER			SUMMER SEMESTER		
2102201	ELECT ENG MATH I	3	2100301	ENGINEERING PRACTICE	2
2110211	INTRO DATA STRUCT	3			
2110213	INFO SYS ORG	3	SEVENTH SEMESTER		
2110254	DIG DESIGN VER	3	2110355	FORM LANG & AUTO	3
2110264	DIG DESIGN VER LAB	2	2110423	SOFTWARE ENG	3
2603284	STAT PHYS SCIENCE	3	2110490	COMP ENG PRE-PROJ	1
xxxxxxx	GENERAL EDUCATION	<u>3</u>	2110xxx	APPROVED ELECTIVES GROUP	6
		20	xxxxxxx	GENERAL EDUCATION	3
			xxxxxxx	FREE ELECTIVE	<u>3</u>
					19
FIFTH SEMESTER			EIGHTH SEMESTER		
2104203	ENG MANAGEMENT	3	2110499	COMP ENG PROJECT	3
2110313	OS AND SYS PROG	3	2110xxx	APPROVED ELECTIVES GROUP	9
2110316	PROG LANG PRIN	3	xxxxxxx	FREE ELECTIVE	<u>3</u>
2110327	ALGORITHM DESIGN	3			
2110352	COMP SYS ARCH	3			
2110361	HW SYN LAB	<u>2</u>			
		17			15

TOTAL CREDITS FOR GRADUATION = 145

**MASTER DEGREE PROGRAMS
COMPUTER SCIENCE**

NAME OF THE DEGREE

: Master of Science
: M.Sc.

ADMISSION

The applicant must hold a Bachelor's Degree and meet the Graduate School requirement.

DEGREE REQUIREMENTS

The program consists of two non-credit courses, 24 credits of elective courses, and 12 credits of thesis. At least three credits from Theoretical Computer Science elective courses, three credits from Computer System elective courses, and three credits from Computer Application elective courses must be taken.

COURSE REQUIREMENTS

1) Required Courses non-credit

2110606	Research Methods in Computer Engineering	3(3-0-9)
2110701	Seminar in Computer Engineering I	1(0-3-1)

2) Elective Courses 24 credits

Student must pass at least three credits from each of the first three groups below.

Group 1 : Theoretical Computer Science

2110681	Computer Algorithm	3(3-0-9)
2110711	Theory of Computation	3(3-0-9)

Group 2 : Computer System

2110631	Operating System	3(3-0-9)
2110661	Computer Network	3(3-0-9)
2110684	Information System Architecture	3(3-0-9)
2110714	Digital Systems	3(3-0-9)

Group 3 : Computer Application

2110614	Programming Languages and Compilation	3(3-0-9)
2110621	System Analysis and Design	3(3-0-9)
2110624	Software Engineering	3(3-0-9)
2110638	Object-Oriented Technology	3(3-0-9)
2110671	Database Management Systems	3(3-0-9)

Group 4 : Others

2110511	Game Programming	3(3-0-9)
2110512	Computer Animation	3(3-0-9)
2110521	Software Architecture	3(3-0-9)
2110541	Computer Systems Audit	3(3-0-9)
2110605	Computer Programs Structure	3(3-0-9)
2110611	Information Processing and Computer System	3(3-0-9)
2110612	System Programming	3(3-0-9)
2110622	Data Management	3(3-0-9)

2110623	Software Requirements Engineering	3(3-0-9)
2110629	File Management	3(3-0-9)
2110632	Advanced Topics in Operating Systems	3(3-0-9)
2110634	Software Design and Development	3(3-0-9)
2110636	Performance Analysis and Evaluation	3(3-0-9)
2110639	Computer System Security	3(3-0-9)
2110642	Object-Oriented Software Engineering	3(3-0-9)
2110644	Formal Software Specification	3(3-0-9)
2110645	Software Engineering Methodology	3(3-0-9)
2110646	User Interface Design	3(3-0-9)
2110651	Digital Image Processing	3(3-0-9)
2110654	Artificial Intelligence	3(3-0-9)
2110657	Computer Simulation	3(3-0-9)
2110664	Network Management	3(3-0-9)
2110665	Computer Communication System and Standards	3(3-0-9)
2110672	Data Modeling Techniques	3(3-0-9)
2110673	Information Storage and Retrieval	3(3-0-9)
2110674	Information Technology Center Management	3(3-0-9)
2110678	Mobile Computing	3(3-0-9)
2110682	Embedded and Real-time Systems	3(3-0-9)
2110683	Concurrent Processing	3(3-0-9)
2110685	Computer Application in Enterprises	3(3-0-9)
2110686	Enterprise Computing	3(3-0-9)
2110694	Directed Studies in Computer Science	3(3-0-9)
2110696	Advanced Topics in Computer Application	3(3-0-9)
2110697	Special Topics in Computer Science I	3(3-0-9)
2110698	Special Topics in Computer Science II	3(3-0-9)
2110712	Analysis of Algorithms	3(3-0-9)
2110713	Optimization Methods	3(3-0-9)
2110721	Software Metrics	3(3-0-9)
2110722	Software Project Management	3(3-0-9)
2110723	Advanced Software Engineering Development	3(3-0-9)
2110724	Software Testing and Quality Assurance	3(3-0-9)
2110731	Distributed Systems	3(3-0-9)
2110732	Parallel Computing	3(3-0-9)
2110741	Robotics	3(3-0-9)
2110742	Evolutionary Computation	3(3-0-9)
2110743	Machine Learning	3(3-0-9)
2110744	Machine Vision	3(3-0-9)
2110745	Cryptography	3(3-0-9)
2110751	Computer Aided Design in Digital Systems	3(3-0-9)
2110752	Design for Testability	3(3-0-9)
2110753	Asynchronous Design	3(3-0-9)
2110771	Advanced Database Design	3(3-0-9)
2110772	Multi-Dimensional Database Systems	3(3-0-9)
2110773	Data Mining	3(3-0-9)
2110781	Special Topics in Distributed Systems	3(3-0-9)
2110791	Advanced Topics in Software Engineering	3(3-0-9)

2110792	Advanced Topics in Artificial Intelligence	3(3-0-9)
2110793	Advanced Topics in Digital Systems	3(3-0-9)
2110794	Advanced Topics in Database Systems	3(3-0-9)
2110795	Advanced Topics in Computer Network	3(3-0-9)

3) *Thesis*

2110811	Thesis	12	credits
---------	--------	----	---------

STUDY PROGRAM

First Semester

2110606	Research Methods	-
2110 xxx	Electives	<u>9</u>
		9

Second Semester

2110701	Seminar Computer Eng. I	-
2110 xxx	Electives	<u>9</u>
		9

Third Semester

2110 xxx	Electives	6
2110811	Thesis	<u>3</u>
		9

Forth Semester

2110811	Thesis	<u>9</u>
		9

COMPUTER ENGINEERING

NAME OF THE DEGREE

: Master of Engineering
: M.Eng.

ADMISSION

The applicant must hold a Bachelor's Degree in Computer Engineering for plan A(1) or a Bachelor's Degree in any Engineering discipline for plan A(2), meet the Graduate School requirements, and also must pass the Interview by the Computer Engineering Department.

DEGREE REQUIREMENTS

Plan A(1) program consists of three non-credit required courses and 36 credits of thesis. Plan A(2) program consists of 3 non-credit required courses, 12 credits of elective courses, and 24 credits of thesis.

COURSE REQUIREMENTS

1) *Required Courses non-credit*

2110606	Research Methods in Computer Engineering	3(3-0-9)
2110701	Seminar in Computer Engineering I	1(0-3-1)
2110702	Seminar in Computer Engineering II	1(0-3-1)

2) *Elective Courses 12 credits*

2110541	Computer Systems Audit	3(3-0-9)
2110605	Computer Programs Structure	3(3-0-9)
2110611	Information Processing and Computer System	3(3-0-9)
2110612	System Programming	3(3-0-9)
2110614	Programming Languages and Compilation	3(3-0-9)
2110621	System Analysis and Design	3(3-0-9)
2110622	Data Management	3(3-0-9)
2110623	Software Requirements Engineering	3(3-0-9)
2110624	Software Engineering	3(3-0-9)
2110629	File Management	3(3-0-9)
2110631	Operating System	3(3-0-9)
2110632	Advanced Topics in Operating Systems	3(3-0-9)
2110634	Software Design and Development	3(3-0-9)
2110636	Performance Analysis and Evaluation	3(3-0-9)
2110638	Object-Oriented Technology	3(3-0-9)
2110639	Computer System Security	3(3-0-9)
2110642	Object-Oriented Software Engineering	3(3-0-9)
2110644	Formal Software Specification	3(3-0-9)
2110645	Software Engineering Methodology	3(3-0-9)
2110646	User Interface Design	3(3-0-9)
2110651	Digital Image Processing	3(3-0-9)
2110654	Artificial Intelligence	3(3-0-9)
2110657	Computer Simulation	3(3-0-9)
2110661	Computer Network	3(3-0-9)
2110664	Network Management	3(3-0-9)
2110665	Computer Communication System and Standards	3(3-0-9)
2110671	Database Management Systems	3(3-0-9)
2110672	Data Modeling Techniques	3(3-0-9)
2110673	Information Storage and Retrieval	3(3-0-9)
2110674	Information Technology Center Management	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)
2110683	Concurrent Processing	3(3-0-9)
2110684	Information System Architecture	3(3-0-9)
2110685	Computer Application in Enterprises	3(3-0-9)
2110686	Enterprise Computing	3(3-0-9)
2110694	Directed Studies in Computer Science	3(3-0-9)
2110696	Advanced Topics in Computer Application	3(3-0-9)
2110697	Special Topics in Computer Science I	3(3-0-9)
2110698	Special Topics in Computer Science II	3(3-0-9)
2110711	Theory of Computation	3(3-0-9)
2110714	Digital Systems	3(3-0-9)
2110712	Analysis of Algorithms	3(3-0-9)
2110713	Optimization Methods	3(3-0-9)
2110721	Software Metrics	3(3-0-9)

2110722	Software Project Management	3(3-0-9)
2110723	Advanced Software Engineering Development	3(3-0-9)
2110724	Software Testing and Quality Assurance	3(3-0-9)
2110731	Distributed Systems	3(3-0-9)
2110732	Parallel Computing	3(3-0-9)
2110741	Robotics	3(3-0-9)
2110742	Evolutionary Computation	3(3-0-9)
2110743	Machine Learning	3(3-0-9)
2110744	Machine Vision	3(3-0-9)
2110745	Cryptography	3(3-0-9)
2110751	Computer Aided Design in Digital Systems	3(3-0-9)
2110752	Design for Testability	3(3-0-9)
2110753	Asynchronous Design	3(3-0-9)
2110771	Advanced Database Design	3(3-0-9)
2110772	Multi-Dimensional Database Systems	3(3-0-9)
2110773	Data Mining	3(3-0-9)
2110781	Special Topics in Distributed Systems	3(3-0-9)
2110791	Advanced Topics in Software Engineering	3(3-0-9)
2110792	Advanced Topics in Artificial Intelligence	3(3-0-9)
2110793	Advanced Topics in Digital Systems	3(3-0-9)
2110794	Advanced Topics in Database Systems	3(3-0-9)
2110795	Advanced Topics in Computer Network	3(3-0-9)

2110814	3) Thesis	
2110814	Thesis (for plan A(2))	24 credits
2110816	Thesis (for plan A(1))	36 credits

STUDY PROGRAMS

Plan A (1)

First Semester

2110606	Research Methods	-
2110816	Thesis	<u>9</u>
		9

Second Semester

2110701	Seminar Computer Eng. I	-
2110816	Thesis	<u>9</u>
		9

Third Semester

2110702	Seminar Computer Eng. II	-
2110816	Thesis	<u>9</u>
		9

Fourth Semester

2110816	Thesis	<u>9</u>
		9

Plan A (2)

First Semester

2110606	Research Methods	-
2110 xxx	Electives	<u>9</u>
		9

Second Semester

2110701	Seminar Computer Eng. I	-
2110 xxx	Electives	<u>3</u>
2110814	Thesis	<u>6</u>
		9

Third Semester

2110702	Seminar Computer Eng. II	-
2110814	Thesis	<u>9</u>
		9

Fourth Semester

2110814	Thesis	<u>9</u>
		9

SOFTWARE ENGINEERING

NAME OF THE DEGREE

: Master of Science
: M.Sc.

ADMISSION

The applicant must hold a bachelor's Degree in Engineering, Statistics, Science, or equivalent, and meet the Graduate School requirements. For Plan B program, the application must have at least one year of work experience.

DEGREE REQUIREMENTS

Plan A program consists of 12 credits of required courses, 12 credits of elective courses, and 12 credits of thesis. Plan B program consists of 18 credits of required courses, 12 credits of elective courses, and 6 credits of Master project. Student in plan B must also pass the comprehensive examination in order to be awarded the degree.

COURSE REQUIREMENTS

Plan A :

1) *Required Courses* 12 credits

2110623	Software Requirements Eng.	3(3-0-9)
2110645	Software Eng. Methodology	3(3-0-9)
2110722	Software Project Management	3(3-0-9)
2110724	Software Testing and QA	3(3-0-9)

2) *Elective Courses* 12 credits

2110631	Operating Systems	3(3-0-9)
2110638	Object-Oriented Technology	3(3-0-9)
2110639	Computer System Security	3(3-0-9)
2110642	Object-Oriented Software Engineering	3(3-0-9)
2110644	Formal Software Specification	3(3-0-9)
2110646	User Interface Design	3(3-0-9)
2110662	Communication and Computer Network	3(3-0-9)
2110671	Database Management Systems	3(3-0-9)
2110673	Information Storage and Retrieval	3(3-0-9)
2110674	Information Technology Center Management	3(3-0-9)
2110681	Computer Algorithm	3(3-0-9)

2110682	Embedded and Real-time Systems	3(3-0-9)
2110683	Concurrent Programming	3(3-0-9)
2110721	Soft Metrics	3(3-0-9)

2110723	Advanced Software Engineering Development	3(3-0-9)
2110731	Distributed Systems	3(3-0-9)
2110773	Data Mining	3(3-0-9)

3) *Thesis*

2110811	Thesis	12	credits
---------	--------	----	---------

Plan B :

1) *Required Courses 18 credits*

2110623	Software Requirements Eng.	3(3-0-9)
2110644	Formal Software Specification	3(3-0-9)
2110645	Software Eng. Methodology	3(3-0-9)
2110721	Software Metrics	3(3-0-9)
2110722	Software Project Management	3(3-0-9)
2110724	Software Testing and QA	3(3-0-9)
2110799	Master Project	6(0-0-24)

2) *Elective Courses 12 credits*

2110631	Operating Systems	3(3-0-9)
2110638	Object-Oriented Technology	3(3-0-9)
2110639	Computer Systems Security	3(3-0-9)
2110642	Object-Oriented Software Engineering	3(3-0-9)
2110646	User Interface Design	3(3-0-9)
2110662	Communication and Computer Network	3(3-0-9)
2110671	Database Management Systems	3(3-0-9)
2110673	Information Storage and Retrieval	3(3-0-9)
2110974	Information Technology Center Management	3(3-0-9)
2110681	Computer Algorithm	3(3-0-9)
2110682	Embedded and Real-time Systems	3(3-0-9)
2110683	Concurrent Programming	3(3-0-9)
2110723	Advanced Software Engineering Development	3(3-0-9)
2110731	Distributed Systems	3(3-0-9)
2110773	Data Mining	3(3-0-9)

STUDY PROGRAMS

Plan A

First Semester

2110623	Software Requirement Eng.	3
2110 xxx	Electives	<u>6</u>
		9

Second Semester

2110645	Software Eng. Methodology	3
2110 xxx	Electives	<u>6</u>
		9

Third Semester

2110722	Software Proj. Management	3
2110724	Software Testing QA	3
2110811	Thesis	<u>3</u>
		9

Fourth Semester

2110811	Thesis	<u>9</u>
		9

Plan B

First Semester

2110623	Software Requirement Eng.	3
2110721	Software Metrics	3
2110 xxx	Electives	<u>3</u>
		9

Second Semester

2110644	Formal Software Specification	3
2110645	Software Eng. Methodology	3
2110 xxx	Electives	<u>3</u>
		9

Third Semester

2110722	Software Proj. Management	3
2110724	Software Testing QA	3
2110 xxx	Electives	<u>3</u>
		9

Fourth Semester

2110 xxx	Electives	3
2110799	Master Project	6
2110896	Comprehensive exam	<u>0</u>
		9

PH.D. DEGREE PROGRAM

NAME OF THE DEGREE

: Doctor of Philosophy
: Ph.D.

ADMISSION

The applicant must hold one of the following qualification :

A) Bachelor's Degree (Hons-2nd level or equivalent) or grade point not less than 3.25.

B) Master's Degree of Engineering or Science in Computer, Physics or Mathematics.

In addition he/she has to meet the Graduate School requirement.

DEGREE REQUIREMENTS

The program for Bachelor's Degree Holder, plan 2(1), consists of 12 credits of required courses including 4 non - credit seminars , 12 credits of elective courses ,and 48 credits of thesis , for a total of 72 credits.

The program for Master's Degree Holder, plan 2(2), consists of 4 non - credits seminars, 12 credits of elective courses, and 48 credits of Dissertation , for a total of 60 credits.

The student who has fulfilled the requirement of the program and of the Graduate School will be awarded the Degree of Doctor of Philosophy in Computer Engineering.

COURSE REQUIREMENTS

	<i>1) Required Courses</i>	<i>12</i>	<i>credits</i>
2110711	Theory of Computation		3(3-0-9)
2110712	Analysis of Algorithms		3(3-0-9)
2110713	Optimization Methods		3(3-0-9)
2110714	Digital Systems		3(3-0-9)
2110716	Seminar I		1(1-0-3)
2110717	Seminar II		1(1-0-3)
2110718	Seminar III		1(1-0-3)
2110719	Seminar IV		1(1-0-3)
	<i>2) Elective Courses</i>	<i>12</i>	<i>credits</i>
2110694	Directed Studies in Computer Science		3(3-0-9)
2110697	Special Topics in Computer Science I		3(3-0-9)
2110698	Special Topics in Computer Science II		3(3-0-9)
2110721	Software Metrics		3(3-0-9)
2110722	Software Project Management		3(3-0-9)
2110723	Advanced Software Engineering Development		3(3-0-9)
2110724	Software Testing and Quality Assurance		3(3-0-9)
2110731	Distributed Systems		3(3-0-9)
2110732	Parallel Computing		3(3-0-9)
2110741	Robotics		3(3-0-9)
2110742	Evolutionary Computation		3(3-0-9)
2110743	Machine Learning		3(3-0-9)
2110744	Machine Vision		3(3-0-9)
2110751	Computer Aided Design in Digital Systems		3(3-0-9)
2110752	Design for Testability		3(3-0-9)
2110753	Asynchronous Design		3(3-0-9)
2110771	Advanced Database Design		3(3-0-9)
2110772	Multi-Dimensional Database Systems		3(3-0-9)
2110773	Data Mining		3(3-0-9)
2110791	Advanced Topics in Software Engineering		3(3-0-9)
2110792	Advanced Topics in Artificial Intelligence		3(3-0-9)
2110793	Advanced Topics in Digital Systems		3(3-0-9)
2110794	Advanced Topics in Database Systems		3(3-0-9)
2110795	Advanced Topics in Computer Network		3(3-0-9)
	<i>3) Dissertation</i>		
2110828	Dissertation		48 credits
2110894	Doctoral Dissertation Seminar		0(0-0-0)
2110897	Qualifying Examination		0(0-0-0)

STUDY PROGRAMS

Plan 2 (1)

First Semester

2110716	Seminar I	-
2110 xxx	Required courses	<u>12</u>
		12

Second Semester

2110717	Seminar II	-
2110 xxx	Electives	9
2110828	Thesis	<u>3</u>
		12

Third Semester

2110718	Seminar III	-
2110 xxx	Electives	3
2110828	Thesis	<u>9</u>
		12

Fourth Semester

2110719	Seminar IV	-
2110828	Thesis	<u>12</u>
		12

Fifth Semester

2110828	Thesis	<u>12</u>
		12

Sixth Semester

2110828	Thesis	<u>12</u>
		12

Plan 2 (2)

First Semester

2110716	Seminar I	-
2110 xxx	Electives	9
		9

Second Semester

2110717	Seminar II	-
2110 xxx	Electives	3
2110828	Thesis	<u>6</u>
		9

Third Semester

2110718	Seminar III	-
2110828	Thesis	<u>9</u>
		9

Fourth Semester

2110719	Seminar IV	-
2110828	Thesis	<u>9</u>
		9

Fifth Semester

2110828	Thesis	<u>12</u>
		12

Sixth Semester

2110828	Thesis	<u>12</u>
		12

**COURSE DESCRIPTIONS IN
COMPUTER ENGINEERING (B.ENG.)**

2110101 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.

2110200 Discrete Structures 3(3-0-6)

Sets, relations, functions, theorem and proof; combinatorics; counting, principle of inclusion exclusion, recurrent relations, generating functions; graphs and trees; introduction to number theory.

2110210 Programming Methodology 2(1-2-3)

*Condition : Prerequisite 2110101 or
Consent of Faculty*

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

2110211 Introduction to Data Structures 3(3-0-6)

Condition : Prerequisite 2110101

Linear allocation: array, stack, queue, dequeues; linked allocation: singly linked lists, and doubly linked lists; string processing and pattern matching; trees: binary tree, traversal, representation, B-tree and AVL-tree; internal searching and sorting: binary, radixes, shell, quicksort and merge sort; heap storage, hash coding and table handling.

2110213 Information Systems Organization 3(3-0-6)

Hardware systems: personal computer, network, Internet, internet protocol, domain name, cable, hub, switch, router, modem, Internet server, corporate server, real-time server, embedded system; application systems: multi-tier system, web server, markup language, application server, database server, query language, multi-vendor database access interface; transaction systems: process abstraction, inter-process communication, synchronization, deadlock, transaction atomicity, checkpoint and rollback, concurrency control.

2110250 Computer Organization 3(3-0-6)

Computer systems organization, hardware components in a computer system, basic computer principles, instruction unit, instruction execution cycle, instruction set architecture, assembly language principles.

2110251 Digital Computer Logic 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.

2110254 Digital Design and Verification 3(3-0-6)

Condition : Prerequisite 2110250

Processor design at instruction set level and register transfer level; hardware description language (HDL); functional verification of HDL models; microprocessors; control unit; memory unit; adders; I/O device interfaces.

2110261 Digital Computer Logic Laboratory 2(0-4-2)

Techniques in implementing digital circuits; correct instrument usage; experiments with digital circuits using various devices: TTL gates, truth table realization of switching circuits, Karnaugh map, flip-flop, latch, tristate, synchronous / asynchronous counters, Schmitt trigger and monostable multivibrator.

2110264 Digital Design and Verification Laboratory 2(0-4-2)

Condition : Prerequisite 2110250

Writing hardware description language (HDL) to implement digital designs, adder, arithmetic logic unit, control unit, memory modules, and integrate them into a working computer; writing test benches to verify the design.

2110271 Programming Tools 3(2-2-5)

Source-code tools; executable-code tools; user-interface tools; code management tools; deployment tools; documentation tools; testing tools; integrated development environments.

2110313 Operating Systems and System Programs 3(3-0-6)

Condition : Prerequisite 2110211, 2110213

OS services: functions, organisation, process, concurrent programming, synchronisation, critical section, semaphore, monitor, deadlock, processor management, memory management, device management, file management, resource protection, and networking; service interfaces: system call, application programming interface (API); service development; tools and utilities: system management tools, development tools, and operation tools.

2110316 Programming Languages Principles 3(3-0-6)

Condition : Prerequisite 2110211

Language definition: grammar, syntax, and semantics; conventional paradigm: data type, control structure, block structure, and recursion; interpretive languages; runtime environment and virtual computer; unconventional paradigm: functional, logic, and markup languages; object-orientation and software components: class, instance, method, message passing, inheritance, method binding, polymorphism, framework, and component-based programming; basic compiling techniques: scanner, parser, code generation, and tools.

2110317 Fundamental of Distributed Systems 3(3-0-6)

Condition : Prerequisite 2110313

Interprocess communication and remote procedure call; Logical clock and ordering; centralised transaction and concurrency control; distributed transaction; two-phase commit protocol; distributed concurrency control; deadlock and distributed deadlock; load distribution; fault tolerance: fault model, recovery; replication: view and vector clock; distributed transaction under failure conditions; security; distributed services.

- 2110327 Algorithm Design 3(3-0-6)**
Condition : Prerequisite 2110200, 2110211
 Algorithm design techniques: divide and conquer, dynamic programming, greedy algorithms, state-space search; asymptotic analysis of algorithms; introduction to computational complexity; algorithm designs for NP-hard problems; backtracking, branch and bound, approximation algorithms.
- 2110332 System Analysis and Design 3(3-0-6)**
Condition : Prerequisite 2110211, 2110331
 Data processing systems and systems life cycle; analysis methodology: tools, cost analysis, problem definition, proposal and feasibility study; design methodology: tools, database approach, systems design, file and form design, program design, documentation; implementation methodology: coding, testing and software maintenance.
- 2110333 Event-Driven Programming 3(2-2-5)**
Condition : Prerequisite 2110101 or Consent of Faculty
 Events, event queues, event focus, event handlers, event loop, callbacks, delegation; GUI and distributed environments; event-driven I/Os; windowing system; GUI programming; event-driven program interactions.
- 2110334 Network Programming 3(2-2-5)**
Condition : Prerequisite 2110210 and 2110213 Consent of Faculty
 Networking concepts; internet standards; sockets programming; web programming; client-server programming.
- 2110352 Computer System Architectures 3(3-0-6)**
Condition : Prerequisite 2110250
 Performance metrics; central processing unit; hardwired and microprogram of control units; instruction level parallelism : pipeline, superscalar; memory system: cache memory, virtual memory, disk array; development and future of architecture.
- 2110355 Formal Languages and Automata Theory 3(3-0-6)**
 Studies concepts of grammars, automata, languages, computability and complexity; the relationship between automata and various classes of languages; Turing machine and equivalent models of computation, the Chomsky hierarchy, context-free grammar, push-down automata, etc.; pumping lemmas and variants, closure properties and decision properties; parsing algorithms.
- 2110361 Hardware Synthesis Laboratory 2(0-4-2)**
Condition : Prerequisite 2110264
 Synthesis of digital systems on FPGA technology, use of hardware description language to model digital systems and implement the design on a programmable device, design decomposition, testing and debugging the design.
- 2110388 Database Programming 4(2-4-6)**
Condition : Prerequisite 2110210 and 2110213, Consent of Faculty
 Structured query language (SQL), database connectivities; database programming tools and components; concurrency control; transactions processing; programming for database-backed site.
- 2110398 Software Development Pre - Project 1(0-2-1)**
 Study and specifying topic, scope, methodologies of problem solving and expected benefit of various areas of software development project under project advisor's supervision. Project proposal is examined by a department committee. Written progress reports must be submitted and presented periodically.
- 2110399 Software Development Project 3(0-6-3)**
 Continuing of the approved project from Software Development Pre-Project course must be carried out under project advisor's supervision. Written progress report must be submitted periodically. A written final report is required and an oral examination must be taken with a department project committee at the end of the project.
- 2110401 Computer Engineering Professional Ethics 3(3-0-6)**
 Ethical theory; privacy; intellectual properties: patents, copyrights; computer crimes; professional codes of ethics; social issues; case studies.
- 2110412 Parallel Computer Architecture 3(3-0-6)**
Condition : Consent of Faculty
 Parallel architectures; parallel computation models; parallel algorithms; parallel programming and languages.
- 2110413 Computer Security 3(3-0-6)**
 Computer security principle; symmetric key cryptography; public key cryptography; message digest; authentication: access control; enterprise security; network security.
- 2110420 Compiler Construction 3(3-0-6)**
 Grammar, syntax, and semantics; lexical analysis; parsing methods; symbol table construction; intermediate representation; code generation; basic and advanced code optimization techniques.
- 2110421 Theory of Programming Languages 3(3-0-6)**
Condition : Prerequisite 2110312
 Data and control abstractions; binding; type checking; advanced control constructs, backtracking and nondeterminism; formal methods for program description, formal syntax and formal semantics; methods for proving programs correctness.
- 2110422 Database Management Systems Design 3(3-0-6)**
Condition : Prerequisite 2110200, 2110211 or Consent of Faculty
 Database concepts: goals, data independence, relationships, logical and physical organizations, schema and subschema; data models: hierarchical, network, and relational models; data normalization: first, second, and third normal forms of data relations; canonical schema, data independence; data description languages; query facilities: relational algebra, relational calculus, data structures for establishing relations, query functions, design and translation strategies; file organization, file security; data integrity and reliability.

2110423 Software Engineering 3(3-0-6)
Design tools and techniques; top-down design, modular design, software tools, debugging and test data; software reliability, theory and concepts, errors, faults and estimation, reliability models, availability models; management techniques, cost estimation, software maintenance.

2110424 Software Process Improvement 3(3-0-6)
Condition : Consent of Faculty
Software process improvement premise; software process modeling; foundation and infrastructure of software process improvement; approach for transitioning to process improvement program; quality assurance components in software project life cycle; software engineering process group; software process and product measurement.

2110428 Introduction to Data Mining 3(3-0-6)
Fundamental concepts of data mining; data mining methodologies, decision trees, classification, association, clustering; data mining algorithms.

2110429 Information Retrieval Systems 3(3-0-6)
*Condition : Prerequisite 2110211
Consent of Faculty*
Modeling; query languages and operations; retrieval evaluation; text and multimedia retrieval system; indexing and searching.

2110431 Introduction to Digital Imaging 3(3-0-6)
Condition : Prerequisite 2102201
Overview of theory of digital image processing and analysis: definition of terms, Basic principles of human visual perception, image representation, preprocessing, image enhancement, image segmentation, feature extraction and analysis, image compression; survey of applications.

2110432 Automatic Speech Recognition 3(3-0-6)
Condition : Consent of Faculty
Overview of speech and language technology; human speech production models; spectrogram; speech sounds in languages and spectrogram reading; speech representation; template matching using dynamic time warping; acoustic modeling; frame-based speech recognition using Hidden Markov models; language modeling; examples of other approaches to automatic speech recognition.

2110435 Introduction to Robotics 3(3-0-6)
An overview of robotics technology; introduction to the configuration space concept, rigid transformation and manipulator kinematics; sensing and control; robot programming; robot motion planning and application; robot manipulation.

2110441 Software Design and Development 3(3-0-6)
Design techniques : models of structured programming, code reading and correctness, stepwise refinement and reorganization, top-down design and development, structured design, strength, and coupling measures; organization and management: milestones and estimation, chief programmer teams, program libraries, walk through, and documentation; team project: organization, management and development of large scale software.

2110442 Object-Oriented Analysis and Programming 3(3-0-6)
*Condition : Prerequisite 2110211 or
Consent of Faculty*
Object-oriented design and object-oriented software construction; design and construct : classes, methods, messages, instances, inheritance, static and dynamic binding, replacement and refinement and polymorphism analyze : frameworks and design patterns, and object-oriented software engineering.

2110443 Human-Computer Interaction 3(3-0-6)
*Condition : Prerequisite 2110101 or
Consent of Faculty*
HCI design, implementation and evaluation; graphical user interface programming; prototyping tools and toolkits; window-based systems; usability engineering.

2110444 Introduction to Formal Verification 3(3-0-6)
Condition : Prerequisite 2110200
Fundamental concepts of mathematical logic; formal specification language definition : syntax, semantics; formal specification language: Z, Object Z, CafeOBJ; mathematical models of software and hardware; formal verification methods.

2110445 Enterprise information Systems 3(3-0-6)
Condition : Consent of Faculty
Enterprise information systems; information technology infrastructure and integration; impact of information systems on organizations; information technology and business strategies; e-business and e-commerce; ethical and social issues related to technology; technology decisions; business value of information systems.

2110455 Testing Digital Circuits 3(3-0-6)
Condition : Prerequisite 2110251
Testing techniques for digital logic circuits; fault modelling; test generation; test evaluation; testability analysis; design for greater testability; automatic test equipment; IDDQ testing; writing simulation programs, current research issues on testing.

2110472 Computer Networks 3(3-0-6)
*Condition : Prerequisite 2110213 or
Consent of Faculty*
Signal; spectrum; seven-Layer architecture; procedure of each layer; network architecture; communication protocols; network applications; network management; network modeling and evaluation.

2110473 Fault Tolerant Computing 3(3-0-6)
Fault model; test generation of combinational and sequential circuits: Boolean difference, path sensitization and algorithm; digital simulation technique; design of self checking circuit; error detection and correction codes redundancy techniques; diagnosis of digital system and design of simplified testing.

2110475 VLSI Design 3(3-0-6)
Integrated circuit technology; design and implementation of very large scale integrated circuits including design methodology: design using stick diagram; the use of CAD tools including layout generators, simulators, and plot utilities; I/O pads; study of some digital subsystem, digital architecture and design styles; Fabrication processes; criterion for foundries; case study of some custom design integrated circuits.

2110476 Artificial Intelligence I 3(3-0-6)
Concept in AI: language will be used for programming: LISP, LOGO PROLOG, and FORTH; survey to current AI techniques.

2110477 Artificial Intelligence II 3(3-0-6)
Use of computer in problem solving, natural language question answering and inference; visual perception, learning; a typical AI programming project required.

2110478 Computer and Communication 3(3-0-6)
Introduction: computer and communication technology; Communication and network model: Shannon and Weaver model, ISO-OSI model, LAN, and Inter/Intranet; System component: modem, multiplexer, interface, and repeater/bridge/router/switch; Resource management and error control; Data security: natural disaster and vandalism.

2110479 Computer Graphics 3(3-0-6)
Survey of uses: animation, CAD/CAM, presentation graphic art and simulation; overview of interactive graphics: definition of terms, interactive methods and 2 and 3 dimensional rendering image, modeling visual attributes, and animation, survey of computer graphics systems.

2110481 Wireless Computer Networks 3(3-0-6)
Condition : Consent of Faculty
Digital transmission; queueing theory, mobile IP internetworking, IPv6, DHCP, proxy service.

2110490 Computer Engineering Pre-Project 1(0-2-1)
Determination of topics or problems; scope, methodologies of problem solving and expected benefit from various areas of computer engineering projects under the supervision of a project advisor; examination of project proposal; periodical writing of progress reports and report presentation.

2110491 Topics in Systems and Languages 3(3-0-6)
Condition : Prerequisite 2110421
Current interest and new developments in the areas of software systems, theory of programming languages and translations.

2110492 Topics in Operations Systems 3(3-0-6)
Condition : Prerequisite 2110411
Topics of current interest and new developments in the areas of operating systems, modeling, performance analysis, utility systems.

2110493 Topic in Database Management Systems 3(3-0-6)
Condition : Prerequisite 2110422
Topics of current interest and new developments in the areas of database management systems, information systems and data dictionary.

2110495 Advanced Topics in Computer Engineering I 3(3-0-6)
Condition : Consent of Faculty
Topics of current interest and new developments in various fields of computer engineering.

2110496 Advanced Topics in Computer Engineering II 3(3-0-6)
Condition : Consent of Faculty
Topics of current interest and new developments in various fields of computer engineering.

2110497 Special Problems in Computer Engineering I 3(2-3-4)
Condition : Consent of Faculty
A study of investigation of special problems assigned by the instructor with the consent of the head of department. The work must be completed within one semester. A written report, a copy of which is to be kept by the department, is required and an oral examination must be taken.

2110498 Special Problems in Computer Engineering II 3(2-3-4)
Condition : Consent of Faculty
A study of investigation of special problems assigned by the instructor with the consent of the head of department. The work must be completed within one semester. A written report, a copy of which is to be kept by the department, is required and an oral examination must be taken.

2110499 Computer Engineering Project 3(0-6-3)
Condition : Prerequisite 2110490
Continuing of approved project from course 2110490 must be carried out under project advisor's supervision. Written progress reports must be submitted periodically. A written final report is required and an oral examination must be taken with a department project committee at the end of project.

COURSE DESCRIPTIONS IN COMPUTER ENGINEERING (M.ENG., M.SC., PH.D.)

2110505 Distributed Systems 3(3-0-9)
Definition; interprocess communication; logical clock; concurrency control: two-phase locking, optimistic, timestamp ordering; distributed transaction, atomic commit protocol; deadlock: detection, prevention, avoidance, distributed detection; scheduling; reliability; fault tolerance, replication, recovery; security; distributed services: name, file, distributed management; standards and cases.

2110511 Game Programming 3(3-0-9)
Theory of game design; graphics programming; computer graphics model; data structure for game programming; online game.

2110512 Computer Animation 3(3-0-9)
Techniques and algorithms in computer-generated animation; vector algebra; numerical techniques; 2D and 3D animation programming; motion specification : shape interpolation algorithms and models for rule-and constraint-based motion generations.

2110521 Software Architectures 3(3-0-9)
Condition : Consent of Faculty
Principles of software architectures; practical methods in software architectures using scenario-based analysis, heuristic, and formal approaches; architectural styles; architectural description language; software architectural analysis and design; software architectures specification tools; software architecture-based testing; use of software architectures in the software development process.

- 2110541 Computer Systems Audit 3(3-0-9)**
Design of information system; internal control and auditing of data; validity; reliability; security and protection.
- 2110605 Computer Programs Structure 3(3-0-9)**
High-level structured programming languages; data types and operations; control structures; subprograms; records, sets, pointers and dynamic memory allocations; recursive programming; non-numerical problem solving techniques; problem analysis and program design; introduction to software engineering.
- 2110606 Research Methods in Computer Engineering 3(3-0-9)**
Research methods in Computer Engineering; Research techniques and tools; Project and time management; Technical paper writing; Oral presentation; Current research topics.
- 2110611 Information Processing and Computer System 3(3-0-9)**
Introduction to information processing concepts, processing methods, computer development and applications; classification and architecture; data communications and computer networks; computer center management.
- 2110612 System Programming 3(3-0-9)**
Components of a programming system; evolution of operating systems; design of assembler, macro language, macro processor, loader schemes; types of loaders; design of loaders.
- 2110614 Programming Languages and Compilation 3(3-0-9)**
Language structures data, operation, control structures; software-simulated computer; language translation lexical analysis, and parsing, and code generation; other language methodologies list processing, logic programming, object-oriented programming.
- 2110621 System Analysis and Design 3(3-0-9)**
Basic analysis steps, determining system alternatives, determining system economics, defining logical system requirements, basic design tools and objectives; hardware and software: selection and evaluation; design and engineering of software; database development, program development, system implementation, post implementation analysis.
- 2110622 Data Management 3(3-0-9)**
List structures: lists, stacks, queues; table and hash in tree structures: binary search trees, AVL trees, B- trees, heaps; searching and sorting; fundamental of file structures
- 2110623 Software Requirements Engineering 3(3-0-9)**
Methods, tools, notations, and validation techniques for the elicitation, analysis and specification of software requirements; investigating the project or applying approaches to software requirements engineering.
- 2110624 Software Engineering 3(3-0-9)**
Fundamental areas of software engineering: life cycle, paradigms, metrics, and tools; management techniques; cost estimation; software maintenance methodologies; incremental programming; very high level languages.
- 2110629 File Management 3(3-0-9)**
Introduction to data management, files, and applications; an overview of input/output system architecture; logical file organizations; mapping logical organization onto physical storage; operating systems; file system interface; higher level languages; data management facilities.
- 2110631 Operating System 3(3-0-9)**
Evolution, types, goals, functions and organization: concepts of process; process synchronization; process management; memory management; device management; file management;
- 2110632 Advanced Topics in Operating Systems 3(3-0-9)**
Condition: Consent of Faculty
Advanced and current topics in Operating Systems.
- 2110634 Software Design and Development 3(3-0-9)**
Techniques of software design and development: project management, structured programming, verification and validation, security and privacy, and project documentation; students are required to apply these techniques to large software projects.
- 2110636 Performance Analysis and Evaluation 3(3-0-9)**
Statistical techniques of computer system performance evaluation and measurement; system selection and tuning strategies; deterministic and probabilistic models of process scheduling and resource allocation; analytic and simulation models of computer system; systematic study of system architectures.
- 2110638 Object-Oriented Technology 3(3-0-9)**
Condition: Consent of Faculty
Classes, methods, messages, instances, inheritance, binding: static, dynamic, replacement, refinement, polymorphism, frameworks, design patterns, object-oriented software engineering: software design and construction, application of object-oriented technology: object-oriented databases, distributed objects, current topics in object-oriented technology
- 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
- 2110642 Object-Oriented Software Engineering 3(3-0-9)**
An overview of object-oriented technology concepts on objects, classes, inheritance, polymorphism, and relationship between classes; software development process, software configuration management, software quality assurance, object-oriented project planning and management, object-oriented analysis and design methodologies, object-oriented programming and object-oriented software testing and maintenance, use of CASE tools.

- 2110644 Formal Software Specification 3(3-0-9)**
 Mathematical Logic: Set, Relation, Function, Predicate Calculus, Algebraic system; Formal software specification language: Z, CafeOBJ; Identifying problem domain; Design and software modeling; Formal software specification method; Consistency verification of formal specification and its proof; Utilization of formal software specification in software process.
- 2110645 Software Engineering Methodology 3(3-0-9)**
 Software engineering process concepts; context for personal software process; planning and measurement concepts; software size measurement; general size estimating methods; resource and schedule estimation; process measurement; design and code reviews; software quality management.
- 2110646 User Interface Design 3(3-0-9)**
 Foundations of user-interface; human-centered software evaluation; software development; graphic user-interface design; graphic user-interface programming; multimedia systems.
- 2110651 Digital Image Processing 3(3-0-9)**
 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.
- 2110654 Artificial Intelligence 3(3-0-9)**
 Definitions and application of artificial intelligence; knowledge representation; Prolog programming; natural language processing; machine learning techniques.
- 2110657 Computer Simulation 3(3-0-9)**
 Monte Carlo simulation; discrete event simulation and implementation techniques, queueing theory; equilibrium and steady state; input/output analysis; random numbers; output measurement; simulation accuracy; trace and execution-driven simulation; computer system simulation; continuous system simulation; combining continuous and discrete-event simulation
- 2110661 Computer Network 3(3-0-9)**
 Introduction to network and network components; transmission links and protocols; design and analysis of networks; WAN; IMP; topology; network protocols; flow control and routing techniques.
- 2110662 Communication and Computer Network 3(3-0-9)**
 Network components; transmission links and protocols; design and analysis of networks; WAN; IMP; topology; network protocols; flow control and routing techniques.
- 2110664 Network Management 3(3-0-9)**
Condition: Consent of Faculty
 Information systems environment, business, and networks; network management data integrity, data security, network availability, network service, network adaptability.
- 2110665 Computer Communication System and Standards 3(3-0-9)**
 Introduction to computer and communication systems: on-line system, computer networks, distributed processing; communication model: OSI Standard; networks and standards: ISDN, X.25.
- 2110671 Database Management Systems 3(3-0-9)**
 Definition, objectives, and basic concepts information storage and retrieval system; data management system; data management functions and components of database management system: database interrogation, update; data model; security policy; major trade-offs in database management; introduction to object oriented database.
- 2110672 Data Modeling Techniques 3(3-0-9)**
 Data modelling concepts; conceptual objects used on simple and complex abstraction level: entity and entity set, entity attributes, relationship and relationship sets, relationship attributes, domain; normalization of relation: 1NF, 2NF,3NF,4NF and 5NF; conceptual data modeling: entity-relationship,data flow,logical and physical model, transformation of the logical model into a physical model,and functional design; object-oriented design concept.
- 2110673 Information Storage and Retrieval 3(3-0-9)**
 Models and methods for storage and retrieval of information; Topics include information retrieval techniques, text analysis and automatic indexing, document clustering, search techniques, retrieval performance measurement, and search mechanisms for retrieval from the World Wide Web.
- 2110674 Information Technology Center Management 3(3-0-9)**
 Organization of the Information-Technology Center, computer personnel; nature of the users; software development tools; computer site operation; personnel management; systems software tuning; hardware evaluation; problems facing the director of the center.
- 2110678 Mobile Computing 3(3-0-9)**
Condition: Consent of Faculty
 Principle of mobile radio communication, principle access communication, teletraffic theory, wireless networking, present and next generation mobile and cordless telecommunication systems.
- 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; proving 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.

- 2110683 Concurrent Processing 3(3-0-9)**
Principles of distributed, parallel and concurrent systems, parallel architecture and concurrent computing models; concepts of networks protocols for concurrent processing, operating systems and hardware support for distribution of codes, concurrent processing, parallel processing and networking.
- 2110684 Information System Architecture 3(3-0-9)**
Hardware systems: personal computers, network equipment, servers, clusters and super servers, embedded system; application systems: multi-tier systems, markup language, query language; transaction systems: process abstraction, inter-process communication, synchronization, deadlock, transactions, concurrency control; Web-based applications; global systems.
- 2110685 Computer Application in Enterprises 3(3-0-9)**
Business transaction; processes and organisation; information and business decision; human resources and knowledge management; data warehousing.
- 2110686 Enterprise Computing 3(3-0-9)**
IT infrastructure; management; stability, efficiency and responsiveness; theoretical and practical aspects of systems management; discipline in data centres; development, integration, and management of IT processes; business-support functions; enterprise services; information systems services.
- 2110694 Directed Studies in Computer Science 3(3-0-9)**
Study of current interest and new developments in various fields of computer science.
- 2110696 Advanced Topics in Computer Application 3(3-0-9)**
Current advanced topics and technologies in computer applications.
- 2110697 Special Topics in Computer Science I 3(3-0-9)**
Current special topics and new technologies in computer science.
- 2110698 Special Topics in Computer Science II 3(3-0-9)**
Current special topics and new technologies in computer science.
- 2110701 Seminar in Computer Engineering I 1(0-3-1)**
Seminar in Computer Engineering about the thesis and assignments.
- 2110702 Seminar in Computer Engineering II 1(0-3-1)**
Seminar in Computer Engineering about the thesis and assignments.
- 2110711 Theory of Computation 3(3-0-9)**
Computable functions decidable predicates and solvable problems; computational complexity; NP-complete problems; automata theory; formal language; lambda calculus.
- 2110712 Analysis of Algorithms 3(3-0-9)**
Algorithm complexity and problem complexity; discrete mathematics real analysis, and combinatorics; algorithms and data structures; average-case worst-case and amortized analysis.
- 2110713 Optimization Methods 3(3-0-9)**
Dynamic optimization; mathematical programming; least square methods; gradient methods; Newton's method; linear programming; nonlinear programming; discrete optimizations.
- 2110714 Digital Systems 3(3-0-9)**
Digital system architecture; logic elements, processor, compilers, operating systems; digital abstraction, synthesis of digital systems; performance measures; interpretation; micro architecture; memory architecture; processes; multiplexing; synchronization; interrupts; real time systems.
- 2110716 Seminar I 1(1-0-3)**
Seminar in the assigned topics on current experiment and / or research on computer engineering.
- 2110717 Seminar II 1(1-0-3)**
Seminar on current experiment and / or research on computer engineering concerning theses.
- 2110718 Seminar III 1(1-0-3)**
Seminar on current experiment and / or research on computer engineering concerning theses.
- 2110719 Seminar IV 1(1-0-3)**
Seminar on current experiment and / or research on computer engineering concerning theses.
- 2110721 Software Metrics 3(3-0-9)**
Theoretical foundations of software metrics; data collection; experimental design and analysis; software metric validation; measuring the software development and maintenance process; measuring software systems; support for metrics; statistical tools; applications of software measurement.
- 2110722 Software Project Management 3(3-0-9)**
Concepts of software product and process quality; roles of Total Quality Management (TQM); use of metrics, feasibility studies; cost and effort estimates; discussion of project planning and scheduling; the Capability Maturity Model; basis tenets and application of process validation.
- 2110723 Advanced Software Engineering Development 3(3-0-9)**
Software development process improvement; a series of individual programming and process projects; project planning measurement size estimation task scheduling and defect clarification.
- 2110724 Software Testing and Quality Assurance 3(3-0-9)**
Technical and management views of software testing and SQA; quality concepts; black and white box testing techniques; test coverage; levels of testing; the formation of a testing organization; testing-in-the-large; documentation for testing; inspections and walkthroughs.

2110731 Distributed Systems 3(3-0-9)
Definition; interprocess communication; logical clock; concurrency control; locking: two-phase, optimistic, timestamp ordering; distributed transaction, atomic commit protocol; deadlock; detection, prevention, avoidance, distributed selection; scheduling reliability; fault tolerance, replication, recovery, security, distributed services; name, file; distributed management; standards and cases: SNMP, CORBA, DCOM, ANSA.

2110732 Parallel Computing 3(3-0-9)
Architectures in parallel computing : shared/distributed memory, SIMD/MIMD architecture, interconnection networks, granularity of the machines, dataflow and systolic arrays computers; parallel processing : pipelining and parallelism, software for parallel computers.

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.

2110742 Evolutionary Computation 3(3-0-9)
Computer algorithms gleaned from the model of biology; algorithms inspired by organic evolution : genetic algorithms, classifier systems, genetic programming and evolution strategies; theoretical basis of these algorithms.

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.

2110744 Machine Vision 3(3-0-9)
Low-level vision and higher-level techniques : binary machine vision, morphology, neighborhood operators, labeling, texture, region segmentation, feature extraction, motion, image matching, model matching and knowledge-based vision systems.

2110745 Cryptography 3(3-0-9)
Introduction; symmetric encryption; 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.

2110751 Computer Aided Design in Digital Systems 3(3-0-9)
Layout editing; schematic datacapture; simulation; design rule checking; automatic placement and routing; logic synthesis for combination and sequential circuits; logic synthesis for architectural design; formal method for specifications.

2110752 Design for Testability 3(3-0-9)
Methods of design for testability; digital chip design for automatic testing equipment; ad hoc rules and structured method called scan design; fault analysis; controllability; observability; Scan-In Scan-Out (SISO) principle; Level Sensitive Scan Design (LSSD); built-in testing and other current techniques.

2110753 Asynchronous Design 3(3-0-9)
Design of digital systems not using global clock; limitation to synchronous processor; hazard analysis; Fundamental of asynchronous logic design; delay assumption; signaling protocol; asynchronous communication; Petri net; signal transition graph; completion detection; data and control paths implementations.

2110771 Advanced Database Design 3(3-0-9)
Fundamental of database design : data modeling, relational theory, query language, dependency theory; query optimization, computing with logic and universal relation.

2110772 Multi-Dimensional Database Systems 3(3-0-9)
Modern multi-dimensional database systems : spatial databases, temporal databases, multimedia databases; algorithms and data structures : R-tree, R+ tree, R* tree, quad-tree, spatial and temporal reasoning, disk clustering and declustering.

2110773 Data Mining 3(3-0-9)
Data mining concepts; data mining applications; data mining methodologies: decision trees, classification, association, clustering, statistical modeling, Bayesian classification, k-nearest neighbors.

2110781 Special Topics in Distributed Systems 3(3-0-9)
Current topics, related researches, and technology trends in distributed systems.

2110791 Advanced Topics in Software Engineering 3(3-0-9)
State of the art and current interest in software engineering.

2110792 Advanced Topics in Artificial Intelligence 3(3-0-9)
In-depth study of the current and interesting topics in artificial intelligence : problem solving, search, heuristic methods, machine learning, knowledge representation, natural language processing, computer vision, expert systems, theorem proving and current applications.

2110793 Advanced Topics in Digital Systems 3(3-0-9)
State of the art and current interest in digital systems.

2110794 Advanced Topics in Database Systems 3(3-0-9)
State of the art and current interest in database systems.

2110795	Advanced Topics in Computer Network	3(3-0-9)
	State of the art and current interest in computer network.	
2110799	Master Project	6(0-0-24)
2110811	Thesis	12 Credits
2110814	Thesis	24 Credits
2110816	Thesis	36 Credits
2110828	Dissertation	48 Credits
2110894	Doctoral Dissertation Seminar	0(0-0-0)
2110896	Comprehensive Examination	0(0-0-0)
2110897	Qualifying Examination	0(0-0-0)

**COURSES OFFERED TO STUDENTS OUTSIDE
FACULTY OF ENGINEERING ONLY :**

2110102 Computer Programming - Fortran

Computer systems, problem-solving procedures, algorithms, control structures, data types, vector, array and record, string manipulation. Coding, compiling and linking Fortran programs, constants and variables, operators and expressions, assignment statements, control statements, functions and subprograms, numeric and character applications.

2110103 Computer Programming-Pascal

Computer systems, problem-solving procedures, algorithms, control structures, data types, vector, array and record, string manipulation. Pascal data types, variables, operators, expression, assignment statement, identifiers, program structure, input, output and control statements, procedures and functions composited data types, files.

2110104 Computer Programming - C

Computer system, problem-solving procedures, algorithms, control structures, data types, vector, array and record, string manipulation. C programming concepts, constants, variables, operators and expressions, statements, functions, array and pointer, structure, preprocessor.

2110172 Information Technology 3(2-2-5)

Application software packages: word processing, spreadsheet, presentation and database software; utility software; basic computer system management: backup and restore, software installation and uninstallation.

2110182 Introduction to computer and data Processing 2(2-0-4)

An overview of computer components, hardware and software interaction: basic data processing concepts, data transformation, method of data processing, data communication and programming concepts.

2110183 Introduction to Computer and Programming 3(3-0-6)

An overview of computer components, hardware and software interaction, EDP concepts: programming concepts and introduction to FORTRAN programming.

2110206 Assembly Language Programming 3(2-2-4)

This course will emphasized hand-on experience with Assembly language programming, loader, assembler and I/O devices.

2110281 Basic Programming 2(1-2-3)

Overview of elements of Basic Language, including BASIC statements: arithmetic, input and output, flow of control, subprogram; file processing; sequential access, and random access; application programs in various fields.

2110284 Pascal Programming Language

Steps involved in computer programming; algorithms construction; data type; names; arithmetic operations; input and output; flow of control; advanced Pascal data type; dynamic data structure functions and procedure, and file management in Pascal.

2110286 Basic Data Structure Concept
Condition : Prerequisite 2110101 or 2110183 or 2110283

Array, stack and queue data structures; singly and doubly linked lists; binary trees; internal sorting techniques: bubble, radix, shell, quick and merge; searching techniques: sequential, binary.

2110288 Introduction to Cobol Programming
Condition : Prerequisite 21101183

An overview of steps in problem solving, Cobol Program organization, the structure of Cobol Programming, identification division, environment division, data division and procedure division, programming techniques, structured programming, table handling, searching and sorting.