NAZARBAYEV UNIVERSITY
SCHOOL OF ENGINEERING AND DIGITAL SCIENCES

Dept. of Computer Science

Program Handbook

Master of Science in Computer Science

Academic year 2020-21 and onwards

Welcome Note

Dear Learners,

On behalf of the Department of Computer Science (CS), it is my great pleasure to welcome you to Nazarbayev University and the Master of Science in Computer Science and Data Science. I wish you all the best and thank you for making NU your choice of postgraduate studies.

There are several reasons why students choose to pursue their higher education. Many do it for career advancement, while others do it for self-satisfaction. Whatever your reason, our diverse and experienced staff at Nazarbayev University will provide you with first-rate education and research knowledge. Just as you are proud of the high quality of professional work that we know you can do, we are proud of the success and reputation of our graduate programs in computer science and data science. As such, The Computer Science Department has aligned the courses that you are about to undertake with the recommendation of higher education accreditation bodies and local and international information technology companies to respond research expectations.

The computer science and data science programs will run over 4 semesters with a duration of 2 years where you will need to complete 120 ECTS credits. A master's thesis begins in the 3rd semester (1st semester of the 2nd year) and ends in the last semester of the master's course where you will be asked to demonstrate your knowledge of current literature in the field; defend your thesis proposal; develop a solution to a real problem by developing a model and/or an algorithm and/or a software system, analyze and evaluate the results of the solution you offer; support your conclusions in a scholarly manner according to disciplinary standards and finally, defend your thesis work. With this in mind, it is recommended to start planning and interacting with the supervisors of your choice at the start of the program so that you can discuss your research topic, organize supervised meetings and receive advice on how to complete your thesis on time.

I wish you success in your Master of Science program!

Adnan YAZICI, Prof. Dr.

Chair of Department of Computer Science,

School of Engineering and Digital Sciences, Nazarbayev University,

Nur-Sultan / Kazakhstan

Contents

Welcome Note 2
Program Overview 8
Aims and Objectives 8
Graduate Attributes 9
Program Learning Outcomes 9
Program Duration 11
Assessment 11
MASTER OF SCIENCE 13
Academic Policies and Procedures 14
Grading System 14
Graded courses 14
Non-graded (PASS/FAIL) courses 15
Program Completion Requirements 15
Continuation / normal progress 15
Appealing against grades 15
Plagiarism 16
Description of Courses 16
Program Core Courses 17
CSCI 501, Software Principles and Practice 17
SEDS 591, Research Methods 17
SEDS 592, Research Seminar 18
CSCI 693, Thesis Proposal 18
CSCI 694, Thesis 19
MSC 601, Technical Communication 19
SEDS 502, Teaching Practicum 19
SEDS 503, Laboratory Practicum 20
Program Elective Courses 20
Elective Courses Descriptions: 21
CSCI 511, CS Track Core Theory 21
CSCI 512, Information Theory 21
CSCI 575, Formal Methods and Applications 22
CSCI 591, Advanced Artificial Intelligence 22
CSCI 545, Big Data Analytics 22
DS 504, Data Mining and Decision Support 23

CSCI 594, Deep Learning 23
CSCI 502, Hardware Software Co-Design 24
CSCI 531, Distributed Systems 24
CSCI 515, Modeling and Simulation for Computer Science 25
DS 507, Database Management Systems 25
CSCI 525, Quantum Computing 26
CSCI 547, Algorithmic Trading 26
CSCI 581, Acquisition and Analysis of Biomedical Data 27
SEDS 504, Innovation and Entrepreneurship 27
Master Thesis Guidelines 29
Aims and Objectives 29
Thesis Content 29
Stages and Procedures 30
STAGE 1: Identify Thesis Supervisor (Thesis Committee) 30
STAGE 2: Thesis Topic Selection 30
STAGE 3: Submission of Thesis Proposal 30
STAGE 4: Carrying out Research and Thesis Manuscript Preparation 31
STAGE 5: Thesis Submission and Defense 31
Thesis Grading 31

Computer Science Department International Team

Adnan Yazici, PhD

Position: Department Chair, Full Professor
Degree: PhD in Computer Science, Tulane University, USA.
Research Interest: Wireless Multimedia Sensor Networks (WMSNs), Computation Intelligence, Multimedia Data Modeling, Fuzzy Logic, Data Science
Office: 7e.425
Email: adnan.yazici@nu.edu.kz
Phone: + 7 (7172) 706658

Ainur Rysbekova

Position: Instructor
Degree: MSc in Computer Science, Columbia University, New York, NY, USA
Research Interest: Machine Learning, Business Analytics
Office: 7.428
Email: ainur.rysbekova@nu.edu.kz
Phone: +7 (7172) 70 4655

Aigerim Yessenbayeva

Position: Instructor
Degree: MSc in Artificial Intelligence, University of St Andrews, UK
Research Interest: Navigation of Robots using different algorithms, Making solvers using the concepts of the Constraint Programming
Office: 7e.428
Email: aigerim.yessenbayeva@nu.edu.kz
Phone: +7(7172) 70 57 27

Ali Kemal Sinop, PhD

Position: Assistant Professor
Degree: PhD in Computer Science, Carnegie Mellon University, USA
Research Interest: Theoretical Computer Science, Approximation Algorithms, Hardness of Approximation, Linear Algebra and Spectral Graph Theory
Office: 7.232
Email: ali.sinop@nu.edu.kz
Phone: +77172692670

Anh Tu Nguyen, PhD

Position: Assistant Professor
Degree: Ph.D., in Computer Science and Engineering, Kyung Hee University, Republic of Korea
Research Interest: computer vision, machine learning, deep learning, and data mining.
Office: 7e426
Email: tu.nguyen@nu.edu.kz
Phone: +7 (7172) 709442

Antonio Cerone, PhD

Position: Associate Professor
Degree: PhD in Computer Science, University of Pisa, Pisa, Italy
Research Interest: Formal Methods, Data-driven Formal Modelling and Verification, Human-computer Interaction, Analysis of FLOSS Communities and Development, Collaborative Learning
Office: 7e.422
Email: antonio.cerone@nu.edu.kz
Phone: +7 (7172) 709084

Askar Boranbayev, PhD

Position: Assistant Professor
Degree: PhD degree in Informatics, Computing Technics and Control from L.N. Gumilyov Eurasian National University, Astana, Kazakhstan
Office: 1.195
Email: aboranbayev@nu.edu.kz

Benjamin Tyler, PhD

Position: Associate Department Chair, Associate Professor
Degree: PhD in Computer and Information Science, Ohio State University, USA
Research Interest: Language design, formal methods, artificial intelligence theory, CS education
Office: 7e.423
Email: btyler@nu.edu.kz
Phone: +7 (7172) 706538

Dinh-Mao Bui

Position: Assistant Professor
Degree: PhD in Computer Science and Engineering, Kyung Hee University, Republic of Korea
Research Interest: Stochastic processes, Convex optimization, Machine learning, Distributed system, Energy efficiency
Office: 7e.442
Email: mao.bui@nu.edu.kz
Phone: + 7 (7172) 694664

Fatih Demirci, PhD

Position: Associate Professor
Degree: PhD in Computer Science, Drexel University, USA.
Research Interest: Object Recognition in Computer Vision, Image Processing, Applied Graph Theory, Deep Learning
Office: 7e.424
Email: muhammed.demirci@nu.edu.kz
Phone: + 7 (7172) 694861

Hans de Nivelle, PhD

Position: Associate Professor
Degree: PhD, Delft University of Technology, Delft, Netherlands
Research Interest: Applying logic to the verification of mathematics and programs
Office: 7e.418
Email: hans.denivelle@nu.edu.kz
Phone: +7 (7172) 694659

Jurn Gyu Park, PhD

Position: Assistant Professor
Degree: Ph.D. in Computer Science, University of California, USA
Research Interest: Mobile Machine Learning and Deep Neural Networks (DNNs); Machine Learning enhanced Prediction Model Building Methodology for Embedded Systems; Energy-efficient CPU-GPU Dynamic Power Management design for mobile HMPSoCs; Parallel Programming using OpenCL/CUDA and modern heterogeneous GPGPU architectures; NAND Flash Storage Systems
Office: 7e.443
Email: jurn.park@nu.edu.kz

Kok-Seng Wong

Position: Assistant Professor
Degree: Ph.D. in Computer Science and Engineering, Soongsil University, South Korea
Research Interest: Cryptography, secret sharing, information security, and data privacy
Office: 7e.441
Email: kokseng.wong@nu.edu.kz
Phone: +7-7172-70-5765

Mark Sterling, PhD

Position: Assistant Professor, Associate Department Chair
Degree: P.h.D. in Electrical and computer engineering, University of Rochester, Rochester NY
Research Interest: biomedical signal processing, mobile health, big data and big data analytics, and sensor networks
Office: 7e.440
Email: mark.sterling@nu.edu.kz
Phone:+7 (7172) 69 46 76

Martin Lukac, PhD

Position: Associate Professor
Degree: PhD in Electrical and computer engineering, Portland State University, USA
Research Interest: Intelligent robotics, machine vision, artificial emotions, new-paradigm computing
Office: 7e.421
Email: martin.lukac@nu.edu.kz
Phone: +7 (7172) 694667

Meiram Murzabulatov, PhD

Position: Assistant Professor
Degree: PhD in Computer Science, Penn State, USA.
Research Interest: Sublinear Algorithms, Property Testing, Approximation and Randomized Algorithms, Theoretical Computer Science, Computational Geometry, Data Science.
Office: 7.240
Email: meiram.murzabulatov@nu.edu.kz
Phone: + 7 (7172) 694544

Michael Lewis

Position: Associate Professor
Office: 7.240
Email: mlewis@nu.edu.kz
Phone: +7 (7172) 706559

Min-Ho Lee, Ph.D

Position: Assistant Professor
Degree: PhD in Brain and Cognitive Engineering, Korea University, Korea.
Research Interest: Machine Learning, Human-Computer Interfaces, Deep Learning
Office: 7.215
Email: minho.lee@nu.edu.kz
Phone: +7 (7768) 289372

Mona Rizvi, PhD

Position: Associate Professor
Degree: Ph.D., Computer Science, Old Dominion University, USA
Research Interest: Mobile and pervasive computing, computer science education, wireless networking
Office: 7e.417
Email: mona.rizvi@nu.edu.kz
Phone: +7 (7172) 706430

Nazgul Tazhigaliyeva

Position: Instructor
Degree: MSc in Artificial Intelligence, University of Edinburgh, United Kingdom
Research Interest: agent-based programming, probabilistic reasoning, human-robot interaction, reinforcement learning and machine learning; Explainable and Human-Friendly Artificial Intelligence i.e. machine learning techniques that can interpret their decisions to human users.
Email: nazgul.tazhigaliyeva@nu.edu.kz

Sain Saginbekov, PhD

Position: Assistant Professor
Degree: PhD in Computer Science, Warwick University, UK
Research Interest: Computer Networks, Wireless Sensor Networks, Reliability and Privacy in Wireless Sensor Networks, Internet of Things
Office: 7e.419
Email: sain.saginbekov@nu.edu.kz
Phone: +7 (7172) 694765

Selim Temizer, PhD

Position: Assistant Professor of Computer Science and Engineering
Degree: PhD in Computer Science and Engineering, Massachusetts Institute of Technology, USA
Research Interests: Artificial Intelligence, Robotics, Unmanned Systems, Simulation Systems, Agricultural Intelligence, Algorithmic Finance
Office: 7e.439
Email: selim.temizer@nu.edu.kz
Phone: +7 (7172) 69 49 14

Siamac Fazli

Position: Associate Professor
Degree: PhD in Computer Science, Technical University of Berlin, Berlin, Germany
Research Interest: Machine Learning, Neuroscience, Brain Computer Interfaces
Email: siamac.fazli@nu.edu.kz
Phone: +7 (7172) 705860

Program Overview

The Master of Science in Computer Science Program is a two-year program (120 ECTS credits) designed to provide students with advanced mastery of the core CS disciplines balanced with exposure to emerging areas (such as mobile and pervasive computing, multi-factor authentication, privacy and security, persistent data collection, "big data" analysis and data mining).

Students will receive the knowledge and experience that demonstrates domain expertise, and the ability to either continue their educational training at the doctoral level or immediately utilize their training in key economic sectors such government, business, industry, health care, and education.

The NU program is distinguished by its stringent and progressive curriculum (more credits than in a typical program, with more courses, and a research thesis requirement), grounded in Computer Science, by its physical resources (labs and equipment), and the quality, experience (professional, technical and international), and the diversity of the program faculty.

The program is further distinguished by the emphasis on hands-on skills development, with a balance between theory and entrepreneurial practice covering both traditional and emerging fields, and by the strong emphasis on the integration of research in teaching and learning.

The program runs exclusively in English, which serves as the "lingua franca" of the field: all major journals publish in English, and all major conferences use English as the primary language of discourse.

The emphasis on communication skills, embedded throughout the curriculum, combined with the multilingual capabilities of the students, will provide the students with competitive advantage as future leaders of IT innovation in Kazakhstan.

Aims and Objectives

The MSc in Computer Science Program is designed to:

1) Prepare graduates to participate effectively in the emerging "knowledge economy", driven by information technology;
2) Provide the skills and experience for graduates to design and manage technology projects in a collaborative and interdisciplinary manner;
3) Provide CS & IT educators with the context and technical knowledge to train the next generation of Kazakh students;
4) Prepare researchers in CS and related fields to collaborate and compete with international peers in a global market of ideas and innovation.

Graduate Attributes

Graduates of the program will possess the following characteristics:

Graduate attribute	How addressed
1. Possess an in-depth and sophisticated understanding of their domain of study.	Immersive course of study, with exposure to primary sources and authoritative analysis, active hands-on learning, technical projects, and thesis.
2. Be intellectually agile, curious, creative and open-minded.	Active deliberation of material, in contexts ranging from in-class discussion to seminar and peer-reviewed presentations, regular written assignments with reflective components.
3. Be thoughtful decision-makers who know how to involve others.	Collaborative group projects, exposure to methods for peer review, development and promulgation of standards and best-practice policies.
4. Be entrepreneurial, self-propelling and able to create new opportunities.	Project-orientation, courses that emphasize emerging technologies (Sensors, Pervasive Computing, Bio-Tech), and a course dedicated to entrepreneurial innovation.
5. Be fluent communicators across languages and cultures.	Active class deliberation, in-class presentations and demonstrations by students, project-oriented activities, significant writing assignments, and thesis preparation and defense.
6. Be cultured and tolerant citizens of the world.	Exploit opportunities for developing ideas of world citizenship, culture and tolerance depending on the context in which the knowledge and skills of the program are presented. Promote exchange programs, international projects, and institutional linkages abroad.
7. Demonstrate high personal integrity.	Consideration of, adoption of and adherence to the codes of conduct as espoused by the ACM, IEEE, the European Research Code of Conduct, and NU.
8. Be prepared to take a leading role in the development of their country.	Team and group projects, regular consideration and analysis of the transformative nature of information technology and how it affects matters ranging from government policy to everyday affairs of citizens.

Program Learning Outcomes

Upon successful completion of the degree, students are able to:

1) demonstrate advanced knowledge of significant issues, intellectual challenges, and milestones within the field (knowledge of the field);
2) assess complex technical problems, and design and implement solutions in the form of devices or software (practical skills);

3) exercise key mathematical skills relevant to the discipline, including the ability to recognize the theoretical capabilities and practical limitations of computing (theoretical understanding);
4) exhibit high levels of communication skills in areas such as public speaking and writing, and to cultivate the capacity to function effectively as part of a team (communications and teamwork);
5) recognize and observe the professional, ethical, and legal responsibilities expected of those practicing in the field (ethics and professionalism);
6) acknowledge the need for ongoing personal and professional development, so as to continuously acquire the knowledge and skills necessary to remain informed and effective (professional development).
7) demonstrate the ability to explain scientific concepts and research findings, using various modalities of communication, with particular emphasis on tertiary education instruction;

Tabulation of Graduate Attributes against Learning Outcomes

		Program Learning Outcomes						
		1	2	3	4	5	6	7
NU Graduate Attributes	1	☑	☑	☑	☑		☑	☑
	2	☑	☑	☑			☑	
	3		☑		☑			
	4	☑	☑	☑	☑		☑	
	5	☑			☑	☑	☑	☑
	6	☑			☑	☑	☑	
	7	☑			☑	☑		☑
	8		☑		☑	☑	☑	☑

Program Duration

The nominal MSc program duration is **two years**, while the maximum allowable duration can be extended up to **two and half years** (excluding leave of absence and deferment of admission; see "*ACADEMIC POLICIES AND PROCEDURES FOR GRADUATE PROGRAMS OF THE AUTONOMOUS ORGANIZATION OF EDUCATION 'NAZARBAYEV UNIVERSITY'*" for further details).

Assessment

Courses are designed to utilize a range of assessment methods, relevant to the teaching and learning methods, to gauge student progress towards curricular goals and learning outcomes.

Assessment methods include regular homework assignments, conducted on an individual basis, individual and group project activities, in-class technical exercises, topical quizzes on specific course modules, mid-term and final exams, and the use of "live-grading" of assignments, where students must defend their work and receive direct personalized evaluation.

The following table summarizes assessment and evaluation points for all stages of the MSc program:

Stage of Program	***Significance***	***Possible Results***	***Evaluation Point***
ADMISSION TO PROGRAM	Initial Evaluation	Admission Admission with Conditional Status, Subject to Satisfactory Completion of Conditions Rejection	***Key Evaluation Point*** Admission is handled on a case-by-case basis by evaluating the student's undergraduate curriculum, English proficiency and letters of recommendation among other documents and interview (only for shortlisted candidates)
COURSEWORK	Determination of Student Competence in Fundamentals of Discipline	Continue in Program Continue on Probation Dismissed from Program	***Continuous Evaluation*** The coursework component for the Master of Science is assessed by the module instructor. It is enforced that all faculty provide a module descriptor to students at the start of the course outlining the weight of each assessment.
DEGREE CANDIDACY	Demonstration of Student's Mastery of Content Knowledge and Skills in the Discipline	Pass and Continue in Program Required to Re-Take Some Courses Dismissed from Program	***Key Evaluation Point***
COMPLETION OF THESIS	Demonstration of Student's Mastery of Content Knowledge and Skills Needed to Graduate	Pass Recommend Changes with or without re-defense Fail and dismissal from Program	***Key Evaluation Point***

Coursework Assessment methods by course & correspondence to Program Learning outcomes are summarized in the following table:

Program Learning Outcome	***Where addressed*** *(course)*	***How addressed*** *(L&T Methods)*
1.	Software Principles and Practice, CS Track Core Theory (Theory of Computation), Information Theory, Formal Methods and Applications, Design and Analysis of Algorithms, Advanced Artificial Intelligence, Big Data Analytics, Data Mining and Decision Support, Deep Learning, Hardware Software Co-Design, Distributed Systems, Modeling and Simulation for Computer Science, Database Management Systems, Quantum Computing, Algorithmic Trading, Acquisition and Analysis of Biomedical Data, Innovation and Entrepreneurship	1. Lectures 2. Workshops 3. Individual and Group Presentations 4. Individual and Group Projects 5. Paper writing and presentation. 6. Exams 7. Flipping/Blending Learning in which on-line and in-class classes are combined resulting in an effective technique to improve the process of learning.
2.	Courses listed above in 1	
3.	CS Track Core Theory (Theory of Computation), Information Theory, Formal Methods and Applications, Design and Analysis of Algorithms	
4.	Technical Communication, Research Methods, Research Seminar, Thesis Proposal, Thesis	
5.	Technical Communication, Research Methods, Research Seminar, Teaching Practicum, Laboratory Practicum,	
6.	Research Methods, Research Seminar, Teaching Practicum, Laboratory Practicum, Thesis Proposal, Thesis	
7.	Courses listed above in 6	

MASTER OF SCIENCE

Our MSc program is core to the mission of the Computer Science Department. At present, the MSc students represent our best avenue for engaging students in our research projects. They also provide invaluable support as part-time teaching assistants.

The current curriculum is summarized below.

Types	Course by program	Course ECTS
Discipline Core 24 ECTS	CSCI 501 Software Principles and Practice	6
	CSCI Theory elective	6
	CSCI Systems elective	6
	CSCI AI/Intelligent Systems elective	6
Research 48 ECTS	SEDS 591 Research Methods	6
	SEDS 592 Research Seminar	6
	CSCI 693 Thesis Proposal	6
	CSCI 694 Thesis	30
Comms./Practicum 18 ECTS	MSC 601 Technical Communication	6
	SEDS 502 Teaching Practicum	6
	SEDS 503 Laboratory Practicum	6
Electives 30 ECTS		6
		6
		6
		6
		6
		120

To ensure that graduates of the program have taken a breadth of courses, students are required to take at least one elective from each of the three topical clusters indicated below. Some electives will not be part of the cluster categories and are designated as free electives. The below list is not exhaustive; the organization of courses into the cluster categories will be the responsibility of the Graduate Committee of the CS Department.

- **Theory Electives**
  - CSCI 511 -- CS Track Core Theory (Theory of Computation)
  - CSCI 512 -- Information Theory
  - CSCI 575 -- Formal Methods and Applications
  - Design and Analysis of Algorithms (under development)
- **Artificial Intelligence / Intelligent Systems Electives**
  - CSCI 591 – Advanced Artificial Intelligence
  - CSCI 545 – Big Data Analytics
  - DS 504 – Data Mining and Decision Support
  - CSCI 594 – Deep Learning
- **Systems Electives**
  - CSCI 502 – Hardware Software Co-Design

- CSCI 531 – Distributed Systems
- CSCI 515 – Modeling and Simulation for Computer Science
- DS 507 – Database Management Systems

- **Free Electives**
  - CSCI 525 – Quantum Computing
  - CSCI 547 – Algorithmic Trading
  - CSCI 581 – Acquisition and Analysis of Biomedical Data
  - SEDS 504 – Innovation and Entrepreneurship

Other MSc-level courses not listed above may also be counted as Free Electives, at the discretion of the Graduate Committee of the CS Department.

These cluster areas are similar to the specializations found internationally. For example, see the Stanford CS MS curriculum guide (https://cs.stanford.edu/degrees/mscs/program-sheets/psguide1617.pdf).

Academic Policies and Procedures

All academic policies and procedures that are not explicitly covered in this handbook are conformant with the corresponding items described in "*SCHOOL OF ENGINEERING AND DIGITAL SCIENCES MASTERS STUDENT HANDBOOK",* which covers School of Engineering and Digital Sciences Master Programs, and the "*ACADEMIC POLICIES AND PROCEDURES FOR GRADUATE PROGRAMS OF THE AUTONOMOUS ORGANIZATION OF EDUCATION "NAZARBAYEV UNIVERSITY" (APP-Graduate Programs-NU)"*, which covers all graduate programs in Nazarbayev University. These policies and procedures include, among others, the following:

1. Admissions
2. Registration
3. Credits (Requirements, awarding & transfers)
4. Grading issues such as: administrative grades, grade appeals
5. Course re-takes
6. Degree withdrawals
7. Academic code of behavior
8. Leaves of absence, including medical reasons, immediate family member issues and others
9. Dismissal & voluntary withdrawal.

Every student participating in the MSc-CS program is expected to have read and understood all the policies, rules, procedures, and guidelines described in this program specific handbook, school's MSc handbook and the general APP for graduate programs in NU.

Grading System

Graded courses

Letter Grade	Grade Points	Percentage
A	4.00	95-100%

A-	3.67	90-94.9%
B+	3.33	85-89.9%
B	3.00	80-84.9%
B-	2.67	75-79.9%
C+	2.33	70-74.9%
C	2.00	65-69.9%
C-	1.67	60-64.9%
D+	1.33	55-59.9%
D	1.00	50-54.9%
F	0.00	0-49.9%

Non-graded (PASS/FAIL) courses

In the case of a non-graded course, the following assessment percentages apply

Description	Percentage
Pass	59% or Above
Fail	Below 59%

Program Completion Requirements

Satisfactory completion of the MSc program requires that the student progress through a number of distinct stages, each of which is characterized by a key evaluation point (See Anex). The necessary stages are:

1) Satisfactory application to the program;
2) Completing all required coursework in the program (90 ECTS);
3) Satisfactory completion of the master thesis (30 ECTS);
4) Satisfactory achievement of minimum GPA for continuation through semesters and graduation (Candidacy).

Continuation / normal progress

To continue in the MSc-CS graduate program at SEDS, NU, a student must maintain a minimum CGPA of no less than a **B- (2.67 on a 4-point scale)** after each grading period and conform to all program rules and policies to maintain normal progress toward degree. A student who fails to satisfy the continuation requirement for the program is subject to dismissal.

Appealing against grades

If a student believes that she or he has received an unfair or erroneous grade, the student may appeal. The following are cases for appeal:

1) In the case of an examination. The student must first consult with the instructor within 5 working days of her or his receipt of the contested grade (this time may be extended in the event that the instructor can be shown to have been unavailable during the period following the student's receipt of the grade in question). The Instructor must respond within the next 5 working days. In the event that the student is still dissatisfied, she or he may appeal to the Dean of the School (or the Dean's designee) within 5 working days. The Dean (or her or his designee) shall consult with the Instructor before making any decision. The decision of the Dean (or of her or his designee) shall be final;

2) In the case of a Final Course Grade. The student must first consult with the instructor within 5 working days of her or his receipt of the contested grade (this time may be extended in the event that the instructor can be shown to have been unavailable during the period following the student's receipt of the grade in question). The date to be used for appeals of Final Course Grades is the date published in the Academic Calendar. The Instructor must respond within the next 5 working days (that time may be extended in the event the instructor is shown to have been unavailable during the period following the student's receipt of their final grade). In the event that the student still believes that the grade is incorrect, or the Instructor has not replied within 15 days, the student may appeal to the Dean of the School (or the Dean's designee) within 5 days. The Dean (or her or his designee) shall consult with the Instructor before making any decision. The decision of the Dean (or her or his designee) shall be final.

Plagiarism

In any coursework or thesis assessment, unacknowledged copying or plagiarism is not acceptable. Plagiarism can result in extremely serious academic actions including cancellation of any or all results, suspension from the program, or even expulsion. Plagiarism means using the work of others in preparing an assignment and presenting it as your own without explicitly acknowledging – or referencing – where it came from. Plagiarism can also mean not acknowledging the full extent of indebtedness to a source. Work can be plagiarized from many sources including books, articles, the internet, and other media. Plagiarism can also occur unconsciously or inadvertently. Direct copying is definitely plagiarism. Paraphrasing of another's work without acknowledgment is also plagiarism. Submitting someone else's work or ideas without attribution is not evidence of your own grasp of the material and cannot earn you marks.

Nazarbayev University's policy on plagiarism sets out student responsibilities in regard to copying. Students are responsible for ensuring that:

- They are familiar with the expected conventions of authorship and the appropriate use and acknowledgement of all forms of intellectual material relevant to their discipline.
- The work submitted for assessment is their own.
- They take all reasonable steps to ensure their work cannot be accessed by others who might seek to submit it, in whole or in part, as their own.

Whenever you refer to another person's research or ideas -either by directly quoting or by paraphrasing them-, you must acknowledge your source by proper referencing. Turnitin is a useful web-based originality checking service that can help in assessing the originality of one's submitted work. More information on Turnitin can be found in **Error! Reference source not found.** and service's web site (http://turnitin.com/).

Description of Courses

***Note: In future, minor changes in courses and/or program, subject to approval by SEDS Teaching and Learning Committee, may not be reflected in this document, however, these would be reflected in the corresponding Course Specification Forms.**

Program Core Courses

- **Discipline Core**
  - CSCI 501 Software Principles and Practice
- **Research**
  - SEDS 591 Research Methods
  - SEDS 592 Research Seminar
  - CSCI 693 Thesis Proposal
  - CSCI 694 Thesis
- **Communications and Practicum**
  - MSC 601 Technical Communication
  - CSCI 502 Teaching Practicum
  - CSCI 503 Laboratory Practicum

CSCI 501, Software Principles and Practice

An accelerated course on modern software design and implementation, which includes modules on abstraction and encapsulation techniques, component-based design, advanced data structures, algorithms, and performance.

CLOs

By the end of the course the student will be expected to be able to

1. Explain why concepts such as abstraction and encapsulation are important in modern software design, and demonstrate with real examples
2. Explain and show how component-based design and object-oriented approaches to software development can be used to enforce good design principles
3. Perform asymptotic analysis and amortization to demonstrate the efficiency of an algorithm or data structure
4. Perform rigorous functional and performance evaluations through testing
5. Describe the key issues relating to the design and implementation of a new programming language
6. Implement a simple functional or imperative programming language from a language specification

SEDS 591, Research Methods

This course introduces students to representative research methodologies such as surveys, interviews, experimentation, and case studies. Students then review the fundamental approaches to research design, data collection, analysis, and presentation.

CLOs

By the end of this course, students will be able to:

1. Understand the need for and role of scientific research;
2. Undertake research activities in a structured and formalized manner;
3. Recognize and observe proper ethical standards used in the conduct of scientific research;
4. Identify potential misconduct or ethical breaches;
5. Identify authoritative sources;
6. Recognize and select relevant methodologies;
7. Understand and implement proper techniques of data acquisition, storage, access, and management;
8. Recognize the role of intellectual property rights (know-how, trade secrets, patents, etc.).
9. Communicate effectively in written and oral formats.

SEDS 592, Research Seminar

The course requires students to select a topic, identify authoritative sources, generate an annotated bibliography, and compose a survey paper representing the current state-of-the-art in the selected topic area, and prepare a presentation based on the survey paper. The course includes a series of research presentations, presented by domain experts, to expose students to current research programs, and facilitate the thesis topic selection by students.

CLOs

By the end of this course, students will be able to:

1. Conduct a literature search;
2. Prepare a detailed bibliography;
3. Analyze current research and critically review for strengths and weaknesses;
4. Recognize and extract relevant information from scientific papers, seminars, and presentations;
5. Prepare a survey paper representing the state-of-the art in the topic area;
6. Present the results to both technical and non-technical audiences.

CSCI 693, Thesis Proposal

The course requires students to select a suitable topic for thesis study, secure the participation of a thesis advisor, then generate and defend a thesis proposal

CLOs

By the end of this course, students will be able to:

1. Conduct a literature search;
2. Prepare a detailed bibliography;
3. Develop a methodology to conduct the project;
4. Describe project milestones and the corresponding timeline, using appropriate project management techniques (PERT, GANTT);
5. Assess resource availability and gap analysis;
6. Prepare and present a thesis proposal.

CSCI 694, Thesis

Student will conduct independent work under the direction of a supervisor on a research problem in the student's designated area of research. The student will prepare and defend the thesis.

CLOs

By the end of this course, students will be able to:

1. Conduct independent work on the topic as designated in the Thesis Proposal;
2. Manage task completion in accordance with the established project milestones;
3. Summarize achievements of each stage of development;
4. Review and revise project schedule in accordance with prior achievements, using critical-path management techniques to ensure reasonable conclusion;
5. Write, in an iterative process, the thesis document in consultation with the thesis advisor;
6. Present the results of the independent work to a technical audience.

MSC 601, Technical Communication

This graduate level course combines the application of rhetorical analysis to stylistic conventions of writing in engineering, with a focus on clarity, conciseness, and coherence. Students will employ process writing to produce genre specific writing familiar to Engineers, including research reports scientific papers designed for specific audiences. This course also trains students to deliver effective and appealing professional and scientific presentations, with attention to best practices in the use of technical English and oral communication.

CLOs

By the end of the course, students will be able to:

1. Understand technical communication along a continuum, identifying appropriate writing and speaking strategies for intra-disciplinary, inter-disciplinary, business and public audiences;
2. Determine audience needs and expectations as they pertain to writing and presentation in engineering genres;
3. Organize and prepare coherent and effective scientific texts and presentations for academic, professional, and public audiences;
4. Communicate effectively and efficiently the process of developing, implementing, and evaluating research;
5. Refine writing style for clarity, concision, coherence, and emphasis;
6. Practice the ethical use of sources and appropriate citation conventions;
7. Work with peers to provide written and oral feedback of student work.

SEDS 502, Teaching Practicum

This course introduces the students to best-practice pedagogical methods and innovations in teaching, under the mentorship of senior faculty. The students will conduct classroom and laboratory observations of prominent instructors, using a variety of teaching and learning styles. Later, they will apply educational, instructional, and assessment methodologies in recitation sections of their respective disciplines under the supervision of an experienced faculty member. The will summarize their observations and experiences in a final report.

CLOs

By the end of this course, students will be able to:

1. Recognize high-level program and curricular structure & purpose;
2. Identify and describe a variety of pedagogical methods;
3. Specify specific learning objectives and outcomes for a given topic;
4. Utilize Bloom's Taxonomy in the articulation of learning objectives;
5. Select appropriate assessment methodologies suitable to determine student achievement of stated learning objectives;
6. Conduct the reflective exercises necessary to implement ongoing quality enhancement processes.

SEDS 503, Laboratory Practicum

Students will apply educational and instructional methodologies in laboratory and practical sessions of their respective disciplines under the supervision of an experienced faculty member. They will summarize their observations and experience in a final report.

CLOs

By the end of this course, students will be able to:

1. Identify pedagogical methods for laboratory sessions.
2. Select appropriate assessment methodologies for evaluate the level of achievement of learning outcomes of the specific lab activity.
3. Conduct reflective exercises to assess the effectiveness of the laboratory learning experience, and implement modifications aimed at quality enhancement.

Program Elective Courses

- **Theory Electives**
  - CSCI 511 -- CS Track Core Theory (Theory of Computation)
  - CSCI 512 -- Information Theory
  - CSCI 575 -- Formal Methods and Applications
- **Artificial Intelligence / Intelligent Systems Electives**
  - CSCI 591 – Advanced Artificial Intelligence
  - CSCI 545 – Big Data Analytics
  - DS 504 – Data Mining and Decision Support
  - CSCI 594 – Deep Learning
- **Systems Electives**
  - CSCI 502 – Hardware Software Co-Design
  - CSCI 531 – Distributed Systems
  - CSCI 515 – Modeling and Simulation for Computer Science
  - DS 507 – Database Management Systems
- **Free Electives**
  - CSCI 525 – Quantum Computing
  - CSCI 547 – Algorithmic Trading
  - CSCI 581 – Acquisition and Analysis of Biomedical Data
  - SEDS 504 – Innovation and Entrepreneurship

Other MSc-level courses not listed above may also be counted as Free Electives, at the discretion of the Graduate Committee of the CS Department.

Elective Courses Descriptions:

CSCI 511, CS Track Core Theory

In the course, we will investigate different models of computation, such as finite-state machines and push-down automata, and discuss their strengths and limitations. We will then look at the historical and theoretical background of Turing machines and computability, and we will investigate ways to demonstrate (un-)decidability and (non-)recognizability of languages. Computational intractability and NP-completeness will also be discussed as part of the course.

CLOs

By the end of the course the student will be expected to be able to:

1. Understand Big-Oh notation to analyze and compare algorithms in terms of their worst case running time.
2. Analyze randomized algorithms in terms of their expected running time performance.
3. Use fundamental algorithm design techniques including divide-and-conquer, dynamic programming and greedy to solve problems.
4. Explain and use main data structures including priority queues, hash tables with different collision resolution schemes, disjoint sets to obtain efficient implementations of algorithms.
5. Explain comparison-based sorting algorithms along with lower bounds on sorting, primary search and order statistics algorithms.
6. Explain what graphs are, different data structures for graph storage and basic graph traversal algorithms.
7. Devise algorithms to solve path and connectivity problems on graphs, using methods learnt thus far, including shortest paths and network flows.
8. Explain what Non-determinism is and the concept of NP-hardness and use reductions to prove NP-hardness.

CSCI 512, Information Theory

The course examines seminar works on the origin of information theory, relating to data generation, storage, and transmission, and related topics of compression, error detection and recovery, and the transformation of data into information, using both structured forms (database, query languages) and unstructured forms (crawling, indexing, data mining).

CLOs

By the end of the course the student will be expected to be able to

1. Understand the fundamental limits of communication in the presence of noise
2. Quantify the information requirements and overhead of a given problem
3. Understand and be able to apply different coding techniques
4. Understand the importance of information theory in the telecommunications industry

CSCI 575, Formal Methods and Applications

This course focuses on the use of formal methods in the modelling, specification and analysis of systems. Various kinds of systems from a number of application domains, such as human-computer interaction, software systems, distributed systems, systems biology and ecology, will be considered. Students will learn how to utilize formal notations and automated tools for simulation and analysis.

CLOs

By the end of the course the student will be expected to be able to:

1. Utilize formal notations to define and analyze real-world problems
2. Know for what scenarios and for what problems a formal approach is appropriate
3. To perform simulations and tests with automated tools to verify and validate the properties

CSCI 591, Advanced Artificial Intelligence

This course covers the latest advances in probabilistic, statistical and network-based computational models for real world problems such as computer vision and decision making. Topical coverage will begin at hidden Markov Models, through Markov networks, up to conditional random fields. Additionally, we will never cover novel advances in artificial neural networks such as convolutional neural networks, deep learning models and recurrent neural networks.

CLOs

By the end of the course the student will be expected to be able to:

1. Utilize common probabilistic graphical models and analyze real-world problems, data
2. Utilize efficiently the causal reasoning methods available to find problems in statistical reasoning
3. To construct models from data, verify them and use them on test cases or other real-world situations

CSCI 545, Big Data Analytics

Recent advances in technology have led to orders-of-magnitude increases in the amount of data that is being produced and archived. This phenomenon has been generically referred to as Big Data. Examples of such data include internet traffic and logs, social media, large scale scientific projects, and health records. The process of deriving actionable insights from these large volume and heterogeneous data sets is referred to as Big Data Analytics, and poses new challenges in all aspects of computing. This course will review essential statistical and machine learning techniques for data processing and examine their scalability. Students will gain an understanding of current best practices in Big Data processing and complete assignments and projects with a variety of relevant software tools.

CLOs

After taking and successfully passing this course, students will be able to:

1. have the required mathematical basis to study big data analytics

2. to derive a whole range of covered algorithms from first principles
3. to understand their theoretical basis and assumptions these may have
4. to implement a range of techniques themselves in python from scratch
5. to identify appropriate techniques for a given dataset
6. to validate their approach, e.g. by means of cross-validation
7. to understand the bias-variance trade-off (i.e. overfitting/underfitting)

DS 504, Data Mining and Decision Support

The course will start with setting the context by exploring the relationships between data mining, artificial intelligence, machine learning, deep learning, and statistics fields. It will then introduce knowledge representation, input preparation (preprocessing), fundamental data mining techniques (like probabilistic modeling, linear modeling, association mining, etc.), minimum description length (MDL) principle, validation techniques, decision trees, association rules, instance-based learning models, data transformations, data projections, Bayesian methods, and ensemble learning techniques (bagging, boosting, stacking, etc.) within the supervised, unsupervised and semi-supervised learning frameworks. Data visualization and warehousing methods along with examples from various application areas will also be visited to illustrate the use of data mining in decision support systems and processes.

CLOs

By the end of the course the student will be expected to be able:

1. to understand a large set of supervised and unsupervised data mining algorithms along with their advantages and limitations
2. to select an appropriate algorithm for a given problem and to quantitatively evaluate the fitness of a model generated by the selected algorithm
3. to develop practical and trustable algorithmic solutions to be used by decision makers
4. to be ready and well-prepared to participate, work in and/or scientifically contribute to related organizations and industries

CSCI 594, Deep Learning

This course is a one-semester course intended for graduate students in Computer Science and Data Science graduate programs. It introduces the students to the concepts and existing models and techniques of deep learning. The main themes of the course are benefits, properties and challenges of deep learning; introduction to machine learning and optimization; challenges and common approaches; regularization; convolutional neural networks; deep recurrent networks and sequence learning; generative adversarial networks; autoencoders; advanced deep learning topics; applications. The students will learn how to design a deep learning architecture. The course presents several common deep learning techniques and exposes the students in learning how to use deep learning in a very efficient manner. Students will gain experience through assignments and projects, with an emphasis on proper deep learning practices with appropriate applications.

CLOs

By the end of the course the student will be expected to be able:

1. to develop solutions using deep learning with Python programming language and environments to solve problems and perform specified tasks, using proper hyper parameters and optimization techniques;
2. to understand and apply concepts related to deep learning, such as logistics regression; gradient descent; regularization; Convolutional Neural Networks; Deep Recurrent Networks; Generative Adversarial Networks; Autoencoders;
3. to critically determine how to select a deep learning approach for a domain and task;
4. to gain knowledge about state-of-the-art solutions using deep learning
5. to understand the strengths and weaknesses of various deep learning approaches;

CSCI 502, Hardware Software Co-Design

This course covers the design of complex hardware-software based systems with an emphasis on embedded devices. Topics cover models for representing hardware and software components of a system, hardware-software partitioning, design space exploration, performance analysis and estimation, scheduling, real-time aspects and hardware interfacing. The course will have practical sessions introducing students to different hardware types such as microcontrollers, microcomputers with real-time operating systems and mobile devices with high connectivity.

CLOs

By the end of the course the student will be expected to be able to:

1. Describe embedded microprocessor architecture, peripheral interfacing and embedded operating system principles;
2. Work in a Linux operating system running on a personal computer PC and an embedded hardware and program multitasking applications in C/C++ language;
3. Interface various sensors to a system-on-chip microprocessor board via various communication protocols and analyze sensor data using data fusion algorithms.
4. Work in a part of the team on embedded system design for engineering problems developing creative thinking and communicative skills.
5. Self-study and work independently on engineering projects.

CSCI 531, Distributed Systems

This course focuses on the design, specification, and verification of distributed systems and their underlying algorithms. Topics such as synchronization, mutual exclusion, safety, liveness, and consensus will be covered. Students will learn how to utilize formal notations and automated tools for simulation and verification of distributed programs as part of this course.

CLOs

By the end of the course the student will be expected to be able:

1. To describe and apply common techniques used for synchronization and mutual exclusion in software systems

2. To understand and describe common techniques used for recovering from errors or failure in distributed systems
3. To understand and apply logical reasoning to show that given distributed systems do or do not have specified safety and liveness properties
4. To gain knowledge about and describe how modern distributed system algorithms are used in real-world systems

CSCI 515, Modeling and Simulation for Computer Science

The roots of computer science can be traced to modeling things such as trajectories of artillery shells and cryptographic protocols, both of which pushed the development of early computing systems in the early and mid-1940's. A principal approach to modeling and simulation is abstraction, so that real world systems can be effectively simulated on a machine. In this course, we will examine modeling techniques such as Monte Carlo methods, stochastic processes, queuing theory, and Markov chains. Assessment and evaluation of approaches will also be covered. Important application areas that may be investigated include computer systems and networks, diagnostics, economics and finance, and urban planning.

CLOs

By the end of the course the student will be expected to be able to:

1. To acquire skills in handling situations involving more than one random variable and functions of random variables.
2. To apply basic probability techniques and models to analyze the performance of computer systems, and, in particular, of networks and queues.
3. To have a well – founded knowledge of standard distributions which can describe real life phenomena.
4. To understand and characterize phenomena which evolve with respect to time in a probabilistic manner.
5. To expose the basic characteristic features of a queuing system and acquire skills in analyzing queuing models.
6. To use discrete time Markov chains to model computer systems.
7. To learn how to analyze a network of queues with Poisson external arrivals, exponential service requirements and independent routing

DS 507, Database Management Systems

This course is a one-semester course intended for graduate students in Data Science and Computer Science graduate programs. This course focuses on the design, analysis and implementation of database management systems. Most of the topics will be covered as case studies using commercial and open-source database components such that the students can learn a wide-range of tools and techniques and also assess the trade-offs. Student will implement their own database management system as the integrated course project. Therefore, strong programming skills are required. The course will cover topics

such as relational, document, key/value data models, storage models and architectures, query languages (e.g. SQL), various types of indexing, transaction management and recovery, query processing, distribute/parallel database architectures, and big data and NoSQL database models and systems.

CLOs

By the end of the course the student will be expected to be able to:

1. Design and develop database applications proficiently
2. Understand the fundamental structure of various database systems.

CSCI 525, Quantum Computing

In this course, students will be introduced to the most salient concepts in quantum computing, a relatively recent approach that specifically targets computing on the atomic and subatomic levels. The basics of quantum computing, including quantum states, unitary operators, and measurements will be presented. Through reversible and quantum circuits, students will learn and understand the advantages and limitations of quantum computing. Finally, different models of quantum computing will be given as illustrations of potential technological implementations.

CLOs

By the end of the course the student will be expected to be able to:

1. Derive residual quantum state after measurement, apply unitary operations on quantum states prove correctness of quantum algorithms
2. Design quantum algorithms, describe quantum circuits and analyze the circuit complexity
3. Explain quantum Fourier transform, construct quantum Fourier transform circuit, Understand phase estimation, describe the quantum algorithm solving phase estimation, explain order finding, describe and analyze the quantum order finding algorithm based on phase estimation, understand reflection and rotation, describe Grover\'s search algorithm and geometric analysis
4. Define mixed states, describe teleportation and CHSH game, distinguish pure states vs. mixed states, understand bit-flip and phase-flip errors, construct simple quantum error correction codes, explain the need and principle of fault-tolerant quantum computing

CSCI 547, Algorithmic Trading

Financial practices have substantially benefited from the domains of computer science (CS) and artificial intelligence (AI), to the point that most trading in major financial markets are now governed by algorithms. This course aims to provide the CS students with the necessary background and guidance in order to have them practically apply their CS and AI knowledge in financial domains. The course consists of 4 parts: In the first part of the course, all necessary financial background will be provided. In the second part, tangible mechanics of the domain (like the Financial Information Exchange, FIX, protocol, and order book dynamics) will be covered. In the third part, algorithmic side of the financial transactions will be elaborated on. And in the last part, quantitative strategies (like portfolio construction, high-frequency trading, news handling, etc.) which make heavy use of statistics, AI, data mining, time series analysis, and performance evaluations will be covered.

CLOs

By the end of the course the student will be expected to be able:

1. to become comfortable and fluent with the terminology and practices of the financial applications of computer science and artificial intelligence
2. to design and develop both client and server sides of trading applications using native Financial Information Exchange protocol
3. to understand the strengths and weaknesses of major trading algorithms, and to assess and compare their performances
4. to develop quantitative financial solutions which make use of statistics, artificial intelligence and computer science practices
5. to be ready and well-prepared to participate, work in and/or scientifically contribute to financial organizations and industries

CSCI 581, Acquisition and Analysis of Biomedical Data

Students will learn a number of important topics in the field of computational biomedicine. They will study various topics within the biomedical domain, including primers of anatomy, physiology as well as the basis of various biomedical imaging techniques. Signal processing tools, such as filter theory, artifact rejection, as well as PCA and CSP will be covered. Additionally, we will cover how uni- as well as multi-variate features can be employed for decoding. Practical computing sessions will be carried out and students will also perform a project, where all research-related steps will be covered.

CLOs

By the end of the course the student will be expected to be able:

1. to know some basic anatomical and physiological concepts
2. to understand the basis of various biomedical imaging techniques, such as EEG, NIRS, fMRI, ECG, EMG, among others
3. to understand which different imaging correlates can be measured and analyzed by various imaging modalities
4. to understand and implement a range of data analytical techniques, that are common to biomedical related data analysis in particular, but also for computational approached in biomedicine in general
5. to design and conduct a small biomedical study, i.e. experimental design, implementation, conduction, data analysis, report writing

SEDS 504, Innovation and Entrepreneurship

This course, which requires no background in business studies, exposes the students to fundamental ideas regarding innovation and entrepreneurship. Topics covered will include: how to identify business opportunities and to acquire customers, how to develop a business model, understand investments, and manage risks.

CLOs

By the end of this course, students will be able to:

1. Conduct a market assessment and niche analysis;
2. Prepare a business plan which describes the opportunity and presents the innovation concept;
3. Provide a technical characterization of the solution strategy;

4. Design and/or prototype the solution;
5. Prepare a marketing plan for the proposal.

Master Thesis Guidelines

The guidelines presented here form a manual designed to provide you with a quick reference for planning, preparation, and compilation of your thesis.

Aims and Objectives

The Master's thesis constitutes a piece of research and in this context, your primary goal is to analyze, solve and present your research findings for a problem relevant to your field of study. This process should be based on existing scientific and engineering knowledge and follow the principles of responsible research conduct.

The topic of your thesis should be related to your degree program and should be decided in agreement with your thesis supervisor and approved by the MSc program coordinator.

The primary focus of your research project is usually expressed in terms of **aims** and **objectives**. Your aims should comprise aspirations and/or intentions defined in broad terms which essentially describe what you are hoping to achieve. These aims set out what you targeting to deliver at the end of the project. Objectives, on the other hand, are specific statements that define measurable outcomes and comprise specific goals and steps that must be followed for achieving your aims. Your objectives should be:

Specific; provide precise descriptions of what you are going to do.
Measurable; be able to provide concrete evidence when reaching a goal.
Achievable; avoid setting infeasible goals.
Realistic; plan your steps and goals based on the available resources (time, equipment, skills, etc.)
Timely delivered; create a timetable, know when each stage needs to be completed, allow extra time for unexpected delays

Thesis Content

You should consider the following when conducting research and compiling your thesis manuscript:

- Always include a detailed literature review. The literature review should describe the existing theory and research in your thesis area and provide a context for your work. Reference all sources mentioned in the review and give full citation in thesis's Reference List.
- Explain the methods used in researching and developing your work. It is important to explain what research methods you used to acquire data.
- Discuss with your thesis supervisor the extent and level of detail required; different levels of research depth will obviously require different levels of detail.
- Clearly present your findings and describe what have been discovered. Include tables, graphs, illustrations etc., so that it is easier for the reader to understand your results.
- Always, include a discussion of your findings. Use a discursive and evaluative writing approach and fully present your interpretations and judgements of your results. Contextualize your ideas in relation to other theories and with similar research, particularly in reference to the works mentioned in your literature review.

Stages and Procedures

Students should follow the roadmap described in five stages to accomplish the MSc thesis:

STAGE 1: Identify Thesis Supervisor (Thesis Committee)

Students are expected to choose their MSc thesis supervisor before the end of the second semester of the first year, and spend the summer conducting preliminary work on their thesis project. Constructive supervision is a significant component aiming in the success of your thesis work and requires the vivid interaction between you and your supervisors. Your Supervisor is responsible for ensuring that the Master's thesis meets the goals and requirements set by SEDS.

Furthermore, the thesis committee must have at least three members. One of these can be assigned as the Co-Supervisor of the student. The thesis committee should include an external committee member who is external to the department and can be an academic from another NU department, university or, alternatively, an expert from the industry holding an appropriate academic degree and specializing in your thesis's scientific field.

STAGE 2: Thesis Topic Selection

Supervisors are in position to suggest appropriate MSc thesis's topics. These may stem from research work being conducted at the school/department or may arise from material covered during your coursework. Furthermore, thesis topics may be also related to work carried out in the context of research projects involving industrial partners. The topic of the thesis is decided in discussions between you and your chosen supervisors; however, the final choice is always made by you. In this regard, it is customary for faculty members to announce topics in helping you choose your thesis topic.

STAGE 3: Submission of Thesis Proposal

The MSc proposal should be submitted by the end of the third semester and approved by the thesis supervisor. Your thesis proposal should clearly address the following items:

- Outline of the problem/area of application
    - Explain why you think it is worth investigating
    - Set your ideas into a theoretical/academic context
- Aims and Objectives
    - Describe what you are aiming to achieve
    - Present the steps and approaches you will employ for reaching your goals
- Methodology
    - Explain what methods you intend to use when researching and developing your work
    - Use a descriptive writing approach corresponding to the detail required for the panel's comprehension of your approach.
- Scope and constraints
    - Clearly set your scope and anticipated constraints:
        - Your selected topic may be vast with numerous applications and thus, you might want to limit your work in an area of application
        - You may not be able to conduct some research due to constraints on time, cost, or availability of resources
- Discuss requirements on resources
    - Do you need any special lab equipment?
    - Is literature review possible with library's resources?
    - Are any materials and/or consumables required in your research?
- Propose a draft timetable for your thesis

STAGE 4: Carrying out Research and Thesis Manuscript Preparation

Once your proposal has been officially approved, the actual work may begin. It is crucial that you are always well-prepared in meetings with your supervisor. In this context, it is a good practice to always keep minutes of your meetings and circulate agendas with clearly outlined discussion points and expected results prior to your meetings. This makes it easier for the supervisor to focus on significant issues, leading to a better response for you. If you feel that you may have misunderstood a concept, or you are not certain of the steps required for performing a task, ask your supervisor for clarifications or further guidance. The supervisors should always guide you with advices on the topics and tasks you should put emphasis on and at the same time turn you away of tasks that may waste your time.

Finally, you must keep in mind that writing a thesis takes significant time and effort. You should keep track of your work, make notes, write intermediate reports so that when your work has approached a certain maturity, you will be able to compile a successful thesis's manuscript.

STAGE 5: Thesis Submission and Defense

Before submitting your manuscript, your supervisor will check it thoroughly and give you feedback on corrections and changes that need to be made.

When you have prepared the revised document, you submit to your supervisory committee and external examiner for evaluation. Keep also in mind that you should aim at meticulously following your supervisor's comment and corrections so that a series of multiple revisions can be avoided. When your supervisory committee & the external examiner approve the final document, your Lead supervisor will get permission to submit your final thesis report for evaluation.

Thesis Grading

The MSc. Thesis must be compiled in a report (manuscript) according to the specification provided by the course instructor of the CSCI 694 Thesis course and defended in front of the MSc. Thesis committee, which comprises of the supervisor and committee members (including the external committee member). The MSc. Thesis manuscript and MSc Defense Oral presentation will be evaluated according to the following assessment criteria.

MSc Thesis Assessment

- ***Presentation of the research problem and thesis's objectives***
  - Is the research problem clearly specified and contextualized?
  - Are the research questions and hypotheses clearly formulated?
  - Does the thesis capture the relevance, rationale, and objectives of the proposed research?
- ***Literature review***
  - Does the thesis include a comprehensive review and critical discussion of the relevant literature and/or technological developments?
  - Is there a description on how the conducted research positions itself within the generic context of works which have been published in the area?
  - Is the relevant background theory covered? Are the presentation, discussion and explanation provided, adequate? Has the theory been contextualized appropriately within the framework of the research problem being investigated?
  - Have the latest theoretical developments in the area been presented and described?
  - Does the student demonstrate a systematic understanding of the relevant background material and knowledge?
- ***Methodology, design and implementation***
  - Are the adopted methodologies and/or design approaches clearly justified and described?

- Is the implementation well explained?
- Is there a clear identification of any limitations, assumptions and constraints which affect the application of the employed methodology, design approach and implementation?

- ***Testing, results, analysis, evaluation concluding remarks & future work***
  - Are the test procedures sound and objective?
  - Do the proposed tests address the research problem being investigated?
  - Are the test conditions, assumptions, constraints, and limitations clearly identified?
  - Are the results clearly presented, analyzed objectively and critically evaluated?
  - Do the concluding remarks summarize the work done? Are there suggestions for any future development and/or enhancements?
- ***Structure and presentation of thesis***
  - Are the thesis contents well structured, focused, and easy to follow?
  - Are the student's contributions and assumptions clearly communicated to the reader?
  - Is it in compliance with the given guidelines?
  - Is it clearly presented and organized? Is the grammar and usage of English of an appropriate level?

Oral Presentation Assessment (MSc Thesis Defense)

PRESENTATION:

- ***Speech & Style***
  - Clear and easily understood. Correct use of terms.
  - Easy-to-understand sequence. Professional appearance. Use of good English.
- ***Structure of the Presentation***
  - Logical sequence, good flow. Supporting body of literature mentioned.
  - Development of topics described clearly. Smooth progression from topic to topic.
  - Key points & challenges sufficiently highlighted.
- ***Layout of Visual Aids***
  - Clear power point slides, uncluttered. Concise & precise slides.
  - Use of good English. Good use of charts, tables, diagrams, etc.
- ***Questions & Answers***
  - Clear understanding of the questions.
  - Concise answer responding to the point of the question.

TECHNICAL CONTENT:

- ***Introduction***
  - Problem statement & project objectives. Coverage of all main points of the project.
  - Literature review and conclusions. Relevance to the need of industry, society etc.
- ***Technical Competency***
  - Viability of the design concept. Justification of the approach
  - Design methodology. Practical Implications.
  - Quality of the concept presentation. Interpretation of the achieved results.
  - Use of relevant tools/equipment/software.
- ***Conclusions, Future Work & Professional ethics***
  - Conclusions: advantages and disadvantages.
  - Level of the project objectives achievement.
  - Future work and possible improvements.
  - Consideration in design and solution. Applicability to real-life situations.
  - Compliance with good practices and standards.

© 2020-21, Dept. of Computer Science, School of Engineering and Digital Sciences Nazarbayev University