

**King Fahd University of Petroleum & Minerals  
College of Computer Sciences and Engineering  
Information and Computer Science Department**

Software Engineering Student Guide

Sep 3, 2013

Version 3.3

## Revision History

| Date       | Version | Description   | Author(s)            |
|------------|---------|---|----------------------|
| 2012-10-31 | 3.1     | Added “*” to ICS 343 to show the lab in the pre-requisite chart | M. Alshayeb          |
| 2012-11-25 | 3.2     | Updated Free Elective   | M. Niazi, S. Mahmood |
| 2013-9-3   | 3.3     | Updated Free Elective   | M. Niazi, S. Mahmood |
| 2013-11-14 | 3.2     | Updated Free Elective   | M. Niazi             |
| 2014-11-26 |         | Updated Free Elective   | M. Niazi             |

**Introduction**

The Department of Information and Computer Science offers a BS in Software Engineering. The current program was revised and approved in April 2008. The program is in full compliance with IEEE/ACM Software Engineering SE2004 guidelines and meets the Engineering Accreditation Criteria (EAC).

**ICS Department Vision**

The vision of the ICS department is to be a regional leader that is recognized worldwide in education, research and professional development in the areas of Computer Science and Software Engineering.

**Software Engineering Program Goal**

Our goal has been, and continues to be, a high quality degree program in Software Engineering that prepares students for lifelong learning as they undertake professional careers in computing. The program prepares students to work as requirements engineer, software architect, software design engineer, software quality engineer, software developer, software test engineer, or software engineering project manager.

**Software Engineering Program Mission**

To bring forth competent Software Engineers with a strong understanding of computer science bodies of knowledge and theories, who can apply sound engineering principles and methods to the cost-effective creation, development, operation, and maintenance of high-quality software and are prepared for lifelong learning.

**Software Engineering Program Objectives**

The graduates of the software engineering program shall be able to:

**1. Contributing Citizens**

*Graduates of the SWE program at KFUPM will meet the needs of local software engineering industry and will be contributing members of the society.*

**2. Leadership**

*Graduates of the SWE program at KFUPM will exhibit leadership in technical and business environment.*

**3. Self-Professional Development**

*Graduates of the SWE program at KFUPM will be adapting and adjusting to the rapid advancements and technological changes in the Software Engineering discipline.*

**Software Engineering Program Learning Outcomes:**

The software engineering program enables students, by the time of graduation, to achieve the ability to:

1. Apply their knowledge of mathematics, sciences, and computer science to the modeling, analysis, and measurement of software artifacts.
2. Work effectively as leader/member of a development team to deliver quality software artifacts.
3. Analyze, specify and document software requirements for a software system.
4. Develop alternative design solutions to a given problem and recommend the best one within limitations of cost, time, knowledge, existing systems, and organizations.
5. Implement a given software design using sound development practices.
6. Verify, validate, assess and assure the quality of software artifacts.
7. Design, select and apply the most appropriate software engineering process for a given project, plan for a software project, identify its scope and risks, and estimate its cost and time.
8. Express and understand the importance of negotiation, effective work habits, leadership, and good communication with stakeholders, in written and oral forms, in a typical software development environment.
9. Understand the impact of computing solutions in a global and societal context.
10. Recognize and be guided by the social, professional, legal, ethical issues involved in the use and development of computer & software technology.
11. Keep abreast of current developments in the discipline to continue their own professional development and life-long learning.
12. Employ appropriate methods and tools for the specification, design, implementation, and evaluation of software systems.

## The Program Requirements

### a. General Education Requirements (52 credits)

|                   |              |              |              |             |
|-------------------|--------------|--------------|--------------|-------------|
| Basic Science     | CHEM 101(4), | PHYS 101(4), | PHYS 102(4)  |             |
| Mathematics       | MATH 101(4), | MATH 102(4), | MATH 201(3), |             |
| Statistics        | STAT 319(3)  |              |              |             |
| Isla. & Ara. Stu. | IAS 101(2),  | IAS 111(2),  | IAS 201(2),  | IAS 212(2), |
|                   | IAS 301(2),  | IAS 322(2)   |              |             |
| English           | ENGL 101(3), | ENGL 102(3), | ENGL 214(3)  |             |
| SE                | ISE 307(3)   |              |              |             |
| Physical Edu.     | PE 101(1),   | PE 102(1)    |              |             |

### b. Core Requirements (65 credits)

|     |             |             |             |             |
|-----|-------------|-------------|-------------|-------------|
| SWE | SWE 205(3), | SWE 215(3), | SWE 312(3), | SWE 316(3), |
|     | SWE 326(3), | SWE 363(3)  | SWE 387(3)  | SWE 417(3), |
|     | SWE 418(2)  |             |             |             |
| ICS | ICS 102(3), | ICS 201(4), | ICS 202(4), | ICS 233(4), |
|     | ICS 253(3), | ICS 254(3), | ICS 324(4), | ICS 343(4)  |
|     | ICS 353(3), | ICS 431(4)  |             |             |
| COE | COE 202(3)  |             |             |             |

### c. Elective (15 credits)

|                   |                 |                 |                 |
|-------------------|-----------------|-----------------|-----------------|
| SWE/ICS Electives | SWE/ICS xxx(3), | SWE/ICS xxx(3), | SWE/ICS xxx(3), |
| Free Electives    | XE xxx(3),      | XE xxx(3)       |                 |

### d. Summer Training (Pass/Fail grade; No credits)

The prerequisites for summer training:

- Student is currently enrolled in the university.
- Student has completed 65 credits or more (including current semester)
- Students has completed or currently doing ENGL 214 and SWE 363.
- Summer training is not in the last semester for the student at the university.

Every student is required to participate in a summer training program of real practical experience, submit a formal written report and make a presentation.

### e. Total Requirements

The total required credits for the BS degree in Software Engineering are 132 semester-credit-hours.

**Curriculum**  
BS (Software Engineering) Program

| Course  |     | Title                          | LT | LB | CR | Course |     | Title                     | LT | LB | CR |
|---|-----|--------------------------------|----|----|----|--------|-----|---------------------------|----|----|----|
| <b>First Year (Preparatory)</b>                         |     |                                |    |    |    |        |     |                           |    |    |    |
| ENGL  | 001 | Preparatory English I          | 15 | 5  | 8  | ENGL   | 002 | Preparatory English II    | 15 | 5  | 8  |
| MATH  | 001 | Preparatory Math I             | 3  | 1  | 4  | MATH   | 002 | Preparatory Math II       | 3  | 1  | 4  |
| ME  | 003 | Preparatory Engg. Tech.        | 0  | 2  | 1  | PYP    | 001 | Prep Physical Science     | 2  | 0  | 2  |
| PYP   | 002 | Prep Computer Science          | 0  | 2  | 1  | PYP    | 003 | University Study Skill    | 0  | 2  | 1  |
| PE  | 001 | Prep Physical Educ. I          | 0  | 2  | 1  | PE     | 002 | Prep Physical Educ. II    | 0  | 2  | 1  |
|   |     |                                | 18 | 12 | 15 |        |     |                           | 20 | 10 | 16 |
| <b>Total Credit required in Preparatory Program: 31</b> |     |                                |    |    |    |        |     |                           |    |    |    |
| <b>Second Year (Freshman)</b>                           |     |                                |    |    |    |        |     |                           |    |    |    |
| 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  |
| ENGL  | 101 | An Intro to Academic Discourse | 3  | 0  | 3  | ENGL   | 102 | Intro to Report Writing   | 3  | 0  | 3  |
| CHEM  | 101 | General Chemistry I            | 3  | 4  | 4  | ICS    | 102 | Intro. To Computing I     | 2  | 3  | 3  |
| IAS   | 101 | Practical Grammar              | 2  | 0  | 2  | IAS    | 111 | Belief & its Consequences | 2  | 0  | 2  |
| PE  | 101 | Physical Education I           | 0  | 2  | 1  | PE     | 102 | Physical Education II     | 0  | 2  | 1  |
|   |     |                                | 15 | 9  | 18 |        |     |                           | 14 | 8  | 17 |
| <b>Third Year (Sophomore)</b>                           |     |                                |    |    |    |        |     |                           |    |    |    |
| SWE   | 205 | Introduction to SW Eng.        | 3  | 0  | 3  | ICS    | 202 | Data Structures           | 3  | 3  | 4  |
| ICS   | 201 | Intro. To Computing II         | 3  | 3  | 4  | SWE    | 215 | SW Requirements Eng.      | 2  | 3  | 3  |
| COE   | 202 | Digital Logic Design           | 3  | 0  | 3  | ICS    | 233 | Comp. Arch.& As. Lang     | 3  | 3  | 4  |
| MATH  | 201 | Calculus III                   | 3  | 0  | 3  | ICS    | 254 | Discrete Structures II    | 3  | 0  | 3  |
| ICS   | 253 | Discrete Structures I          | 3  | 0  | 3  | IAS    | 201 | Writing for Prof. Needs   | 2  | 0  | 2  |
|   |     |                                | 15 | 3  | 16 |        |     |                           | 13 | 9  | 16 |
| <b>Fourth Year (Junior)</b>                             |     |                                |    |    |    |        |     |                           |    |    |    |
| SWE   | 312 | User-Interface Design          | 3  | 0  | 3  | SWE    | 326 | SW Testing & QA           | 3  | 0  | 3  |
| SWE   | 316 | SW Design and Arch.            | 3  | 0  | 3  | SWE    | 363 | Web Eng. & Development    | 3  | 0  | 3  |
| ICS   | 324 | Database Systems               | 3  | 3  | 4  | SWE    | 387 | Software Project mgt.     | 3  | 0  | 3  |
| STAT  | 319 | Prob.& Stat. for Engrs         | 2  | 3  | 3  | ICS    | 343 | Fund. of Comp NW          | 3  | 3  | 4  |
| IAS   | 212 | Professional Ethics            | 2  | 0  | 2  | IAS    | 322 | Human Rights in Islam     | 2  | 0  | 2  |
|   |     |                                |    |    |    | ENGL   | 214 | Academic & Prof Comm      | 3  | 0  | 3  |
|   |     |                                | 13 | 6  | 15 |        |     |                           | 17 | 3  | 18 |
| <b>Fifth Year (Senior)</b>                              |     |                                |    |    |    |        |     |                           |    |    |    |
| SWE   | 417 | SWE Project I                  | 1  | 6  | 3  | SWE    | 418 | SWE Project II            | 0  | 6  | 2  |
| XE  | xxx | (Elective I)                   | 3  | 0  | 3  | ICS    | 431 | Operating Systems         | 3  | 3  | 4  |
| ICS   | 353 | Design and Anal of Algo.       | 3  | 0  | 3  | SWE    | xxx | (SWE/ICS Elective II)     | 3  | 0  | 3  |
| ISE   | 307 | Eng. Economics Analysis        | 3  | 0  | 3  | SWE    | xxx | (SWE/ICS Elective III)    | 3  | 0  | 3  |
| SWE   | xxx | (SWE/ICS Elective I)           | 3  | 0  | 3  | IAS    | 301 | Oral Comm. Skills         | 2  | 0  | 2  |
|   |     |                                |    |    |    | XE     | xxx | (Elective II)             | 3  | 0  | 3  |
|   |     |                                | 13 | 6  | 15 |        |     |                           | 14 | 9  | 17 |
| <b>Total credits required in Degree Program: 132</b>    |     |                                |    |    |    |        |     |                           |    |    |    |

## SWE Courses Summary

### A. Core

#### A.1: SWE Courses

|    |         |                                      |   |   |   |
|----|---------|--------------------------------------|---|---|---|
| 1. | SWE 205 | Introduction to Software Engineering | 3 | 0 | 3 |
| 2. | SWE 215 | Software Requirement Engineering     | 2 | 3 | 3 |
| 3. | SWE 312 | User-Interface Design                | 3 | 0 | 3 |
| 4. | SWE 316 | Software Design and Architecture     | 3 | 0 | 3 |
| 5. | SWE 326 | SW Testing & Quality Assurance       | 3 | 0 | 3 |
| 6. | SWE 363 | Web Engineering & Development        | 3 | 0 | 3 |
| 7. | SWE 387 | Software Project management          | 3 | 0 | 3 |
| 8. | SWE 417 | Software Engineering Project I       | 1 | 6 | 3 |
| 9. | SWE 418 | Software Engineering Project II      | 0 | 6 | 2 |

#### SUB TOTAL:

**26 Credits**

#### A.1: CS Courses

|     |         |   |   |   |   |
|-----|---------|---|---|---|---|
| 1.  | ICS 102 | Introduction to Computing I                 | 2 | 3 | 3 |
| 2.  | ICS 201 | Introduction to Computing II                | 3 | 3 | 4 |
| 3.  | ICS 202 | Data Structures                             | 3 | 3 | 4 |
| 4.  | ICS 233 | Computer Architecture and Assembly Language | 3 | 3 | 4 |
| 5.  | ICS 253 | Discrete Structures I                       | 3 | 0 | 3 |
| 6.  | ICS 254 | Discrete Structures II                      | 3 | 0 | 3 |
| 7.  | ICS 324 | Database Systems                            | 3 | 3 | 4 |
| 8.  | ICS 343 | Fundamentals of Computer Networks           | 3 | 3 | 4 |
| 9.  | ICS 353 | Design and Analysis of Algorithms           | 3 | 0 | 3 |
| 10. | ICS 431 | Operating Systems                           | 3 | 3 | 4 |

#### SUB TOTAL:

**36 Credits**

#### A.2: COE Courses

|    |         |                      |   |   |   |
|----|---------|----------------------|---|---|---|
| 1. | COE 202 | Digital Logic Design | 3 | 0 | 3 |
|----|---------|----------------------|---|---|---|

#### SUB TOTAL:

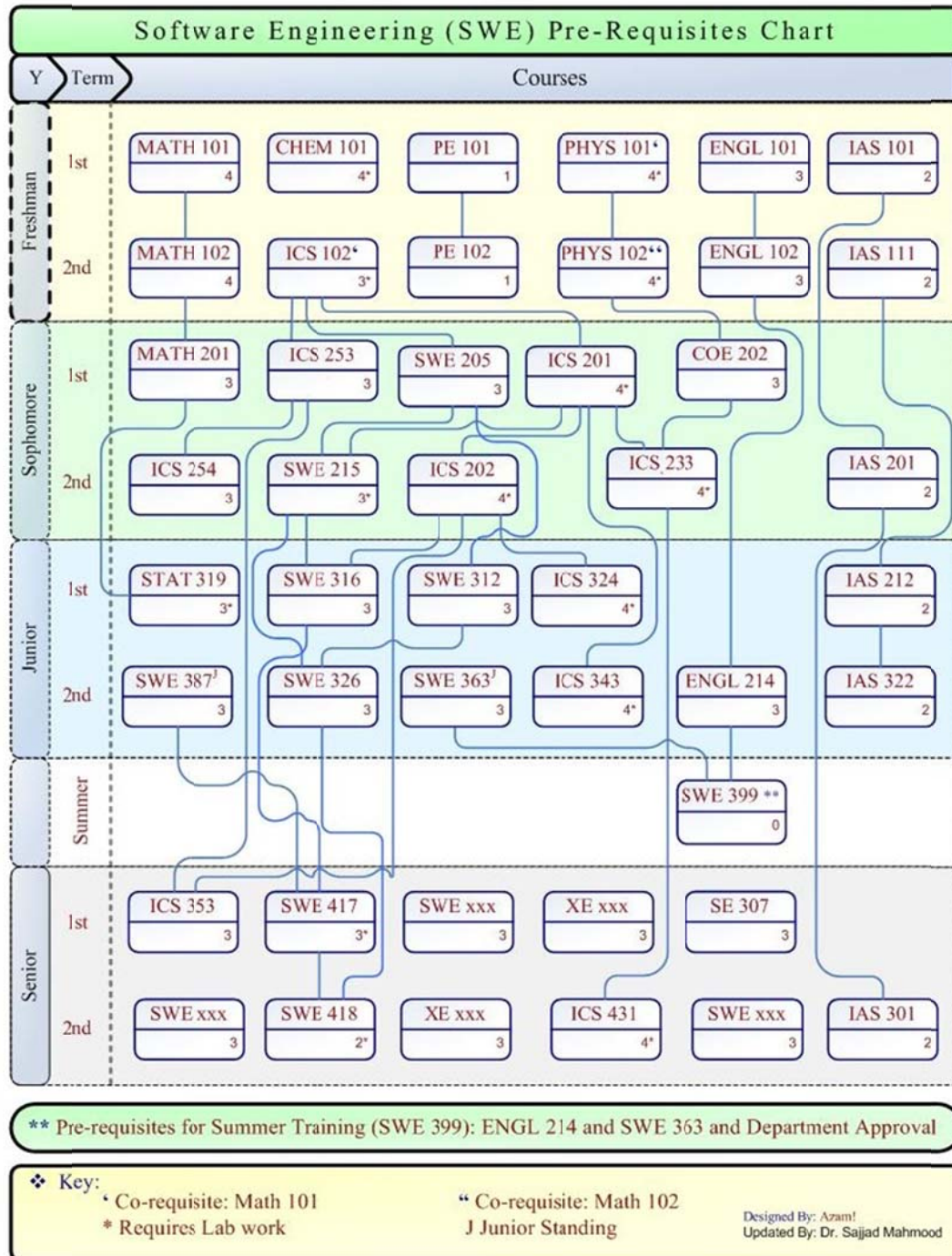
**3 Credits**

### B. Electives

ICS 300 - ICS 499 and SWE 300 - SWE 499 courses

#### SUB TOTAL (3 SWE/ICS Electives):

**9 Credits**



### Approved Free Electives for the Software Engineering Program

| #   | Course #  | Course Name  | College                          |
|-----|-----------|--|----------------------------------|
| 1.  | ACCT 201  | Principles of Accounting I                           | College of Industrial Management |
| 2.  | ACCT 202  | Principles of Accounting II                          | College of Industrial Management |
| 3.  | AE 220    | Introduction to Aerospace Engineering                | College of Engineering Sciences  |
| 4.  | AE 325    | Gas Dynamics I                                       | College of Engineering Sciences  |
| 5.  | AE 333    | Aerodynamics I                                       | College of Engineering Sciences  |
| 6.  | AE 313    | AE Systems and Control                               | College of Engineering Sciences  |
| 7.  | AE 426    | Flight Dynamics I                                    | College of Engineering Sciences  |
| 8.  | AE 427    | Aerospace System Design                              | College of Engineering Sciences  |
| 9.  | AE 403    | Aerospace Materials                                  | College of Engineering Sciences  |
| 10. | AE 410    | Astronautics   | College of Engineering Sciences  |
| 11. | AE 414    | Flight and Air Traffic Control                       | College of Engineering Sciences  |
| 12. | AE 415    | Flight and Aviation Safety                           | College of Engineering Sciences  |
| 13. | AE 416    | Flight and Aviation Management                       | College of Engineering Sciences  |
| 14. | AE 417    | Flight and Aviation Law                              | College of Engineering Sciences  |
| 15. | AE 418    | Flight and Aviation Economics                        | College of Engineering Sciences  |
| 16. | ARC – 124 | Computer Aided Architectural Design                  | Environmental Design             |
| 17. | ARC – 225 | Virtual Reality in Architecture                      | Environmental Design             |
| 18. | ARE – 211 | Building Materials                                   | Environmental Design             |
| 19. | ARE 212   | Construction Systems                                 | Environmental Design             |
| 20. | ARE 413   | Construction Management                              | Environmental Design             |
| 21. | ARE 431   | Building Economy                                     | Environmental Design             |
| 22. | CHE 201   | Introduction to Chemical Engineering                 | College of Engineering Sciences  |
| 23. | CHE 203   | Chemical Engineering Thermodynamics I                | College of Engineering Sciences  |
| 24. | CE 201    | Statics  | College of Engineering Sciences  |
| 25. | CE 203    | Structural Mechanics I                               | College of Engineering Sciences  |
| 26. | CE 215    | Computer Graphics                                    | College of Engineering Sciences  |
| 27. | CE 230    | Engineering Fluid Mechanics                          | College of Engineering Sciences  |
| 28. | CE 318    | Numerical & Statistical Methods in Civil Engineering | College of Engineering Sciences  |

|     |                |   |   |
|-----|----------------|---|---|
| 29. | CE 332         | Engineering Hydrology and Hydraulics      | College of Engineering Sciences           |
| 30. | CE 330         | Environmental Engineering Principles      | College of Engineering Sciences           |
| 31. | CE 341         | Transportation Engineering                | College of Engineering Sciences           |
| 32. | CE 420         | Construction Engineering                  | College of Engineering Sciences           |
| 33. | CHEM 102       | General Chemistry II                      | College of Science                        |
| 34. | CHEM 431       | Chemistry of the Environment              | College of Science                        |
| 35. | CISE 301       | Numerical Methods                         | College of Computer Science & Engineering |
| 36. | COE 308        | Computer Architecture                     | College of Computer Science & Engineering |
| 37. | COE341/COE 342 | Data & Computer Communication             | College of Computer Science & Engineering |
| 38. | COE 402        | Computer System Performance Evaluation    | College of Computer Science & Engineering |
| 39. | COE 403        | Advanced Microprocessor Architecture      | College of Computer Science & Engineering |
| 40. | COE 405        | Design and Modeling Digital Systems       | College of Computer Science & Engineering |
| 41. | COE 420        | Parallel Computing                        | College of Computer Science & Engineering |
| 42. | COE 443        | High Speed Networks                       | College of Computer Science & Engineering |
| 43. | COE 445        | Internet Information Services             | College of Computer Science & Engineering |
| 44. | COE 484        | Introduction to Robotics                  | College of Computer Science & Engineering |
| 45. | COE 488        | Data Acquisition Interfacing              | College of Computer Science & Engineering |
| 46. | ISE 303        | Operations Research                       | College of Computer Science & Engineering |
| 47. | ISE 304        | Principles of Industrial Costing          | College of Computer Science & Engineering |
| 48. | ISE 320        | Quality Control and Industrial Statistics | College of Computer Science & Engineering |
| 49. | ISE 323        | Work and Process Improvements             | College of Computer Science & Engineering |
| 50. | ISE 405        | Stochastic Systems and Simulations        | College of Computer Science & Engineering |
| 51. | ISE 420        | Quality Improvement Methods               | College of Computer Science & Engineering |
| 52. | ISE 421        | Operation Research II                     | College of Computer Science & Engineering |
| 53. | ISE 443        | Human Factors Engineering                 | College of Computer Science & Engineering |
| 54. | ISE 447        | Decision Making                           | College of Computer Science & Engineering |
| 55. | ISE 460        | Industrial Process Re-Engineering         | College of Computer Science & Engineering |
| 56. | ISE 464        | Industrial Information Systems            | College of Computer                       |

|     |          |   |   |
|-----|----------|---|---|
|     |          |   | Science & Engineering                     |
| 57. | ISE 480  | Reliability and Maintainability                         | College of Computer Science & Engineering |
| 58. | MATH 202 | Elements of Differential Equations                      | College of Science                        |
| 59. | MATH 232 | Introduction to Sets and Structures                     | College of Science                        |
| 60. | MATH 260 | Introduction to Differential Equations & Linear Algebra | College of Science                        |
| 61. | MATH 280 | Introduction to Linear Algebra                          | College of Science                        |
| 62. | MATH 301 | Methods of Applied Mathematics                          | College of Science                        |
| 63. | MATH 302 | Engineering Maths                                       | College of Science                        |
| 64. | MATH 305 | Development of Mathematics                              | College of Science                        |
| 65. | MATH 311 | Advanced Calculus I                                     | College of Science                        |
| 66. | MATH 321 | Introduction to Numerical Computing                     | College of Science                        |
| 67. | MATH 330 | Euclidean and Non-Euclidean Geometry                    | College of Science                        |
| 68. | MATH 345 | Modern Algebra I  | College of Science                        |
| 69. | MATH 335 | Linear Algebra  | College of Science                        |
| 70. | MATH 411 | Advanced Calculus II                                    | College of Science                        |
| 71. | MATH 425 | Graph Theory  | College of Science                        |
| 72. | MATH 440 | Differential Geometry                                   | College of Science                        |
| 73. | MATH 480 | Linear & Nonlinear Programming                          | College of Science                        |
| 74. | STAT 301 | Introduction to Probability Theory                      | College of Science                        |
| 75. | STAT 302 | Statistical Inference                                   | College of Science                        |
| 76. | STAT 320 | Statistical Quality Control                             | College of Science                        |
| 77. | STAT 460 | Time Series   | College of Science                        |
| 78. | PHYS 211 | Optics  | College of Science                        |
| 79. | PHYS 212 | Modern Physics  | College of Science                        |
| 80. | PHYS 215 | Introduction to Astronomy                               | College of Science                        |
| 81. | PHYS 301 | Classical Mechanics I                                   | College of Science                        |
| 82. | GEOL 202 | Applied Geosciences for Scientists and Engineers        | College of Science                        |
| 83. | GEOL 303 | Sustaining the Earth                                    | College of Science                        |
| 84. | GEOP 202 | Introduction to Geophysics                              | College of Science                        |
| 85. | GS 220   | Information Searching Skills                            | College of Applied & Supporting Studies   |
| 86. | GS 221   | Work & Society  | College of Applied & Supporting Studies   |
| 87. | GS 318   | World Civilization                                      | College of Applied & Supporting Studies   |
| 88. | GS 321   | Principles of human behavior                            | College of Applied & Supporting Studies   |
| 89. | GS 355   | Cultural Anthropology                                   | College of Applied & Supporting Studies   |
| 90. | GS 434   | Mass Media and Society                                  | College of Applied & Supporting Studies   |
| 91. | GS 423   | International Relations                                 | College of Applied & Supporting Studies   |
| 92. | GS 424   | Planning and Social Development                         | College of Applied & Supporting Studies   |
| 93. | GS 420   | Personality Psychology                                  | College of Applied & Supporting Studies   |
| 94. | GS 427   | Human and Environment                                   | College of Applied &                      |

|      |          |  |   |
|------|----------|--|---|
|      |          |  | Supporting Studies                      |
| 95.  | GS 447   | Globalization                              | College of Applied & Supporting Studies |
| 96.  | ECON 101 | Principles of Economics I (MICRO)          | College of Industrial Management        |
| 97.  | ECON 202 | Principles of Economics II (MACRO)         | College of Industrial Management        |
| 98.  | MGT 210  | Business Communication                     | College of Industrial Management        |
| 99.  | MGT 301  | Principles of Management                   | College of Industrial Management        |
| 100. | MGT 311  | Legal Environment                          | College of Industrial Management        |
| 101. | MGT 410  | Human Resources Management                 | College of Industrial Management        |
| 102. | MIS 345  | Information Technology in Society          | College of Industrial Management        |
| 103. | MGT 410  | Organization Behavior and Design           | College of Industrial Management        |
| 104. | EE 200   | Digital Logic Circuit Design               | College of Engineering Sciences         |
| 105. | EE 201   | Electric Circuits I                        | College of Engineering Sciences         |
| 106. | EE 204   | Fundamentals of Electrical Circuits        | College of Engineering Sciences         |
| 107. | EE 205   | Electric Circuits II                       | College of Engineering Sciences         |
| 108. | EE 208   | Electrical Systems                         | College of Engineering Sciences         |
| 109. | EE 390   | Digital Systems Engineering                | College of Engineering Sciences         |
| 110. | ME 203   | Thermodynamics I                           | College of Engineering Sciences         |
| 111. | ME 204   | Thermodynamics II                          | College of Engineering Sciences         |
| 112. | ME 215   | Materials Science for Mechanical Engineers | College of Engineering Sciences         |

## Catalog Description of Courses

### **ICS 102 Introduction to Computing I (2-3-3)**

Overview of computers and computing. Introduction to a typical object-oriented programming language. Basic data types and operators. Basic object-oriented concepts. Wrapper classes. Console input/output. Logical expressions and control structures. Classes and methods. Arrays and strings.

**Co-requisite:** MATH 101 or MATH 132

### **ICS 201 Introduction to Computing II (3-3-4)**

Advanced object-oriented programming; inheritance; polymorphism; abstract classes and interfaces, container and collection classes, packages, object-oriented design, software modeling, event-driven programming, recursion, use of stacks, queues and lists from API, searching and sorting.

**Prerequisite:** ICS 102

### **ICS 202 Data Structures (3-3-4)**

Review of object-oriented concepts; Introduction to design patterns; Basic algorithms analysis; Fundamental data structures - implementation strategies for stacks, queues and linked lists; Recursion; Implementation strategies for tree and graph algorithms; Hash tables; Applications of data structures (e.g. data compression and memory management).

**Prerequisite:** ICS 201

### **ICS 233 Computer Architecture and Assembly Language (3-3-4)**

Machine organization; assembly language: addressing, stacks, argument passing, arithmetic operations, decisions, modularization; Input/Output Operations and Interrupts; Memory Hierarchy and Cache memory; Pipeline Design Techniques; Super-scalar architecture; Parallel Architectures.

**Prerequisite:** COE 202, ICS 201

### **ICS 253 Discrete Structures I (3-0-3)**

Propositional Logic, Predicate Logic, Sets, Functions, Sequences and Summation, Proof Techniques, Mathematical induction, Inclusion-exclusion and Pigeonhole principles, Permutations and Combinations (with and without repetitions), The Binomial Theorem, Recurrence Relations; Graphs terminology and applications, Connectivity, Isomorphism, Euler and Hamilton Paths and Circuits, Planarity and Coloring; Trees terminology and applications.

**Prerequisite:** ICS 102

### **ICS 254 Discrete Structures II (3-0-3)**

Number Theory: Modular Arithmetic, Integer Representation, Fermat's Little Theorem, Chinese Remainder Theorem, RSA.; Proof Techniques: Methods of Proofs, Applications from Number Theory, Recursive Definitions; Algorithm Correctness; Relations: Closures and Equivalence Relations, Partial Orderings and Lattices, Hasse Diagrams; Recurrence Relations and Generating Functions; Automata Theory: Finite State Machines, Regular Expressions, DFA, N DFA and their equivalence, Grammars and Chomsky Hierarchy, Introduction to Turing Machines.; Abstract Algebra: Groups, Homomorphisms and Lagrange's Theorem, Applications.

**Prerequisite:** ICS 253

**ICS 324 Database Systems (3-3-4)**

Basic database concepts, conceptual data modeling, relational data model, relational theory and languages, database design, SQL, introduction to query processing and optimization, and introduction to concurrency and recovery.

**Prerequisite:** ICS 202

**ICS 343 Fundamentals of Computer Networks (3-3-4)**

Introduction to computer networks and layered architectures: connectivity, topology, circuit and packet switching, TCP/IP and ISO models; Application layer: C/S model, DNS, SMTP, FTP, WWW, socket programming and network security; Transport layer: TCP and UDP, congestion control; Network layer: internetworking, addressing and routing algorithms and protocols; Data link layer: framing, flow and error control protocols, PPP, MAC and LANs; Physical layer: principles of data communications, circuit switching, coding, multiplexing and transmission media.

**Prerequisite:** ICS 201

**Note:** This course cannot be taken for credit with COE 344.

**ICS 353 Design and Analysis of Algorithms (3-0-3)**

Algorithms and Problem Solving; Basic Algorithmic Analysis; Advanced algorithmic analysis; Advanced Data Structures; Algorithmic strategies & Analysis of fundamental computing algorithms; Basic computability; The complexity classes P and NP.

**Prerequisites:** ICS 202 and ICS 253

**ICS 431 Operating Systems (3-3-4)**

This course introduces the fundamentals of operating systems design and implementation. Topics include history and evolution of operating systems; Types of operating systems; Operating system structures; Process management: processes, threads, CPU scheduling, process synchronization; Memory management and virtual memory; File systems; I/O systems; Security and protection; Distributed systems; Case studies.

**Prerequisite:** ICS 233.

**SWE 205 Introductions to Software Engineering (3-0-3)**

Introduction to software engineering and software processes. Construction techniques and principals. Concepts of Programming Languages: Syntax and semantics. Analysis and Design Modes. Ethical and professional responsibilities.

**Prerequisites:** ICS 102

**SWE 215 Software Requirements Engineering (2-3-3)**

Requirements engineering process. Methods, tools and techniques for eliciting, organizing and documenting software requirements. Analysis and validation techniques, including need, goal, and use case analysis. Requirements documentation standards. Traceability. Requirements management. Handling requirements changes. Students participate in a group project on software requirements.

**Prerequisites:** ICS 201 and SWE 205

**SWE 312 User Interface Design (3-0-3)**

Study of both theoretical and practical issues in human-computer interfaces. User interface design process. Usability engineering. Development, programming, and evaluating interface designs. Design of windows, and menus. Commands and natural languages I/O. Visual

prototyping. User manuals, online help and tutorials. Students participate in a group project on software user interface design.

**Prerequisites:** SWE 205

**SWE 316 Software Design and Architecture (3-0-3)**

Study of design concepts and notations. Architecture, middleware architectures, design patterns, frameworks and components. Designing for qualities such as performance, security, reusability, reliability. Metrics and measurement. Basics of software evolution, reengineering, and reverse engineering. Students participate in a group project on software design.

**Prerequisites:** ICS 202 and SWE 215

**SWE 321 Formal Methods and Models in Software Engineering (3-0-3)**

Mathematical foundations for formal methods. Formal languages and techniques for specification and design, including specifying syntax using grammars and finite state machines. Analysis and verification of specifications and designs. Use of assertions and proofs. Automated program and design transformation.

**Prerequisites:** ICS 202 and ICS 253

**SWE 326 Software Testing and Quality Assurance (3-0-0)**

Concept of software quality, and software quality metrics. Software quality assurance planning & implementation. Quality process standards. Validation & verification. Reviews, walkthroughs, & inspections. Mechanisms for validating software systems. Techniques for generating and validating test data. Students participate in a group project on software validation and verification.

**Prerequisites:** SWE 215 and SWE 312

**SWE 344 Internet Protocols and Client-Server Programming (2-3-3)**

Principles of inter-network architecture and communication protocols. Open systems and interoperability. Case studies of particular protocols from network layer and above. Socket programming. Remoting. Selected examples of networked client-server applications such as e-mail, news, file-transfer, HTTP. Client-Server Programming Project(s). Using APIs. Software tools and environments.

**Prerequisites:** ICS 202

**SWE 363 Web Engineering and Development (3-0-3)**

Web Engineering fundamentals: requirements, analysis modeling, design modeling, testing. Internet basics for web applications. Technologies and tools for developing web applications: markup languages, styling, data description and transformation, client and server side programming. Web services. Advances in web engineering.

**Prerequisites:** Junior Standing

**SWE 387 Software Project Management (3-0-3)**

Introduction project management concepts, tools, and techniques: integration management and project planning, scope management, scheduling, budget control, human resource management, communication management, risk analysis and management, project quality management, and procurement management.

**Prerequisites:** Junior Standing

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

A summer period of 8 weeks spent as a trainee in industry, business, or government agencies for the purpose of familiarizing the student with the real job world and enabling him to apply and relate his academic knowledge to a real work environment.

The student is required to participate in computer science related activities and use his time to get acquainted with the computer science related functions and resources used by his employing organization. Besides progress reports, the student is required to submit a final report and do a presentation on his experience and the knowledge he gained during his summer training program. The student receives a zero-credit Pass/Fail grade.

**Prerequisites:** SWE 363, ENGL 214, and Department Approval

**SWE 416 Software Architecture****(3-0-3)**

Study the concepts, principles, methods, and best practices in software architecture. Different architectural styles, patterns and product lines are presented and compared. Methods to analyze, evaluate and document software architectures are also discussed. Students participate in a group project on software architecture design.

**Prerequisites:** SWE 316

**SWE 417 Software Engineering Project I****(1-6-3)**

This is the first part of a two-semester senior-year capstone project. Student teams employ knowledge gained from courses throughout the program such as development of requirements, design, implementation, and quality assurance to develop a software solution to a real-world problem from conception to completion. In this part students develop project plan, software requirement specification and software design document.

**Prerequisites:** SWE 316 and SWE 387

**SWE 418 Software Engineering Project II****(0-6-2)**

This is the second part of a two-semester, senior-year capstone project. Student teams employ knowledge gained from courses throughout the program such as development of requirements, design, implementation, and quality assurance to develop a software solution to a real-world problem from conception to completion. In this part, students implement the design they produced in SWE 417, test their code, and evaluate their final product.

**Prerequisites:** SWE 417 and SWE 326

**SWE 436 Object-Oriented Design Patterns****(3-0-3)**

A depth study of object-oriented design patterns. How design patterns solve design problems? How to select a design pattern? How to use a design pattern? Detailed study of creational patterns, structural patterns, and behavioral patterns. Case studies.

**Prerequisites:** SWE 316

**SWE 469 Software Metrics****(3-0-3)**

Overview of software metrics, basics of measurement theory, goal-based framework for software measurement, empirical investigation in software engineering. Measuring internal product attributes, measuring external product attributes, measuring cost and effort, measuring software reliability, software test metrics, and object-oriented metrics.

**Prerequisites:** SWE 316 and STAT 319

**SWE 487 Software Processes and Process Improvements. (3-0-3)**

Software process models. Software process analysis. Life cycle process models and standards. Process implementation at various levels like organization, project, team, or individual. Measurement and analysis of software process. Process improvements.

**Prerequisite:** SWE 326

**SWE 490 Special Topics I (3-0-3)**

In-depth study of a selected special topic relevant to software engineering

**Prerequisites:** Senior Standing

**SWE 491 Special Topics II (3-0-3)**

In-depth study of a selected special topic relevant to software engineering

**Prerequisites:** Senior Standing