Ministry of Education

King Saud University (KSU)

Deanship of Graduate Studies

College of Computer and Information Sciences

Department of Software Engineering

Ph.D. in Software Engineering

(Thesis with some Courses Option)

1439 / 1440 AH

2018/ 2019

• Program's Study Plan:

❖ First Level:

#	Course Code	Name	No. of Study Units	Prerequisite
1	SWE 601	Empirical and Data Analysis Methods for Software Engineering	3(3+0)	
2	SWE 602	Modeling and Optimization for Software Engineering	3(3+0)	
3	SWE ---	Elective course (1) from List (1)	3(3+0)	
Total			(9) study units	

❖ Second Level:

#	Course Code	Name	No. of Study Units	prerequisite
1	SWE 696	Independent study (1)	2(2+0)	
2	SWE 698	Research seminar*	1(1+0)	
3	SWE ---	Elective course (2) from List (1)	3(3+0)	
4	SWE ---	Elective course (3) from List (2)	3(3+0)	
Total			(9) study units	

* Annual course

❖ Third Level:

#	Course Code	Name	No. of Study Units	prerequisite
1	SWE 697	Independent study (2)	2(2+0)	SWE 696
3	SWE ---	Elective course (4) from List (2)	3(3+0)	
4	SWE 699	Thesis proposal preparation	One study unit	(12) units
Total			(6) study units	

❖ Forth Level:

#	Course Code	Name	No. of Study Units	prerequisite
1	COM 700	Comprehensive exam	0	(24) units
Total			0	

❖ Fifth Level:

#	Course Code	Name	No. of Study Units	prerequisite
1	SWE 700	Thesis	(24) study units	SWE 699 & COM 700
Total			(24) study units + (24) units for thesis	

❖ **Elective Courses** (**LIST 1**): Student selects (6) study units from this list:

#	Course Code	Name	No. of Study Units	prerequisite
1	SWE 603	Advanced Topics in Software Architecture	3(3+0)	
2	SWE 604	Software Verification and Validation	3(3+0)	
3	SWE 605	Software Dependability	3(3+0)	
4	SWE 606	Software Process and Project Management	3(3+0)	
5	SWE 607	Software Analytics	3(3+0)	
6	SWE 608	Search–based Software Engineering	3(3+0)	
7	SWE 609	Advanced Topics in Software Requirements Engineering	3(3+0)	
8	SWE 610	Advanced Topics in Software Maintenance and Evolution	3(3+0)	
9	SWE 611	Advanced Topics in Interaction Design	3(3+0)	
10	SWE 612	Formal Methods for Software Engineering	3(3+0)	

❖ **Elective Courses (LIST 2):** Student selects (6) study units from this list:

#	Course Code	Name	No. of Study Units	prerequisite
1	SWE 620	Software Mining and Intelligence	3(3+0)	
2	SWE 621	Data Science and Engineering	3(3+0)	
3	SWE 622	Advanced Topics in Multimedia Software Systems	3(3+0)	
4	SWE 623	Mobile and Pervasive Software Systems	3(3+0)	
5	SWE 624	Cybersecurity and Software Systems	3(3+0)	
6	SWE 625	Cloud–based Software Systems	3(3+0)	
7	SWE 626	Select Topics in Software Engineering	3(3+0)	
8	SWE 627	Simulation and Modelling of Distributed Software Systems	3(3+0)	
9	SWE 628	Text Retrieval and Analysis for Software Engineering	3(3+0)	

- **Description of Courses**:

SWE 601	Empirical and Data Analysis Methods for Software Engineering	3(3+0)
The course will first introduce, discuss, and classify various software engineering research methods and approaches. Then the course will focus on the principles, main practices and technologies relevant to using data and statistical analysis to address various software engineering research problems. This course will put emphasis on grasping statistical concepts and interpretation of the outcome of analysis of the statistical data gathered during the different stages of software development lifecycle. Application of statistical methods to empirical software engineering will be in particular covered in-depth. Additionally, students will review different articles, case studies and research papers to have a practical understanding of the use of statistical and data analysis techniques in relevant software engineering.		
SWE 602	**Modeling and Optimization for Software Engineering**	**3(3+0)**
This course will introduce advanced modeling and optimization techniques from the software engineering perspective. It encompasses relevant methods, models, and techniques from graph theory, operations research, mathematical logic, and discrete mathematics. It will include discussions on modeling principles, model analysis and software engineering methods. It will also focus on formalizing decision making problems affected by uncertainties at different stages of a software development, solving the models with different optimization techniques, and interpreting the results. An important part of the course will be devoted to reading, presentation, and discussion of relevant research papers.		
SWE 696	**Independent study (1)**	**2(2+0)**
The student registers in this course under a faculty member. The student selects a research topic, with the approval of his adviser, and conduct a research study on the topic. The student submits a detailed report at the end of the course.		
SWE 697	**Independent study (2)**	**2(2+0)**
The student registers in this course under a faculty member. The student selects a research topic, with the approval of his adviser, and conduct a research study on the topic. The student submits a detailed report at the end of the course.		
SWE 698	**Research seminar***	**1(1+0)**
The student registers in the Research Seminar course. The student should present their work in research seminars. He should present at least twice (2) on a topic given by the supervisor, and attend at least three (3) research seminars. The research seminars can be organized inside the department, college, or University, or outside the University. Participation in national or international conferences can be counted also up to 50% of the total research seminar requirements.		

COM 700	Comprehensive exam	0
The comprehensive exam will cover three courses. One of the courses must be from one of the research fundamentals courses (SWE 601 or SWE 602). The two other courses will be decided by the department council in coordination with the department graduate studies committee (taking into consideration the research area of the student). The comprehensive exam will have a written part and an oral part.		
SWE 699	**Thesis proposal preparation**	**One study unit**
The student prepares a PhD thesis proposal describing the research problem(s) to be addressed by the proposed research, a thorough literature review of the related works, the objectives, the methodology to be followed, the results and contributions expected from the proposed research, as well as timeline and schedule of the proposed research. The research proposal must be approved by the adviser, the department and the college. The proposal will be defended orally in front of a committee (the advisor and two members). The thesis proposal starts in the third semester, after the student finished successfully 50% of coursework and shall be defended successfully by the end of the 6th semester at latest.		
SWE 700	**Thesis**	**(24) study units**
The student writes a detailed thesis dissertation report describing in details all aspects of the research work accomplished and defends publicly his work in front of a Jury according to the university regulations.		

List of Elective Courses (1)

SWE 603	Advanced Topics in Software Architecture	3(3+0)
This course covers Concepts and methods for the architectural design of large-scale software systems. Fundamental design concepts, notations, strategies, and methods. This includes architectural patterns and styles, qualitative and quantitative assessment of architectures, quantitative modelling using architecture description languages such as AADL and MARTE, and qualitative architecture evaluation methods, e.g., ATAM. Finally, the course will also address the specific research challenges related to deployment, mobility, and QoS.		
SWE 604	**Software Verification and Validation**	**3(3+0)**
The objectives of this course are to explore and evaluate the verification and validation theories and practices from a software engineering perspective. The course covers the concepts and techniques for testing software and assuring its quality at the unit, module, subsystem, and system levels. Topics covered include criteria-based test design, test design, test automation, test coverage criteria, Test plan, Various types of tests including white-box, black-box, unit, integration, functional. Regression testing and mutation testing will also be covered. Testing processes as well as automatic versus manual techniques for generating and validating test data will also be covered. Various quality assurance techniques including inspections, reviews, consistency check, quality metrics, etc. will be also part of the course. Software testing best practices (patterns) as well as bad practices (anti-patterns or smells) will be discussed as well as test-		

driven development (TDD) will also be discussed. Part of the course will be devoted to reading, presentation, and discussion of relevant research papers as well as depicting research trends in software verification and validation.

SWE 605	Software Dependability	3(3+0)

Modern Software systems have extended in its distribution, mobility, and complexity. They are failure-prone and difficult to manage and thus hardly dependable. The dependability problems are hard to solve but must be dealt with regularly in order to detect, isolate and recover systems from these problems. This advanced graduate-level course focuses on dependability in software systems and covers different dimensions of software dependability including software availability, software reliability, software survivability/resilience, and software safety. The course will also address current research aiming at addressing challenges caused by software and hardware bugs and software misconfiguration. Students are expected to read and comment on recent research papers related to software dependability. Students are expected to work on a relevant research project during the course.

SWE 606	Software Process and Project Management	3(3+0)

This course covers software process development as well as software project management issues, models, methods, and techniques. Topics covered include software development processes, software development methodologies with a special focus on agile methodologies; Software project management aspects include the key concepts and techniques in software project management knowledge areas including Time management, Cost management, Quality management, Risk management, etc. In addition, software engineering decision support techniques are covered in this course. A special focus will be on models and techniques used in cost, effort, and time estimation and management as well as patterns and anti-patterns in software project management. Relevant research papers will be discussed as part of the course.

SWE 607	Software Analytics	3(3+0)

This course covers analytics models and techniques relevant to the area of Software Systems by analyzing software repositories data. Data in software repositories include various software artifacts such as source code, software bugs, bug reports, test cases, execution traces, user feedback, developers' comments, programming forums questions and answers, etc. The course covers models and techniques from various domains in order to analyze software repositories data, and gain insights to help software developers and software managers do their work properly and efficiently (improve quality and productivity). Furthermore, the course will also focus on how to predict useful information about new software projects based on the completed projects, gather insight, and make recommendations in light of related literature and research trends.

SWE 608	Search-based Software Engineering	3(3+0)

A large number software engineering problems, in many areas of software engineering, can be viewed and treated as a computational search problem. This course introduces the techniques that can be used to address such problems. Topics covered include: Overview on Search-based Software engineering, large-scale software engineering problems as an optimization problem, Computational search-based approaches, heuristics and meta-heuristics,

Applications of search-based approaches to various areas of software engineering including software testing, software project management, and software maintenance. Relevant evaluation techniques and metrics to search-based solutions will also be covered. Students will be exposed to current research trends.

SWE 609	Advanced Topics in Software Requirements Engineering	3(3+0)

This courses focuses on advanced software requirements models, methods, techniques, and issues. Topics covered include methods, tools and processes for software requirements elicitation, analysis; notations and models for requirements specification; quality assurance techniques and quality metrics for requirements; formal versus non-formal specifications, patterns and anti-patterns in requirements, requirements traceability, and requirements prioritization techniques. Requirements management in the case of agile methodologies versus traditional methodologies will be also discussed. Part of the course will be devoted to reading, presenting, and discussing relevant research papers in this area.

SWE 610	Advanced Topics in Software Maintenance and Evolution	3(3+0)

This course focuses on advanced software maintenance and evolution issues, models, methods, techniques, and processes. Topics covered include software evolution processes, change impact analysis models and techniques, change propagation techniques, program comprehension and visualization for maintenance purposes, code smells and refactoring techniques for software maintainability, design versus code refactoring, managing technical debt, program evolution and automatic program repair, and software re-engineering. Student will go through the state-of-the-art research in this field.

SWE 611	Advanced Topics in Interaction Design	3(3+0)

Nowadays, we are surrounded by cutting edge technology that bridges the digital and physical worlds and then revolutionized the User eXperience (UX). This course gives an insight into some innovative technologies and discusses how they have contributed tremendously to the Human Machine Interaction design and evaluation. It develops deeply into the impact of the evolution of Touch-screen based interfaces, Wearable devices as well as Tangible User Interfaces (TUI), the advent of Augmented Reality (AR) and Virtual Reality (VR) technology, the potential of Gaze-controlled (eye tracking) and Brain-controlled interfaces (BCI), the direct interaction of Human with Artificially Intelligent (AI) machines or Robots… This course covers concepts and techniques that might be used throughout the whole software development process with special focus on the Interaction Design and User-Centered Design (UCD): starting from user needs finding and going through User experience design to usability evaluation. The course work will be supplemented with relevant research papers.

SWE 612	Formal Methods for Software Engineering	3(3+0)

This course studies the formal specification, verification, and synthesis of software. The course will first introduce formal mechanisms for specifying software systems using variety of specification notations, e.g., Z and UML/OCL, and discuss corresponding analysis techniques, e.g., theorem proving, constraint checking,

and model checking, using existing commercial and research tools. In addition, the course covers the integration of formal methods with existing programming languages, and the application of formal methods to requirements analysis, testing, safety analysis, and object-oriented approaches. Also, recent research advances will be covered in the course.

List of Elective Courses (2)

SWE 620	**Software Mining and Intelligence**	**3(3+0)**

This course is designed to help researchers in software engineering develop critical thinking, skills, and tools necessary to understand and apply different mining techniques to various real-world software engineering data, in addition to utilizing these concepts and techniques to manage, maintain and evolve complex software systems and projects. Topics covered include Data preprocessing (selection, cleaning, and transformation), Supervised/unsupervised learning, data mining and processing techniques (e.g. classification, clustering, association rules, decision-trees, etc.), Text mining approaches, applied to various software artifacts. Various machine learning techniques will be discussed with enough depth including deep learning approaches, and their potential applications in Software Engineering. The emerging and promising field of software intelligence, which relies on the advances in mining software engineering data, will also be introduced and discussed from the perspective of supporting decision-making processes throughout the lifetime of a software system.

SWE 621	**Data Science and Engineering**	**3(3+0)**

This course provides a solid view on data science and engineering, in the context of big data, including scientific methods, processes, techniques, and tools to extract process and analyze the data, and extract new knowledge and insights from data in various forms. The successful deployment of data science in any organization depends on how data is stored and processed. We cover in this course also the fundamentals and architecture of data storage, retrieval and processing, and visualization. A special attention will be given to analyzing and interpreting data, and applying reasoning techniques for tactical as well as strategic decision making. Advanced hands-on data visualization techniques for data exploration, pattern discovery, data interpretation and explanation of data results will also be covered in this course. Reading and presenting research papers will be also part of this course.

SWE 622	**Advanced Topics in Multimedia Software Systems**	**3(3+0)**

This course will tackle Multimedia Software Systems from two complementary angles: 1) apply multimedia computing to the practice of software engineering; and 2) apply software engineering principles to the development of multimedia software systems. In fact, developing multimedia software systems entails understanding a variety of advanced technologies; in addition, multimedia software systems design and programming poses a significant challenge in terms of handling a variety of hardware devices, multimedia data formats, or communication protocols. This course will cover multimedia enabling technologies to understand,

analyze, and build multimedia software systems. Topics covered include multimedia content analysis and processing, services and applications, Internet concepts and protocols, compression and networking technology in multimedia system, Multimedia and the Internet, Quality of Service (QoS) and Resources Management, Scheduling and synchronization, conferencing and collaboration tools and Security, and multimedia information retrieval. Research trends related to this field will be covered.

SWE 623	Mobile and Pervasive Software Systems	3(3+0)

This course will focus on the understanding of mobility, ubiquity, and the pervasiveness of modern software systems. The students will explore and research on different software engineering aspects in this paradigm. More specifically, this course will investigate different design issues of mobility and pervasiveness of modern smart systems, like IoT systems, cyber-physical systems and smart city services. Part of the course will be devoted to reading, presentation, and discussion of relevant research papers.

SWE 624	Cybersecurity and Software Systems	3(3+0)

This course teaches the principles of cyber-security aspects, with a particular emphasis upon the security properties and implications on software and information technologies. It provides the opportunity to focus on the application of these principles, the best practices and the current advances in the field. More specifically this course will provide the knowledge and skills that will support the development of secure, robust, and reliable software systems by detecting fraud, upholding the trust, and safeguarding privacy. The traditional information, computer, and network security constitutes the basics on which we rely, but go further in studying research approaches, models, and methodologies for the design, implementation, and testing of secure software systems. The course will also expose the students to the research trends in the area.

SWE 625	Cloud-based Software Systems	3(3+0)

This course will give the students a comprehensive view of the cloud computing landscape. It will explore the software defined architecture of cloud and the approaches of defining and configuring highly available cloud services. Also will be explored the different service models of the cloud: IAAS, PAAS, SAAS. The course will further elaborate on the techniques of developing enterprise software solutions on cloud platform. The students will conduct research and implement cloud computing services as part of project work to get further understanding of the concept.

SWE 626	Select Topics in Software Engineering	3(3+0)

This course teaches the principles of modern software engineering that arise in the area, together with the tools, methods and techniques that support their application. It aims to refine the understanding of foundational topics and to explore the state-of-the-art and new trends in software engineering research. Examples of topics that can be covered in this course for now include theoretical concepts around Agent Oriented Software Engineering or Service Oriented Architecture (SOA) are growing in importance in industrial application. Practical tools and methods around Big Data, Cloud computing and Virtualization,

Artificial Intelligence and Internet of Things (IoT) have become topics of keen interest to software engineers and researchers. This course combines the investigation of theory and practical aspects in software engineering and discusses its flourishing research directions.		
SWE 627	**Simulation and Modelling of Distributed Software Systems**	**3(3+0)**
The aim of the course is to provide an understanding of methods, techniques and tools for modeling, simulation and performance analysis of large-scale distributed software systems. This includes studying Distributed Interactive Simulation (DIS), High Level Architecture (HLA) and Test & Training Enabling Architecture (TENA) Standards. The course discusses issues related to simulation interoperability and composability execution, and explore the time management algorithms and approaches to synchronization. Part of the course will be devoted to reading, presentation, and discussion of relevant research papers.		
SWE 628	**Text Retrieval and Analysis for Software Engineering**	**3(3+0)**
Text Retrieval (TR) and Natural Language Processing (NLP) have a large number of applications in almost all areas of Software Engineering including Use case analysis, Traceability Link Recovery, Feature or bug location, Program comprehension, Defect prediction and debugging, Automatic documentation, Requirements, Refactoring, Change Impact analysis, etc. The bottom line is to formulate a given software engineering task as a text retrieval problem and find the software artifacts that satisfy a particular information need. The main NLP and TR concepts and techniques presented will be relevant to Software Engineering problems and will cover the whole retrieval lifecycle including corpus preprocessing, corpus indexing, query formulation, documents similarity and ranking, and Performance evaluation. Techniques include tokenization, stemming, Vector Space Model (VSM), Latent Semantic Indexing (LSI), Latent Dirichlet Allocation (LDA), Term Frequency-Inverse Document Frequency (TF-IDF), Relevance feedback, Scoring and Thresholding, Precision and recall and F-measure metrics, etc. The corpus used to illustrate these concepts and techniques will be a collection of software engineering documents including the code, use case narratives, programming forums' questions and answers, etc. The course introduces also the use of semantic computing/technologies (e.g., ontologies, text mining, and knowledge integration techniques) in diverse tasks such as traceability and impact analysis, system comprehension, software artifact analysis, etc. The course will cover research trends in this domain.		