**ATILIM UNİVERSITY**

**SOFTWARE ENGINEERING DEPARTMENT**

**PRINCIPLES ON THE EXECUTION OF Ph.D. QUALIFYING EXAMS**

According to Article 31 (2) of the **Regulation on Atilim University Graduate Programs, the Ph.D. qualification exam is held twice a year (in May and December) on the dates determined by the Software Engineering Doctorate Qualification Committee (DQC). The aim of the exam is to test whether the student has the depth of knowledge required in the scientific area that he/she will conduct his/her doctoral studies. The exam is executed as follows:**

**General Rules**

1. The students who are eligible to take the Ph.D. qualifying exam, should register to the related course at the beginning of the semester during registration, and also apply to the Head of the Institute Major Science Department (EABD) in writing. EABD presents the list of students who will take the exam to the Institute (FORM\_9).
2. The head of EABD invites the DQC to a meeting during the week following the registration period. If the DQC has completed its term of office, the new members proposed by the EABD Academic Council are presented to the approval of the FBEYK during the registration period.
3. The head of the Doctorate Qualification Committee is the head of the relevant department if he is a member of the committee. If the head of the Department is not in the committee, the committee members elect a president from among themselves.
4. Qualification exams consist of two parts; WRITTEN (consisting of two stages) and ORAL. These examinations are given on the dates determined by the **Regulation on Atilim University Graduate Programs**. The dates of the written exams will be notified to students at least one month before the dates determined by the examination committee. Candidates who are successful in the first stage of the written exam are eligible to enter the second stage of the written exam. Candidates who are successful in the WRITTEN examination are eligible to take the ORAL examination.
5. DQC establishes examination juries of five permanent members including the thesis supervisor, and at least two members from outside the institution, and two substitute members consisting of one member from the institution and one from the outside. The committee presents the established examination committee to SE EABD. SE EABD sends the list of jury members to FBE, to the jury members (with official invitation letters), and the students (FORM\_10a, 10b, 10c).
6. The EABD conducts a meeting with the written exam jury within one week from the appointment date. The jury chooses a chairman at the first meeting. The jury examines the students' files and determines the faculty members who will prepare and evaluate the exam content and questions. The head of the jury informs the relevant faculty members, and the assignment is made by the EABD.
7. The qualification examination committee chair informs the student(s) who will take the qualification exam within one week from the date of the first meeting of the jury about the exam content and the examination method.
8. **Written Examination**

Written examination is executed in two stages.

 **First Stage – Covers core courses at the undergraduate level**

This stage consists of two questions from each of the following subjects:

* Object-Oriented Analysis and Design
* Computer Networks and Operating Systems
* Algorithms and Optimization Methods
* Data Structures

Each student is asked to choose one question from each subject. Candidates who cannot attain 70% mark in the first stage are declared as **unsuccessful** and should repeat the examination in the following semester. Successful candidates are invited to the second stage of the written examination.

A list of required topics in each of the four subjects are outlined in the following tables.

**Table 1. Contents of the First Stage written examination**

|  |
| --- |
| **Object-oriented Analysis and Design** |
| **Topic** | **References** |
| * Definition and Challenges of Information Systems
* Fundamentals of Object-orientation
* Object-oriented Modeling Concepts (​​objects, classes, modularity, encapsulation, polymorphism, inheritance, etc)
* Requirement Elicitation
* Requirement Modeling
* Object Interaction
* Specification of Operations and Control
* System Architecture
* System Design
* Design Patterns
 | 1. *Object Oriented Systems Analysis and Design using UML, Simon Bennett, Steve McRobb, Ray Farmer, 3/e, MacGraw Hill, 2005*
2. *Larman, C. (2004). Applying UML and patterns: an introduction to object oriented analysis and design and the unified process (3rd Edition), Prentice Hall*
3. *Robert V. Stumpf, Lavette C. Teague, Object Oriented Systems Analysis and Design With UML, 1/e, Prentice Hall, 2005.*
4. *Richard C. Lee, William M. Tepfenhart, UML and C++: A Practical Guide to Object-Oriented Development, 2nd Edition, Prentice Hall, 2001*
5. *Martin fowler, UML Distilled: A Brief Guide to the Standard Object Modeling Language, 3rd Edition, Addison Wesley, 2004.*
6. *Design Patterns: Elements of Reusable Object-Oriented Software, Erich Gamma, Richard Helm, Ralph Johnson, and John Vlissides, Addison-Wesley, ISBN 0201633612*
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| **Computer Networks and Operating Systems** |
| **Topic** | **References** |
| * Introduction to computer networks
* Circuit and packet switching
* ISO layered structure for network services (Delay, loss and throughput)
* Fundamentals of well-known Internet applications (HTTP, SMTP, DNS)
* Overview of transport layer services (UDP, TCP)
* Reliability in transport layer
* Segment structures (UDP/TCP)
* Network layer and network layer addressing
* Basics of IP-routing.
* Datagram structure
* Overview of link layer services
* Ethernet frame structure
* Computer networking topologies
* Switches and hubs
* Process and threads
* Multitasking
* Scheduling Algorithms
* Synchronization and Mutual exclusion
* Semaphores
* Deadlock and its detection
* Virtual Memory
* Paging algorithms
 | 1. *Computer Networking: A Top-Down Approach Featuring the Internet, 5/E, James F. Kurose, Keith W. Ross, Addison-Wesley, 2010, ISBN: 978-0-13-136548-3*
2. *Operating System Concepts, 7th Edition, John Wiley and Sons, 2005, Silberschatz, Galvin, and Gagne, ISBN 0-471-69466-5.*
3. *Computer Networks 4/E, Andrew S. Tanenbaum, Pearson Education Inc., 2006*
4. *Introduction to Data Networks, Lawrence Harte, ALTHOS Publishing, 2005*
5. *Computer Networking First-Step, Wendell Odom, Cisco Press, 2004*
6. *Bilgisayar Ağları, Nazife Baykal, Sas Bilişim, 2005*
7. *TCP/IP Tutorial and Technical Overview, On-line book available at “http://www.redbooks.ibm.com/” Redbooks, published 19 December 2006, Last accessed May 14, 2009*
8. *Modern Operating Systems, Andrew S. Tanenbaum, 2nd edition, Prentice-Hall, 2001.*
9. *Operating Systems, Gary Nutt, Addison-Wesley, 2004.*
10. *Operating Systems: Internals and Design Principles, 6/e, Prentice Hall, by Stallings, ISBN-10: 0136006329 | ISBN-13: 9780136006329*
 |
| **Algorithms and Optimization Methods**  |
| **Topic** | **References** |
| * Fundamentals of the Algorithm Efficiency
* Brute Force and Exhaustive Search
* Decrease-and-Conquer
* Divide-and-Conquer
* Transform-and-Conquer
* Space and Time Trade-Offs
* Dynamic Programming
* Greedy Technique
* Iterative Improvement: The Simplex Method, The Maximum-Flow Problem, Maximum Matching in Bipartite Graph, The Stable Marriage Problem
* Limitations of Algorithm Power: P, NP, and NP-Complete Problems
* Coping with the Limitations of Algorithm Power: Backtracking, Branch-and-Bound, Approximation Algorithms for NP-Hard Problems
 | 1. *Anany Levitin, Introduction to the Design & Analysis of Algorithms, 3rd edition, Pearson, 2012.*
2. *T.H.Cormen, C.E.Leiserson, R.L.Rivest and C.Stein: Introduction to Algorithms, MIT Press 2001.*
3. *E.Horowitz, S.Sahni: Fundamentals of Computer Algorithms, Computer Science Press, 1989.*
4. *E.Horowitz, S.Sahni, S.Rajasekeran, Computer Algorithms, ISBN: 978-0-929306-41-4, Silicon Press, 2008.*
5. *J.Kleinberg, E.Tardos, Algorithm Design, Addison – Wesley, ISBN: 0-321-29535-8, 2006.*
6. *A.V.Aho, J.E.Hopcroft, J.D.Ullman, The Design and Analysis of Computer Algorithms, Addison-Wesley Series in Computer Science and Information Processing, 1979.*
7. *S.S. Skiena, The Algorithm Design Manual, Springer – Verlag, New York, 1998.*
 |
| **Data Structures** |
| **Topic** | **References** |
| * Linked Lists
* Recursion
* Stack
* Queues
* Searching and Hashing Algorithms
* Sorting Algorithms
* Binary Trees and B-Trees
* Graphs
 | 1. *Data Structures Using C++, D.S. Malik, Thomson Course Technology, 1st Edition.*
2. *Data Structures Using C and C++, Y.Langsam, Prentice-Hall International Inc., 2nd Edition.*
3. *Data Structures and Algorithm Analysis in C++, M. Weiss, Addison Wesley, 3rd Edition*
4. *Practical Data Structures in C++, B. Flamig, John Wiley & Sons, Pap/Dis Edition.*
5. *Fundamentals of Data Structures in C++, E. Horowitz, S. Sahni, D. Mehta, Silicon Press, 2nd Edition.*
6. *Data Structures and Algorithms in C++, M.T. Goodrich, R.Tamassia, D. M. Mount, Wiley, 2nd Edition.*
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**Second Stage – Covers core courses at the graduate level**

During the second stage of the written examination, candidates are asked about the main topics outlined in Table 2 within the framework of the two compulsory courses (SE650, and SE654) they have taken in the doctoral program.  For each course three questions are posed and students are asked to solve only two. Candidates who cannot attain at least 70% mark from each compulsory course are declared as unsuccessful and should repeat the second stage of the WRITTEN examination in the following semester. Successful candidates are invited to the ORAL examination. Sample questions for this stage are provided in the next page.

**Table 2. Contents of the second stage written examination**

|  |  |  |
| --- | --- | --- |
| Course/Subject | Content | Reference/Reading List |
| SE650 - Advanced Topics in Software Engineering | * Software project management
* Software quality and quality management
* Requirements engineering
* Software process models and lifecycle activities
* Software metrics
* Risk management
 | 1. Pressman, R. S. & Maxim, B. R. Software Engineering: A Practioner’s Approach, McGraw Hill, 2020 (9th edition), *ISBN: 978-1-260-54800-6*
2. Sommerville, I., Software Engineering, Addison-Wesley, 2014 (10th edition)
3. Van Vliet, H., Software Engineering: Principles and Practice, Wiley, 2008 (3rd  edition)
 |
| SE654 - Advanced Topics in Software Quality Management | * *Components of software quality assurance*
* *Reviews, inspection and audits*
* *Software testing strategies and techniques*
* *Software quality standards, certification and assessment*
* *Software process improvement and quality metrics*
 | Course Book1. *Software Quality Assurance: From Theory to Implementation by Daniel Galin, Addison-Wesley, 2004, ISBN: 0201709457*

Other Sources1. *Metrics and Models in Software Quality Engineering, Kan S.H., Addison-Wesley, 2002, ISBN: 0201729156.*
2. *Software Quality Management and ISO 9001, Jenner M. John-Wiley&Sons, 1995, ISBN: 0471118885*
3. *Software Metrics: A Rigorous and Practical Approach, N.Fenton and Shari Pfleeger, Thomson Computer Press, 1996, ISBN: 0-534-95425-1.*
 |

**Sample question types for the second stage of the written examination**

1. **Scenario-based**

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| --- |
| **Question 1.** Ankara Teknoloji Co. is a software development company working in the health domain. The company will start to develop a novel application for Company B. Ankara Teknoloji Co. is now looking for a suitable process model based on the preferences of Company B which are given below:    * Company B has a broad view of the novel application but lacks details about how it functions and what it looks like. The company believes to identify the details over time with the help of the Ankara Teknoloji Co.
* Company B wants to experience the product under development from time to time, and may change requirements if needed.
* Company B wants to play a part in the ongoing development process.
1. Which process model would be suitable for this case? Please explain the reason(s) in detail. (Hint: You can choose from traditional and/or agile development approaches)
2. Which process model is NOT suitable for this situation? Please explain the reason(s).
3. Which process models can be combined to manage change in customer requirements better?
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1. **Comparison-based**

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| --- |
| **Question 2.** What is the difference among problem-based estimation, process-based estimation and estimation with use cases? Explain with an example case.  |

1. **Conceptual / Informational**

|  |
| --- |
| **Question 3.** What does an architectural style encompass?**Question 4.** Pick an architectural style, define specific elements of that style and explain with a real world example.**Question 5.** Name the other five design principles. |

**B. Oral Examination**

1. Students who succeed in the two stages of the WRITTEN exam are entitled to enter the ORAL exam. The ORAL exam is conducted in three successive sessions, after the announcement of the written exam results, within two weeks at the latest.
2. In the ORAL exam, the student's research skills, presentation skills, ethical understanding and command of the topic are assessed.
3. The duration of the oral exam is 45 minutes. In the oral examination, the student is evaluated out of 100. Students with an average of at least 70% of the three sessions of the oral exam are considered SUCCESSFUL.

*Oral Exam – First Session*

For the first session of the ORAL exam, a topic is given to the student with the approval of the thesis advisor regarding the field of study determined by the student during his/her application and he/she is requested to prepare and present a paper of at least 6 pages in the related IEEE format. The student provides a copy of the article to the jury members one week before the oral examination. In addition, the plagiarism report (maximum acceptable similarity is 35%) relating to the student's article is forwarded to the chairman of the jury before the oral examination.

*Oral Exam – Second Session*

In this session, the candidate is expected to answer the questions from the topics of the written parts of the examination.

*Oral Exam – Third Session*

This session includes questions to assess candidates’ approach to cases and research patterns. For this purpose, case-based interpretation and research design questions are posed. The aim is to evaluate the adequacy of the candidate in terms of what kind of solution proposals he/she can offer in a particular situation within the scope of a research and how he/she will defend these scientific research approaches. Below are some sample questions that can be asked in this context.

**Case 1)** Software requirements for a specific system are given below. In order to satisfy these requirements in the best way, please explain your suggestions considering the method, tool and solution.

A doctor's office has a software system requirement for keeping patient records. The system should allow the user to create records for new patients, update information and delete patient records. The system should also generate billing information for insurance companies, record payments from companies and patients, generate invoices for patients, and send patients reminders about follow-up treatments. The system displays the patient's name, patient social security number, date of birth, address and telephone number, patient's insurance information, employer, parent or guardian (if under 18), and spouse (if married). The system should also keep each patient's medical history, including the date of each visit, diagnosis, treatment prescribed, duration of treatment, and outcome.

**Case 2)** What are your solution(s) suggestions for the problem given below? Please explain your suggestions in detail. Consider the complexity and efficiency of your solution.

Let's assume that there is a series of cities and a series of buses traveling between these cities. Each bus traveling between two cities on the route has a fixed travel time. Also, when passengers arrive in a city, they do not wait to board the bus they will continue on. Find the route from city A to city B in order to arrive the destination in the shortest time period.

**C. Collective Evaluation of Written and Oral Examinations**

Doctorate Qualification Committee evaluates the written and oral exam minutes sent by the written exam committee and the oral exam jury and decides the success of the student by simple majority. The written examination commission and the oral exam jury chairperson are invited to the meeting where this decision is taken. According to this:

* 1. In the **WRITTEN** exam
		1. The student should achieve at least 70% average in the first stage. Students who cannot pass the first stage of the written exam must retake the qualifying examination from the very first stage in the next semester.
		2. The student who are successful in the first stage of the written exam enters to the second stage and should achieve at least 70% in each course of the second stage. Students who cannot pass the second stage of the written exam must retake it in the next semester.
		3. The students who are successful in the WRITTEN exam will be invited to the ORAL exam.
	2. In the **ORAL** exam
		1. The students with at least 70% average mark from the three stages of the oral examination are considered to be **SUCCESSFUL**.
		2. The student who fails the oral examination is given a second oral examination within 30 days. The student who cannot attain 70% average mark the second time will be declared **FAILED** from the qualification exam and will be called again to the ORAL exam next semester.
		3. In case of deficiency observed during the both stage of the examination, jury may ask the students to take extra courses to be taken in the first semester they are offered.
	3. The exam result report is given to the EABD Chair. The head of EABD presents the exam result to the Institute and the student, within three days following the qualification examination (FORM\_11).
1. According to Article 31 (6) of the FBE Regulation, the failed student has to retake the examination in the following semester.
2. For a successful student, a thesis monitoring committee is appointed within a month. (FORM\_12).