

**KING FAHD UNIVERSITY OF PETROLEUM AND MINERALS  
DHAHRAN - KINGDOM OF SAUDI ARABIA**

**College of Computer Sciences and Engineering  
Computer Engineering Department**

***STUDENT GUIDE***

**Academic Year 2006-2007**

## INTRODUCTION

The dramatic reduction in the cost of digital systems over the last decade has led to an enormous growth in the use of computers. Today, computer engineering is one of the fastest growing university disciplines.

Computer engineering is a discipline of much interest and demand locally in Saudi Arabia, regionally and worldwide. Currently, there is a critical shortage of computer professionals who can design and implement computer systems and networks. The Kingdom of Saudi Arabia has focused on computer technology and its utilization as one of the fundamental tools to modernize its industry to cope up with advances in modern technology. It is therefore, mandatory to prepare highly qualified computer engineers who are capable of mastering the latest advances in such a rapidly growing technology.

## WHAT IS COMPUTER ENGINEERING?

Computer Engineering (COE) is an engineering discipline concerned with the design, analysis, modeling, implementation and utilization of modern [digital computing and networking systems](#). Both the [software](#) and the [hardware](#) aspects of these systems are studied in a balanced and coherent manner.

The IEEE/ACM joint Task Force on Computing Curricula for **Computer Engineering** (CCCE 2004) has defined “Computer Engineering” *as follows*:

*“Computer Engineering embodies the science and technology of design, construction, implementation, and maintenance of [software](#) and [hardware components](#) of [modern computing systems](#) and [computer-controlled equipment](#). Computer Engineering has traditionally occupied the territory that lies at the interface between Computer Science and Electrical Engineering. It evolved over the past three decades as a separate, although intimately related discipline. Computer Engineering is solidly grounded in theories and principles of computing, mathematic, science, and engineering and it applies these theories and principles to solve technical problems through the design of hardware, software, networks and processes.”*

The COE program at KFUPM provides a comprehensive coverage of a wide range of COE subjects. These are presented below.

- Computer Architecture & Digital Design;
- Parallel and Distributed Systems;
- Communications and Networks;
- VLSI and Design Automation;
- Computer Systems and Applications.

## STUDY IN COMPUTER ENGINEERING

The Computer Engineering Department provides a program that develops the necessary *skills* and *competence* required to design and implement computer systems and networks. The computer engineering curriculum emphasizes the areas of digital system architecture and design, microprocessors, integrated circuit technology, computer communication, and computer networks. In addition, sufficient emphasis is given to the study of computer science to provide a coherent view of computer systems and an understanding of the interdependencies of hardware and software components and their interfaces and tradeoffs.

The Computer Engineering Department offers a program leading to a B.S. degree in computer engineering, a program leading to an MS degree in computer engineering, and a Ph.D. program, jointly with the Information and Computer Science Department.

## **JOB OPPORTUNITIES**

Job opportunities for computer engineers, which are on the increase, are available in various domains such as:

### *i) Data Communication & Computer Networks*

Design of data communication and computer networks, the installation and management of computing facilities and networks, e.g. computer systems / networks of major banks.

### *ii) Computer & Microcomputer Engineering*

Design of computer and microcomputer-based systems for dedicated applications involving machine control, interfacing machines, and computer installation and operation

### *iii) Information Technology System Analysts*

Many leading IT companies are establishing offices in Saudi Arabia. Some of these, provide full IT solutions to customers, as well as provide advice on security issues of their systems.

### *iv) Digital Hardware/Software Development and Management*

Development/installation, operation, and maintenance of application-specific system software and hardware. Computing systems performance measurements and analysis (both software and hardware) in addition to improvement, and capacity planning for these systems.

### *v) Automation Engineer*

Development, installation, management, and maintenance of factory and office automation systems.

A partial list of government and private organizations currently requiring computer engineers includes:

- National Information Center
- Ministry of Defense and Aviation
- Advanced Electronics Company
- Saudi Aramco
- Financial institutions, especially those utilizing large networks and automated teller machines (ATM)
- Universities
- Computer companies and
- Commerce and Industry

This document contains the various courses offered by COE, information on graduation requirements, a list of electives, and catalog description & prerequisite of COE courses.

## Components of the COE curriculum

### I. Introductory Courses & Core (34 CR)

1. **Mathematics:** Calculus I, II, and III (MATH 101, and MATH 102) (8 CR)
2. **Science:** Physics I and II, and Chemistry I (PHYS 101, PHYS 102, and CHEM 101) (12 CR)
3. **English Language:** English Composition I and II (ENGL 101 & 102) (6 CR)
4. **Programming Fundamentals:** Introduction to Computing (ICS 102) (3 CR)
5. **Humanities, Arabic, and Religious Studies:** Belief & Arabic Grammar (IAS 101 & 111) (4 CR)
6. **Other Courses:** Physical Education (PE 101) (1 CR)

### II. Intermediate Courses & Core (52 CR)

1. **Mathematics:** Calculus, Linear Algebra & Differential Equations, and Probability & Statistics (MATH 201, MATH 260, and STAT 319) (9 CR)
2. **Humanities, Arabic, and Religious Studies:** Ethics in Islam, Objective Writing, and Islamic Shareah (IAS 212, 201, 322) (6 CR)
3. **English Language:** Technical Report writing (ENGL 214) (3 CR)
4. **Circuits Fundamentals:** Electric Circuits I (EE 201) (4 CR)
5. **Electronics Fundamentals:** Electronics I (EE 203) (4 CR)
6. **Digital Logic Design:** Fundamentals of Computer Engineering and Digital Design Laboratory (COE 202 and COE 203) (4 CR)
7. **Programming Fundamentals:** One more Programming course and Data Structures (ICS 201 202) (7 CR)
8. **Discrete Mathematics:** Discrete Mathematics (ICS 252) (3 CR)
9. **Computer Architecture and Organization:** Computer Org/Assembly, Microcomputer System Design, and Computer Architecture (COE 205, COE 305, and COE 308 and) (11 CR)
10. **Networks:** Data and Computer Communications (COE 341) (3 CR)
11. **Digital Electronics/VLSI:** Principles of VLSI Design COE 360 (3 CR)
12. **Social and Professional Issues:** Seminar (COE 390) (1 CR)
13. **Other Courses:** Physical Education (PE 102) (1 CR)

### III. Advanced Courses (39 CR or 40 CR)

1. **Humanities, Arabic, and Religious Studies:** Literary Styles and Humanity Elective (IAS 301 and 4xx) (4 CR)
2. **Digital Systems Design:** System Design Laboratory (COE 400) (3 CR)
3. **Networks:** Computer Networks (COE 344) (4 CR)
4. **Operating Systems:** Operating Systems (ICS 431) (4 CR)
5. **Database Systems** (ICS 324) (4 CR) → **Required only for the Coop option**
6. **IT elective**<sup>1</sup>:  $\begin{cases} \in \{COE\ xxx, ICS\ 353, ICS\ 324, SWE\ 311\} \rightarrow No - Coop \\ \in \{COE\ xxx, ICS\ 353, SWE\ 311\} \rightarrow Coop \end{cases}$
7. **Capstone:**  $\begin{cases} 3\ CR\ (No\ Coop)\ Senior\ Design\ Project\ (COE\ 485) \\ 0\ CR\ (Coop) \end{cases}$
8. **COE Elective Courses:**  $\begin{cases} 6\ CR\ (No\ Coop) \\ 3\ CR\ (Coop) \end{cases}$
9. **General Elective:** XXX xxx (3-0-3) may be COE or non-COE course
10. **Free Electives:**  $\begin{cases} 6\ CR\ (No\ Coop) \\ 0\ CR\ (Coop) \end{cases}$
11. **Cooperative Work:**  $\begin{cases} 0\ CR\ (No\ Coop) \\ 9\ CR\ (Coop)\ Cooperative\ Work\ COE\ 350, 351, \text{ and } 352 \end{cases}$

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<sup>1</sup> ICS 324 is a required course for Coop students. Accordingly, IT elective, for Coop students, is only one of 3 possible choices {ICS 353, SWE 360, or COE xxx}.

## The COE Degree Requirements

The COE Department offers two options for its students. These are:

- (1) B.S. in Computer Engineering, and
- (2) B.S. in Computer Engineering with Co-Op.

The program requirements for each of these options are listed below.

### Option I: B.S. in Computer Engineering.

Area	Courses	Credit-Hours
Basic Sciences	CHEM 101, PHYS 101, 102	4 4+4=8
Mathematics	MATH 101, 102, 201, 260 STAT 319	4+4+3+3=14 3
English	ENGL 101, 102, 214	3+3+3=9
Physical Education	PE 101, 102	1+1=2
Islamic Studies and Humanities	IAS 111, 101, 212, 201, 322, 301, 4xx	2+2+2+2+2+2+2=14
Information & Computer Science	ICS 102, 201, 202, 252, 431	3+4+4+3+4 = 18
Electrical Engineering	EE 201, 203	4+4=8
Electives	Xxx*, yyy, zzz	3+3+3=9
IT Elective	COE xxx, ICS 353, ICS 324, or SWE 360	3
Computer Engineering	COE 202, 203, 205, 305, 308, 341, 360, 390, 399, 400, 344, 485, 4xx, 4xx	3+1+4+4+3+3+3+ 1+0+3+4+3+3+3=38
<b>Total Credits</b>		<b>130</b>

### Option II: B.S. in Computer Engineering with Co-op

Area	Courses	Credit-Hours
Basic Sciences	CHEM 101, PHYS 101, 102	4 4+4=8
Mathematics	MATH 101, 102, 201, 260 STAT 319	4+4+3+3=14 3
English	ENGL 101, 102, 214	3+3+3=9
Physical Education	PE 101, 102	1+1=2
Islamic Studies and Humanities	IAS 111, 101, 212, 201, 322, 301, 4xx	2+2+2+2+2+2+2=14
Information & Computer Science	ICS 102, 201, 202, 252, 324, 431	3+4+4+3+4+3+4 =22
Electrical Engineering	EE 201, 203	4+4=8
General Electives	Xxx	3
IT Elective	COE xxx, ICS 353, or SWE 360	3
Computer Engineering	COE 202, COE 203, 205, 305, 308, 341, 360, 390, 400, 344, 4xx,	3+1+4+4+3+3+3+1+3+4+3 =32
Co-Op	COE 350, COE 351	0+9= 9
<b>Total Credits</b>		<b>131</b>

\* xxx is a general elective which may include COE courses; while yyy and zzz are free non-COE electives.

## List of COE Courses with Pre-Requisites

### COE Core Courses

S.N.	Course	Title	Credit			Prerequisite
1-	COE 202	Fundamentals of Computer Engineering	3	0	3	Phys 102
2-	COE 203	Digital Design Laboratory	0	3	1	COE 202
3-	COE 205	Computer Organization and Assembly Language	3	3	4	ICS 102, COE202
4-	COE 305	Microcomputer System Design	3	3	4	COE 203, COE 205
5-	COE 308	Computer Architecture	3	0	3	COE 203, COE 205
6-	COE 341	Data & Computer Communications	3	0	3	Math 102
7-	COE 360	Principles of VLSI Design	3	0	3	EE 203
8-	COE 390	Seminar	1	0	1	JS
9-	COE 400	System Design Laboratory	1	6	3	COE 305&SS
10	COE 344	Computer Networks	3	3	4	COE 341 & STAT 319
<b>Subtotal (COE Core)</b>					<b>29</b>	

### A-1. Option I (Regular)

1-	COE 399	Summer Training	0	0	0	ENGL 214, JS&DA
2-	COE 485	Senior Design Project	1	6	3	SS
<b>Subtotal</b>			<b>1</b>	<b>6</b>	<b>3</b>	

### A-2. Option II (Co-Op)

1-	COE 350	Cooperative Work	0	0	0	See details inside.
2-	COE 351	Cooperative Work (Continued)	0	0	9	
<b>Subtotal</b>			<b>0</b>	<b>0</b>	<b>9</b>	

### B. COE Elective Courses

1.	COE 402	Computer System Performance Evaluation	3	0	3	STAT 319 OR CI
2.	COE 405	HDL Modeling of Digital Systems	3	0	3	COE 308 OR CI
3.	COE 409	Special Topics in Comp. Arch. & Dig. Syst. Des.	3	0	3	COE 308
4.	COE 410	Design of Sequential Systems	3	0	3	COE 308
5.	COE 420	Parallel Computing	3	0	3	COE 308
6.	COE 421	Fault-Tolerant Computing	3	0	3	COE 308
7.	COE 422	Real Time Systems	3	0	3	COE 305
8.	COE 423	Distributed Systems	3	0	3	SS
9.	COE 425	Cryptosystems: Theory and Design	3	0	3	COE308 & ICS252
10.	COE 429	Special Topics in Parallel & Distributed Systems	3	0	3	SS
11.	COE 441	Local Area Networks	3	0	3	COE 344 OR CI
12.	COE 443	Advanced WAN Communication	3	0	3	COE 344 OR CI
13.	COE 444	Internetwork Design and Management	3	0	3	COE 344 OR CI
14.	COE 445	Internet Information Services	3	0	3	COE 344 OR CI
15.	COE 446	Mobile Computing	3	0	3	COE 344 OR CI
16.	COE 447	Fundamentals of Optical Networking	3	0	3	COE 344 OR CI
17.	COE 449	Special Topics in Comp. Comm. and Networking	3	0	3	COE 341 OR CI
18.	COE 451	Computer and Network Security	3	0	3	COE344 OR CI
19.	COE 460	Advanced Digital Electronics	3	0	3	COE 360
20.	COE 462	Design Automation of VLSI Circuits	3	0	3	COE 360 OR CI
21.	COE 464	Testing of Digital Circuits	3	0	3	SS
22.	COE 465	VLSI System Design Methodology	3	0	3	COE 360
23.	COE 469	Special Topics in VLSI and Design Automation	3	0	3	COE 360 OR CI
24.	COE 484	Introduction to Robotics	3	0	3	SS
25.	COE 486	Multimedia Architectures and Communications	3	0	3	COE 341
26.	COE 487	Computer Vision Processing	3	0	3	SS
27.	COE 488	Data Acquisition Interfacing	3	0	3	COE 305

28	COE 499	Special Topics in COE	3	0	3	SS
<b>Subtotal Option I → Two COE Electives</b>					<b>6</b>	
<b>Subtotal Option II (Co-Op) → One COE Elective</b>					<b>3</b>	

#### D. Other Core Courses

1-	ICS 102	Introduction to Computing	2	3	3	Math 101 or Math132
2-	ICS 201	Introduction to Computer Science	3	3	4	ICS 102
3-	ICS 202	Data Structures	3	3	4	ICS 201
4-	ICS 252	Discrete Mathematics	3	0	3	Math 101
5-	ICS 431	Operating Systems	3	3	4	ICS 232 or COE 205
6-	EE 201	Electric Circuits I	3	3	4	Phys 102, Math 102
7-	EE 203	Electronics I	3	3	4	EE 201
<b>Subtotal</b>					<b>26</b>	

#### C. IT Elective Course

1.	COE xxx	COE elective	3	0	3	
2.	ICS 353	Design and Analysis of Algorithms	3	0	3	ICS 202 & ICS 252
3.	ICS 324	Database Systems	3	3	4	ICS 202
4.	SWE 360	Introduction to Software Engineering.	3	3	4	ICS 201
<b>Subtotal (One IT Elective)</b>					<b>3</b>	



# Curriculum Check List

## B.S. in Computer Engineering (Regular)

Mathematics	cr	Gr	Science	cr	Gr	Human. & Soc. Sc.	Cr	Gr
Math 101			Phys 101			IAS 101		
Math 102			Phys 102			IAS 111		
Math 201			Chem 101			IAS 201		
Math 260						IAS 212		
STAT 319						IAS 301		
						IAS 322		
						IAS 4xx		
						ENGL 101		
						ENGL 102		
						ENGL 214		
						PE 101		
						PE 102		

COE	Cr	Gr
COE 202		
COE 203		
COE 205		
COE 305		
COE 341		
COE 360		
COE 308		
COE 344		
COE 390		
COE 485		
COE 400		
COE 399		

ICS	Cr	Gr	EE	cr	Gr
ICS 102			EE 201		
ICS 201			EE 203		
ICS 202					
ICS 252					
ICS 431					
COE xxx, ICS 353, ICS 324, or SWE 360					

## B.S. in Computer Engineering (Co-op)

Mathematics	cr	Gr	Science	cr	Gr	Human. & Soc. Sc.	cr	Gr
Math 102			Phys 101			IAS 101		
Math 102			Phys 102			IAS 111		
Math 201			Chem 101			IAS 201		
Math 260						IAS 212		
STAT 319						IAS 301		
						IAS 322		
						IAS 4xx		
						ENGL 101		
						ENGL 102		
						ENGL 214		
						PE 101		
						PE 102		

COE	cr	Gr
COE 202		
COE 203		
COE 205		
COE305		
COE341		
COE360		
COE 308		
COE 344		
COE 390		
COE 400		
COE 399		
COE 350		
COE 351		
(352)		

ICS	Cr	Gr	EE	cr	Gr
ICS 102			EE 201		
ICS 201			EE 203		
ICS 202					
ICS 252					
ICS 431					
COE xxx, ICS 353, ICS 324, or SWE 360					

# 1. Computer Engineering Curriculum Plan

## (I) Regular Program (Non-Coop)

### First Year (Preparatory)

Course	Num.	Title	LT	LB	CR	Course	Num.	Title	LT	LB	CR
MATH	001	Preparatory Math I	3	1	4	MATH	002	Preparatory Math II	3	1	4
ENGL	001	Preparatory English I	15	5	8	ENGL	002	Prep. English II	15	5	8
PE	001	Prep Physical Educ. I	0	2	1	PE	002	Prep. Physical Educ. II	0	2	1
ME	001	Prep. Shop I	0	2	1	ME	002	Prep. Shop II	0	2	1
<b>Total</b>			<b>18</b>	<b>10</b>	<b>14</b>				<b>18</b>	<b>10</b>	<b>14</b>

Total Credits required in Preparatory Program: 28

### Second Year (Freshman)

Course	Num.	Title	LT	LB	CR	Course	Num.	Title	LT	LB	CR
MATH	101	Calculus I	4	0	4	MATH	102	Calculus II	4	0	4
PHYS	101	General Physics I	3	3	4	PHYS	102	General Physics II	3	3	4
CHEM	101	General Chemistry I	3	4	4	ICS	102	Introd. to Computing	2	3	3
ENGL	101	English Composition I	3	0	3	ENGL	102	English Composition II	3	0	3
IAS	111	Belief and its Consequences	2	0	2	IAS	101	Practical Grammar	2	0	2
						PE	101	Physical Education I	0	2	1
<b>Total</b>			<b>15</b>	<b>7</b>	<b>17</b>				<b>14</b>	<b>8</b>	<b>17</b>

### Third Year (Sophomore)

Course	Num.	Title	LT	LB	CR	Course	Num.	Title	LT	LB	CR
COE	202	Fundam. of Comp. Eng.	3	0	3	COE	205	Comp. Org. & Ass. Lang.	3	3	4
EE	201	Electric Circuits I	3	3	4	COE	203	Dig. Design Lab.	0	3	1
ICS	201	Introduction to CS	3	3	4	ICS	202	Data Structures	3	3	4
MATH	201	Calculus III	3	0	3	ICS	252	Discrete Mathematics	3	0	3
IAS	212	Ethics in Islam	2	0	2	MATH	260	Introduction to Linear Algebra & Diff. Equ.	3	0	3
PE	102	Physical Education II	0	2	1	ENGL	214	Tech. Report Writing	3	0	3
<b>Total</b>			<b>14</b>	<b>8</b>	<b>17</b>				<b>15</b>	<b>9</b>	<b>18</b>

### Fourth Year (Junior)

Course	Num	Title	LT	LB	CR	Course	Num	Title	LT	LB	CR
COE	305	Microcomp. Syst. Design	3	3	4	COE	308	Computer Architecture	3	0	3
STAT	319	Prob & Stat. For Eng. & Sc.	2	3	3	COE	344	Computer Networks	3	3	4
COE	341	Data & Computer Comm.	3	0	3	COE	390	Seminar	1	0	1
COE/ICS/SWE	Xxx	<b>IT Elective</b>	3	0	3	EE	203	Electronics I	3	3	4
IAS	201	Objective Writing	2	0	2	yyy	yyy	Free Elective	3	0	3
<b>Total</b>			<b>13</b>	<b>6</b>	<b>15</b>	IAS	322	Islamic Shareah	2	0	2
COE	399	COE Summer Training	0	0	0				<b>15</b>	<b>6</b>	<b>17</b>

### Fifth Year (Senior)

Course	Num.	Title	LT	LB	CR	Course	Num.	Title	LT	LB	CR
COE	485	Senior Design Project	1	6	3	COE	400	System Design Lab	1	6	3
COE	4xx	COE Elective	3	0	3	COE	4xx	COE Elective	3	0	3
ICS	431	Operating Systems	3	3	4	zzz	zzz	Free Elective	3	0	3
COE	360	Principles of VLSI Desg.	3	0	3	xxx	xxx	General Elective	3	0	3
IAS	301	Literary Styles	2	0	2	IAS	4xx	IAS Elective	2	0	2
<b>Total</b>			<b>15</b>	<b>9</b>	<b>15</b>				<b>12</b>	<b>6</b>	<b>14</b>

**Total Credits required in COE B.S. Degree Program is: 130**

## (I) COOP Program

### First Year (Preparatory)

Course	Num.	Title	LT	LB	CR	Course	Num.	Title	LT	LB	CR
MATH	001	Preparatory Math I	3	1	4	MATH	002	Preparatory Math II	3	1	4
ENGL	001	Preparatory English I	15	5	8	ENGL	002	Prep. English II	15	5	8
PE	001	Prep Physical Educ. I	0	2	1	PE	002	Prep. Physical Educ. II	0	2	1
ME	001	Prep. Shop I	0	2	1	ME	002	Prep. Shop II	0	2	1
<b>Total</b>			<b>18</b>	<b>10</b>	<b>14</b>				<b>18</b>	<b>10</b>	<b>14</b>

Total Credits required in Preparatory Program: 28

### Second Year (Freshman)

Course	Num.	Title	LT	LB	CR	Course	Num.	Title	LT	LB	CR
MATH	101	Calculus I	4	0	4	MATH	102	Calculus II	4	0	4
PHYS	101	General Physics I	3	3	4	PHYS	102	General Physics II	3	3	4
CHEM	101	General Chemistry I	3	4	4	ICS	102	Introd. to Computing	2	3	3
ENGL	101	English Composition I	3	0	3	ENGL	102	English Composition II	3	0	3
IAS	111	Belief and its Consequences	2	0	2	IAS	101	Practical Grammar	2	0	2
						PE	101	Physical Education I	0	2	1
<b>Total</b>			<b>15</b>	<b>7</b>	<b>17</b>				<b>14</b>	<b>8</b>	<b>17</b>

### Third Year (Sophomore)

Course	Num.	Title	LT	LB	CR	Course	Num.	Title	LT	LB	CR
COE	202	Fundam. of Comp. Eng.	3	0	3	COE	205	Comp. Org. & Ass. Lang.	3	3	4
EE	201	Electric Circuits I	3	3	4	COE	203	Dig. Design Lab.	0	3	1
ICS	201	Introduction to CS	3	3	4	ICS	202	Data Structures	3	3	4
MATH	201	Calculus III	3	0	3	ICS	252	Discrete Mathematics	3	0	3
IAS	212	Ethics in Islam	2	0	2	MATH	260	Introduction to Linear Algebra & Diff. Equ.	3	0	3
PE	102	Physical Education II	0	2	1	ENGL	214	Tech. Report Writing	3	0	3
<b>Total</b>			<b>14</b>	<b>8</b>	<b>17</b>				<b>15</b>	<b>9</b>	<b>18</b>

### Fourth Year (Junior)

Course	Num.	Title	LT	LB	CR	Course	Num.	Title	LT	LB	CR
COE	305	Microcomp. Syst. Design	3	3	4	COE	308	Computer Architecture	3	0	3
STAT	319	Prob & Stat. For Eng. & Sc.	2	3	3	COE	344	Computer Networks	3	3	4
COE	341	Data & Computer Comm.	3	0	3	COE	390	Seminar	1	0	1
COE/ICS/SWE	xxx	IT Elective	3	0	3	COE	360	Principles of VLSI Desg.	3	0	3
EE	203	Electronics I	3	3	4	ICS	324	Data Base Systems	3	3	4
IAS	201	Objective Writing	2	0	2	IAS	322	Islamic Shareah	2	0	2
<b>Total</b>			<b>16</b>	<b>9</b>	<b>19</b>				<b>15</b>	<b>6</b>	<b>17</b>

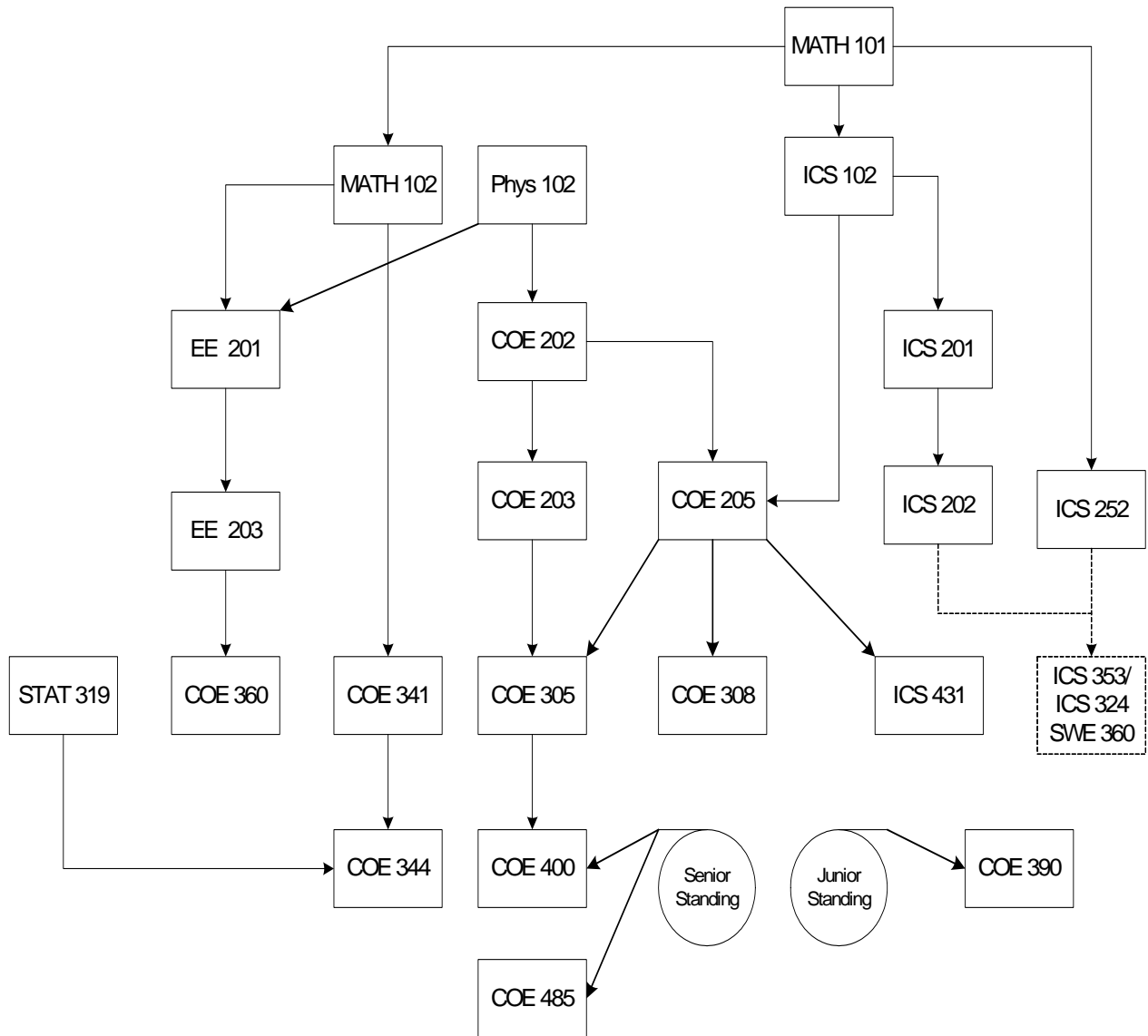
COE 350 Co-operative work 0 0 0

### Fifth Year (Senior)

Course	Num.	Title	LT	LB	CR	Course	Num.	Title	LT	LB	CR
COE	351	Co-op. Work (cont.)	0	0	9	COE	400	System Design Lab.	1	6	3
						COE	4xx	COE Elective	3	0	3
						ICS	431	Operating Systems	3	3	4
						xxx	xxx	General Elective	3	0	3
						IAS	301	Literary Styles	2	0	2
						IAS	4xx	IAS Elective	2	0	2
<b>Total</b>			<b>0</b>	<b>0</b>	<b>9</b>				<b>14</b>	<b>9</b>	<b>17</b>

Total Credits required in COE B.S. Degree Program with co-op is: 131

## 2. COE Core Courses Pre-requisite Chart



## **Course Description**

### **COE 202: Digital Logic Design (3-0-3)**

Introduction to information representation and number systems. Boolean algebra and switching theory. Manipulation and minimization of completely and incompletely specified Boolean functions. Physical properties of gates: fan-in, fan-out, propagation delay, timing diagrams and tri-state drivers. Combinational circuits design using multiplexers, decoders, comparators and adders. Sequential circuit analysis and design, basic flip-flops, clocking and timing diagrams. Registers, counters, RAMs, ROMs, PLAs, PLDs, and FPGA's.

**Prerequisite:** PHYS 102.

### **COE 203: Digital Logic Laboratory (0-3-1)**

The course consists of a set of laboratory experiments for students to gain hands-on experience in digital logic. Use of state-of-the-art CAD tools and boards for the design, simulation, and implementation of digital logic. Combinational and sequential digital systems as well as data and control path design experiments will be conducted.

**Prerequisite:** COE 202.

### **COE 205: Computer Organization and Assembly Language (3-3-4)**

Introduction to computer organization. Signed and unsigned number representation, character representation, ASCII codes. Assembly language programming, instruction format and types, memory and I/O instructions, dataflow, arithmetic, and flow control instructions, addressing modes, stack operations, and interrupts. Datapath and control unit design. RTL, microprogramming, and hardwired control. Practice of assembly language programming.

**Prerequisite:** COE 202 and ICS 102

### **COE 305: Micro Computer System Design (3-3-4)**

Microprocessor architecture and organization, Bus architectures, types and buffering techniques; Memory and I/O subsystems, organization, timing and interfacing; I/O data transfer – Programmed I/O, Interrupt driven I/O and DMA; Peripheral controllers and programming; Bus interfaces, Practice of the design and fabrication of a microprocessor system, testing, debugging and reporting.

**Prerequisite:** COE 203 and COE 205.

**COE 308 Computer Architecture (3-0-3)**

Memory hierarchy and cache memory. Integer and floating point arithmetic. Instruction and arithmetic pipelining, superscalar architecture. Reduced instruction set computers. Parallel architectures and interconnection networks.

**Prerequisite:** COE 203 and COE 205.

**COE 341 Data and Computer Communications (3-0-3)**

Introduction to data communication. Overview of the OSI model. Frequency response, bandwidth, filtering, and noise. Fourier series and transform. Information theory concepts such as Nyquist theorem, Shannon theorem, and Sampling theorem. Analog and digital modulation techniques. Pulse Code Modulation (PCM). Communication systems circuits and devices. Data encoding. Physical Layer Protocols. Data Link Control (point to point communication; design issues; link management; error control; flow control). Multiplexing.

**Prerequisite:** Math 102.

**COE 344 Computer Networks (3-3-4)**

This course will be taught using the top-down approach. Topics covered include introduction to computer networks, OSI model, WAN and LAN design issues. Application layer design issues and protocols are discussed. Then, Transport layer design issues, protocols as well as congestion control mechanisms are presented. Socket programming is explained. An in-depth analysis is presented of the Network layer design issues, and internetworking. MAC layer design issues and protocols are presented. Finally, multimedia network applications, network security and simple examples of network management protocols are explored.

**Prerequisite:** COE 341 and STAT 319. This course cannot be taken for credit with ICS 342.

**COE 350 Cooperative Assignment (0-0-0)**

The starting of the cooperative work in the summer just preceding the senior year. Description as given in COE 351.

**Prerequisite:** ENGL 214 and the completion of 90 credit hours + Department requirements.

### **COE 351 COE Cooperative Work (0-0-9)**

A continuous period of 28 weeks spent in industry with the purpose of acquiring practical experience in different areas of Computer Engineering. During this period, a student is exposed to the profession of Computer Engineering by working in the field. Students are required to submit a final report and give a presentation about their experience and the knowledge they gained during their cooperative work.

**Prerequisite:** COE 350 if registering in the Fall semester, and ENGL 214 + Completion of 90 Credits + Department requirements if registering in Spring semester.

### **COE 352 End Cooperative Work (0-0-0)**

This course is the same as COE 350. The only difference is that COE 352 must be taken by students who start their co-op program during the second term of the academic year.

**Prerequisite:** COE 351

### **COE 353 Fundamentals of Computer Communications (3-0-3)**

Digital communications fundamentals. Voice and data transmission equipment. Communications channels. Data coding and modulation. Multiplexing. Modems. Transmission media. Data transmission codes and protocols. Software packages. Data networks. Planning and design of communication networks.

**Prerequisite:** Junior standing.

**Note:** This course is *NOT open for COE students*.

### **COE 360 Principles of VLSI Design (3-0-3)**

MOS Transistor operation and limitations, MOS digital logic circuits (NMOS & CMOS), static & dynamic logic, combinational and sequential circuits, propagation delay, transistor sizing, MOS IC fabrication, layout and design rules, stick diagrams, IC Design and Verification Tools, subsystem design and case studies, and practical considerations.

**Prerequisite:** EE 203.

### **COE 385 Personal Computers (2-3-3)**

Overview of system features and components. Microprocessor types and specifications. Motherboards, bus slots and I/O cards, memory, power supply, input devices, video display hardware, and audio hardware. Floppy disk, hard disk, and CD-ROM drives and controllers. Network cards. Preventive maintenance, backups, and warranties. Software and hardware diagnostic tools. Software and hardware troubleshooting. Applications.

**Prerequisite:** Junior standing.

### **COE 390 Seminar (1-0-1)**

The purpose of this course is to help improve students' ability for presenting their technical work. In addition, the course emphasizes the various social and ethical responsibilities of the computing professional. It teaches students about the nature of engineering as a profession, codes of professional conduct, ethics & responsibility, and the role of professional societies. Case studies of conflict between engineering professional ethical values and external demands. The course features students participation in discussions held by faculty members and invited guests.

**Prerequisite:** Junior standing.

**COE 399 Summer Training (0-0-0)**

The aim of the summer training is to provide students with direct on-the-job experience working with professionals in the field. This training provides an opportunity to expose students to the reality of professional practice. Students are required to submit a report and make a presentation on their summer training experience and the knowledge gained.

Prerequisite: ENGL 214, junior standing, and approval of the department.

**COE 400: System Design Laboratory (1-6-3)**

This is a project-oriented course to integrate student's hardware and software knowledge through the design, implementation, debugging and documentation of one major system. Hardware design cycle, design principles: top down/bottom up, divide and conquer, and modular design techniques. Students are expected to work in teams to come up with a final working system where they learn to make design decisions weighing various engineering factors and tradeoffs, e.g cost/performance, and hardware/software.

**Prerequisite:** COE 305 and senior standing.

**COE 402 Computer System Performance Evaluation (3-0-3)**

Introduction to computer system performance analysis and evaluation. Review of basic probability distributions and basic concepts of statistics. Performance measures and measurement techniques. Performance analysis, performance prediction, asymptotic bounds on performance. Simulation and modeling of computer systems. Experimental and analytical approaches. Introduction to queuing network modeling. Case studies.

**Prerequisite:** STAT 319 or consent of instructor.



**COE 405: HDL Modeling of Digital Systems (3-0-3)**

Design methodology. Basics of hardware modeling. Modeling concurrency and timing aspects. Hardware modeling at the behavioral, structural, and RTL/data flow levels. System level modeling and design of practical processors, controllers, arithmetic units, etc. Translation of instruction sets to hardware models for software emulation. Case studies.

**Prerequisite:** COE 308 or Consent of Instructor.

**COE 409 Special Topics in Comp. Arch. & Dig. Sys. Design (3-0-3)**

Special topics in issues related to computer architecture and digital systems design. Topics and specifics will be announced well before the course starting date.

**Prerequisite:** COE 308.

**COE 410: Design of Sequential Systems (3-0-3)**

Finite state machines, state minimization and assignment, hardware description language and RTL level modeling. Design of arithmetic circuits considering area-speed tradeoff of sequential multipliers and dividers, floating point addition and multiplication and pipelined design techniques. Design and analysis of asynchronous logic: analysis and design of fundamental mode circuits, reduction of state and flow tables, races, cycles, race-free assignment, and hazards.

**Prerequisite:** COE 308.

**COE 420 Parallel Computing (3-0-3)**

Introduction to parallel computing. Parallel architectures, MIMD, SIMD, interconnection topologies. Performance measures, speedup, efficiency, limitations of parallel processing. Parallel programming paradigms, shared memory, message passing, data parallel, data flow. Parallelizing compiler techniques, code and data partitioning, vectorization. Parallel programming environments and tools. Parallel algorithms examples.

**Prerequisite:** COE 308.

**COE 421 Fault-Tolerant Computing (3-0-3)**

Introduction to fault-tolerant computing (FTC). Goals of fault tolerance (FT). Design techniques to achieve FT. Evaluation of FT systems. Reliability modeling and analysis of FT systems. Availability modeling. Design of practical FT systems. Design of FT VLSI circuits. Introduction to testing.

**Prerequisite:** COE 308.

**COE 422 Real Time Systems (3-0-3)**

Fundamentals of real time systems design; scheduling, interrupts, process communication and synchronization. Design of real time systems. Decomposition of real time systems. Applications of real time systems. Instrumentation for real time applications. Real time operating systems. Case studies.

**Prerequisite:** COE 305.

**COE 423 Distributed Systems (3-0-3)**

Characterization of distributed systems, interprocess communication, client-server, remote procedure calls, logical and physical time, distributed coordination. File services, naming and directory services, distributed concurrency control, transactions and atomic commit problem. Case studies.

**Prerequisite:** Senior standing.

**COE 425 Cryptosystems: Theory and Design (3-0-3)**

Symmetric encryption techniques: substitution ciphers, transposition ciphers, AES, and key channel establishment. Asymmetric encryption techniques: Diffie-Hellman key-exchange protocol, the discrete logarithm problem, RSA, ElGamal, Rabin, and Elliptic curve cryptography. Data integrity and Authentication: Hash functions, and digital signatures. Cryptographic hardware processors: modulo multipliers, Montgomery technique, exponentiation and Galois field operations.

**Prerequisite:** COE 308 and ICS 252.

**COE 429 Special Topics in Parallel and Distributed Systems (3-0-3)**

Special topics in issues related to parallel and distributed systems. Topics and specifics will be announced well before the course starting date.

**Prerequisite:** Senior standing.

**COE 441 Local Area Networks (3-0-3)**

LAN media, topology, media access control (MAC), data link and physical layer protocols and internetworking. The IEEE 802 LAN standards are used as the basis for understanding LAN technology. An in-depth analysis is presented of the basic IEEE LAN standards: IEEE 802.2 logical link control protocol and the MAC protocols for the contention bus (802.3) and token ring (802.5) networks. An analysis of the MAC protocols for high speed LANs is presented including the ANSI X3T9.5 Fiber Distributed Data Interface (FDDI) LAN and the IEEE standards for 100 Mbps LANs: 802.3u Fast Ethernet. The newest standard for very high speed Ethernet, the 802.3z Gigabit Ethernet is explored. New and emerging techniques for wireless LANs will be discussed including 802.11b/a. Fiber-based LAN technologies are presented including ATM LAN Emulation (LANE) and Fibre Channel. Virtual local area networks (VLAN) and virtual private networks (VPN) are explored. Finally, general performance figures evaluation for local area networks and design issues are discussed.

**Prerequisite:** COE 344 or Consent of Instructor.

**COE 443 Advanced WAN Communications (3-0-3)**

Circuit Switching Principles, Signaling and Control in Circuit Switching Networks, Packet Switching Principles, X.25 VC services, Packet Format and Multiplexing, Frame Relay Networks Architecture, ATM Architecture & Logical Connections, ATM Services, AAL Services & Protocols, ISDN Channels & Protocols, B-ISDN, Traffic Engineering & Performance Concepts, Queuing Models, Self-Similar Traffic, Impact on Packet Switching Networks Performance, Congestion Control & Traffic Management in ATM and FR Networks, WAN Physical Layer Technologies: SONET/SDH Standards, WDM Networks, Satellite Networks.

**Prerequisite:** COE 344 or Consent of Instructor.

### **COE 444 Internetwork Design and Management (3-0-3)**

Types of computer networks. Principles of internetworking. The network development life cycle. Network analysis and design methodology. Internetworking hardware. Connectionless internetworking. Connection-oriented internetworking. Routing strategies. Structured wiring and backbone design. OSI internetworking. Network management (SNMP). Network security and firewalls. Network administration. Case studies.

**Prerequisite:** COE 344 or Consent of Instructor.

### **COE 445 Internet Information Services (3-0-3)**

Electronic mail and file transfer. Information retrieval services and tools. Multimedia applications: Computer Supported Cooperative Work (CSCW); audio-video conferencing; networked hypertext and hypermedia; visual cyberspace; networking requirements of multimedia applications. World Wide Web (WWW) page and program development. The HyperText Markup Languages and the HyperText Transfer Protocols. Common Gateway Interfaces, Java and Java Script language. Web page style and design.

**Prerequisite:** COE 344 or Consent of Instructor.

**COE 446 Mobile Computing (3-0-3)**

Introduction to mobile computing. Designing computer networks to support user mobility. Models for indoor and outdoor mobile networks. System issues such as performance, quality of service, reliability, and security in mobile computing environment. Hardware, and access protocols, for mobile networks. Adapting existing protocols to support mobility.

**Prerequisite:** COE 344 or Consent of Instructor.

**COE 447 Fundamentals of Optical Networking (3-0-3)**

Passive and Active Optical Components. Optical Modulation and Demodulation. Transmission System Design. SONET/SDH and other Client Layers. WDM Networks. Control and Management. Survivability and Resiliency. Access Technologies. Photonic Packet Switching

**Prerequisite:** COE 344 or Consent of Instructor.

**COE 449 Special Topics in Computer Communications and Networking (3-0-3)**

Special topics in issues related to computer communication networks. Topics and specifics will be announced well before the course starting date.

**Prerequisite:** COE 344 or consent of instructor.

**COE 451: Computer and Network Security (3-0-3)**

Introduction to cryptography and its application to information, network and systems security; security threats; secret key and public key cryptographic algorithms; hash functions; basic number theory; authentication; security for Electronic mail, the Internet and computer networks; real world security applications.

**Prerequisite:** COE 344 or Consent of Instructor.

**COE 460 Advanced Digital Electronics (3-0-3)**

Sub-micron CMOS technology, BiCMOS process technology, device design considerations, device modeling, BiCMOS digital integrated circuits, BiCMOS digital circuit applications, GaAs process technology, device design, and digital logic design. Comparison between CMOS, BiCMOS, and GaAs performance. Future trends.

**Prerequisite:** COE 360

### **COE 462 Design Automation of VLSI Circuits (3-0-3)**

Introduction to computer-aided design of integrated circuits. Design approaches, design steps and corresponding design automation problems and tools. Logical and physical partitioning. Solution techniques for floorplanning, placement, global routing and detailed routing. Strategies for grid and channel routing. Layout generation problem and solutions. Symbolic layout, layout editors and compaction. Silicon compilation.

**Prerequisite:** COE 360 or consent of instructor.

### **COE 464 Testing of Digital Circuits (3-0-3)**

Introduction to the testing problem, fault modeling, e.g., stuck-at, bridging, transistor-open and transistor-short faults. Fault simulation, gate-level testing, automatic test pattern generation (ATPG) algorithms. Testing of regular structures. Testing of sequential circuits. Signature analysis. Design-for-testability (DFT).

**Prerequisite:** Senior standing.

### **COE 465 VLSI System Design Methodology (3-0-3)**

VLSI MOS system design. Layout and design rules, layout graphic editors, design rule checking, layout extraction and verification (LVS). Full custom versus semicustom design styles. Design entry tools, schematic capture and HDLs. Logic and switch level simulation. Static timing analysis concepts and tools. Concepts and tools in floorplanning, placement and routing, layout generation and design synthesis. The course stresses hands-on experience of VLSI design using CAD tools.

**Prerequisite:** COE 360.

### **COE 469 Special Topics in VLSI and Design Automation (3-0-3)**

Special topics in issues related to the VLSI technology. Topics and specifics will be announced well before the course starting date.

**Prerequisite:** COE 360 or Consent of Instructor.

### **COE 484 Introduction to Robotics (3-0-3)**

Introduction to Robotics. Motion coordination, configuration space and task space. Mathematical operators, direct and inverse geometric method, direct and inverse variational method. Robot programming, effector-level and object-level, and applications. Practice of robot programming. Introduction to sensors systems and robotics vision. Architectural aspects of robotics systems.

**Prerequisite:** Senior standing.

### **COE 485 Senior Design Project (1-6-3)**

This course is designed to give students the experience of tackling a realistic engineering problem. The intent is to show how to put theoretical knowledge gained into practical use by starting from a word description of a problem and proceeding through various design phases to end up with a practical engineering solution. Various projects are offered by COE faculty in their respective specialization areas.

The project advisor guides the student in conducting feasibility study, preparation of specifications, and the methodology for the design. Detailed design and implementation of the project are carried out followed by

testing, debugging, and documentation. An oral presentation and a final report are given at the end of the semester.

**Prerequisite:** Senior standing.

### **COE 486 Multimedia Architectures and Communications**

Multimedia information representation (text, audio, image and video). Compression techniques and standards. Multimedia Storage and Retrieval. Standards for Multimedia Communications. Multimedia Real time streaming and Synchronization in Multimedia Systems. Multimedia and Entertainment Networks, Video on Demand Systems, Quality of Service (QoS).

**Prerequisite:** COE 341.

### **COE 487 Computer Vision Processing**

Introduction to vision processing. Illumination and imaging techniques. Planar and stereo-vision, pixel representation, preprocessing, smoothing, enhancement, and equalization. Edge detection, gradient, Laplacian, and thresholding. Segmentation, linear, polygonal, and Fourier descriptors. Introduction to 3D structures. Shape matching, search approaches, interpretation, and recognition.

**Prerequisite:** Senior standing.

**COE 488 Data Acquisition Interfacing (3-0-3)**

Data acquisition systems, basic sampling concepts, data collection fundamentals. Interfaces. Special instruments. IEEE 488 standard. RS 232C data acquisition software technique. I/O operation queuing. Hardware for data acquisition systems. Multibus. VME bus. Examples and designs.

**Prerequisite:** COE 305.

**COE 499 Special Topics in Computer Engineering (3-0-3)**

Special topics in issues related to computer engineering. Topics and specifics will be announced well before the course starting date.

**Prerequisite:** Senior standing.

## The COE Degree Elective Courses

### List of COE electives

- ❖ Any COE 4xx course

### List of IT electives

- ❖ Any COE 4xx course, **or**
- ❖ ICS 334 Database Systems, **or**
- ❖ ICS 353 Design and Analysis of Algorithms, **or**
- ❖ ICS 413 Software Engineering

### List of General Electives

- ARE 221 Computer Applications in Building Design
- ARE 443 Computer-Aided Building Design
- ARE 444 Knowledge-Based Systems in Buildings
- CHE 453 Mathematical Methods in Chemical Engineering
- ECON 403 Engineering Economics
- EE 207 Signals and Systems
- EE 303 Electronics II
- EE 340 Electromagnetics
- EE 370 Communications Engineering I
- EE 380 Control Engineering I
- EE 406 Digital Signal Processing
- EE 415 Analog Integrated Circuits and Design
- EE 417 Communication Engineering II
- EE 420 Optical Fiber Communications
- EE 430 Information Theory & Coding
- EE 432 Digital Control Systems
- EE 433 Applied Control Engineering
- MATH 301 Methods of Applied Mathematics
- MATH 311 Advanced Calculus I
- MATH 321 Introduction to Numerical Computing
- MATH 421 Introduction to Topology
- MATH 425 Graph Theory
- MATH 430 Introduction to Complex Variables
- MATH 442 Calculus of Variations Optimal Control
- MATH 460 Applied Matrix Theory
- MATH 465 Ordinary Differential Equations
- MATH 470 Partial Differential Equations
- MATH 471 Numerical Analysis I
- MATH 472 Numerical Analysis II



- MATH 480 Linear & Nonlinear Programming
- MGT 301 Principles of Management
- MIS 301 Business Systems Analysis and Design I
- MIS 401 Business Systems Analysis and Design II
- MIS 490 Information Resources Management
- PETE 402 Reservoir Simulation
- PHYS 201 General Physics III
- PHYS 211 Optics
- PHYS 212 Modern Physics
- PHYS 215 Introduction to Astronomy
- PHYS 234 How Things Work
- PHYS 301 Classical Mechanics I
- PHYS 302 Classical Mechanics II
- PHYS 303 Experimental Physics I
- PHYS 304 Experimental Physics II
- PHYS 373 Introduction to Computational Physics
- SE 301 Numerical Methods
- SE 303 Operations Research I
- SE 305 Optimization Methods
- SE 312 Instrumentation
- SE 320 Quality Control and Industrial Statistics
- SE 325 Engineering Statistics
- SE 405 Stochastic Systems Simulation
- SE 421 Operations Research II
- SE 438 Instrumentation for Process Control
- STAT 320 Statistical Quality Control
- STAT 355 Demographic Methods
- STAT 361 Operations Research I
- STAT 415 Stochastic Processes
- STAT 430 Experimental Design
- STAT 460 Time Series
- STAT 461 Operations Research II
- **or** approval of department council

### **List of Free electives**

*Any of the general elective courses:*

- GS 3xx or GS 4xx courses, **or**
- approval of department council.