Committee for the Evaluation of Computer Science Study Programs

The Hebrew University of Jerusalem
School of Computer Science and Engineering
Evaluation Report

November 2014

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Chapter 1: Background

The Council for Higher Education (CHE) decided to evaluate study programs in the field of Computer Science during the academic year of 2012-2013.

Following the decision of the CHE, the Minister of Education, who serves ex officio as Chairperson of the CHE, appointed a Committee consisting of:

- Prof. Maurice Herlihy - Computer Science Department, Brown University, USA - Committee Chair
- Prof. Robert L. Constable - Computer Science Department ,Cornell University, USA[1]
- Prof. David Dobkin - Department of Computer Science, Princeton University, USA[2]
- Prof. Sarit Kraus - Department of Computer Science, Bar Ilan University, Israel[3]
- Prof. Dmitry Feichtner-Kozlov - Department of Mathematics, Bremen University, Germany
- Prof. Joe Turner, Jr. - (Emeritus) - Department of Computer Science, Clemson University, USA - ABET Representative
- Prof. Moshe Vardi - Department of Computer Science, Rice University, USA

Ms. Maria Levinson-Or served as the Coordinator of the Committee on behalf of the CHE.

Within the framework of its activity, the Committee was requested to:[4]

1. Examine the self-evaluation reports, submitted by the institutions that provide study programs in Computer Science, and to conduct on-site visits at those institutions.

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[1] In accordance with the CHE's policy, Prof. Robert L. Constable did not participate in the evaluation of the Computer Science department at Ben Gurion University to prevent the appearance of a conflict of interests.

[2] Due to scheduling constraints, Prof. David Dobkin did not participate in the site visits to the Jerusalem College of Technology, Hadassah Academic College, Ariel University, the Weizmann Institute of Science, the College of Management Academic Studies, Holon Institute of Technology, the Hebrew University of Jerusalem, and the Technion.

[3] In accordance with the CHE's policy, Prof. Sarit Kraus did not participate in the evaluation of the Computer Science department at Bar Ilan University to prevent the appearance of a conflict of interests.

[4] The Committee's letter of appointment is attached as **Appendix 1**.

2. Submit to the CHE an individual report on each of the evaluated academic units and study programs, including the Committee's findings and recommendations.
3. Submit to the CHE a general report regarding the examined field of study within the Israeli system of higher education including recommendations for standards in the evaluated field of study.

The entire process was conducted in accordance with the CHE's Guidelines for Self-Evaluation of (October 2011).

Chapter 2: Committee Procedures

The Committee held its first meetings on May 21, 2013, during which it discussed fundamental issues concerning higher education in Israel, the quality assessment activity, as well as Computer Science Study programs in Israel.

In May - June 2013, the Committee held its first round of visits of evaluation, and visited the Hadassah Academic College, Jerusalem College of Technology, Ariel University, Tel Aviv University and Bar-Ilan University. In January 2014, the committee held its second round of visits of evaluation, and visited Ben-Gurion of the Negev, the Open University of Israel, the Interdisciplinary Center Herzliya, Tel-Aviv Yaffo Academic College, Netanya Academic College, Weizmann Institute of Science, College of Management Academic Studies, and Holon Institute of Technology. In May 2014, The committee held its third round of visits of evaluation, and visited the Hebrew University of Jerusalem, the University of Haifa, Tel-Hai Academic College, and the Technion. During the visits, the Committee met with various stakeholders at the institutions, including management, faculty, staff, and students.

This report deals with the Computer Science program at the Hebrew University of Jerusalem. The Committee's visit to the Hebrew University of Jerusalem took place on May 18-19, 2014.

The schedule of the visit is attached as **Appendix 2**.

The Committee thanks the senior management of The Hebrew University of Jerusalem and the School of Computer Science and Engineering for their self-evaluation report and for their hospitality towards the committee during its visit at the institution.

Chapter 3: Evaluation of the Computer Science Study Program at the Hebrew University of Jerusalem

This Report relates to the situation current at the time of the visit to the institution, and does not take account of any subsequent changes. The Report records the conclusions reached by the Evaluation Committee based on the documentation provided by the institution, information gained through interviews, discussion and observation as well as other information available to the Committee.

1. Executive Summary

Computer science is central to the Israeli economy and even to its security. Among winners of the Turing award (generally considered as the "Nobel Prize" for computer scientists), Israel has more recipients than all but one other country.

The Hebrew University of Jerusalem Computer Science department ranks among the top computer science academic units in the world. The committee was impressed by the high morale of faculty at all levels and of graduate students. The department also provides excellent administrative and technical support both to her students and staff.

The undergraduate program in Computer Science is considered among the best in the country. However, it has grown very quickly over the past decade, without receiving adequate resources to support that growth. The mandatory classes, which also attract many students from different departments other than computer science, are often very large, as are many practice sessions. This mismatch results in a declining learning experience for the students. Comprehensive thinking on that subject, which might have a long term effect on the program, is required by both the university and the program.

The Computer Science faculty is of distinguished scholars, engaged in rigorous research and it is the committee's believe that the department is in a position to secure more European funding. Members of the faculty should also be nominated

for more national and international distinctions and honors. Both things will increase the department's ability to attract students and faculty, and will raise its academic ranking.

The committee was concerned with the high attrition of students both from the undergraduate program and the graduate program. Given the academic strength of the students admitted to the Computer Science Department, holding one of the highest admission rates in the university (second only to the Medical School) one would expect a lower attrition. The Committee could not determine the exact reasons for that attrition after only a short visit, and few options are possible. Nevertheless the department should look more thoroughly into that phenomenon and take steps to decrease the dropout rate dramatically.

The Computer Science Department has no established alumni relations program, nor does it have an industrial affiliates program. We believe that such programs may benefit the school. The industrial affiliates program should be accompanied with the forming of an industrial advisory board that can help guide the department on industry needs and advocate for it.

In addition, the Computer Science Department should create a strategic plan, articulating and prioritizing areas for future expansion, based on the school needs. Future hiring should not be left to ad hoc decisions.

Overall the school made a good effort in their self-evaluation to obtain input from a variety of sources. The committee appreciate the effort and hope the school will find both the internal process and the committee's report helpful in improving the program.

2. <u>**Organizational Structure**</u>

<u>Observations and findings</u>

The Computer Science Department is part of the School of Computer Science and Engineering, which is the home for different programs (e.g., Applied Physics, Bioengineering, Computer Engineering etc.). A positive aspect of this structure, and specifically of having computer science together with computer engineering, is that it leads to a healthy balance between practical and theoretical areas, strengthening both disciplines. However practical areas in computer science are still underrepresented in the program.

The School of Computer Science and Engineering appears to be in transition from a unit of the Faculty of Science to a stand-alone faculty. Such a transition will advance the goal of making computer science central to a variety of disciplines and will support the evolving interdisciplinary nature of the filed.

The Hebrew University also has a Programming Instruction Unit, however this unit has no formal relationship with the School of Computer Science and Engineering. The committee finds it odd. Such a relationship may prove to be beneficial if leads to the involvement of Computer Science in conversations about the impact of information technology on educational programs across the university.

There is no structured contact of the school with its alumni at the moment. The university is now trying to establish an alumni relations program and the committee encourages the university and the school to maintain and expand this program. Furthermore, the school has no industrial affiliates program. We encourage the school to create such a program, and to go further and set up an industrial advisory board with carefully chosen members. Such a board can advise the school on industry needs and advocate for the school.

<u>Recommendations</u>

Short term [~ within 1 year]:

1. The university should establish structures, such as joint positions and joint programs, to facilitate synergistic interaction between computer science and other disciplines.

2. The school should continue its efforts to hire from a diverse range of technical areas in computer science.

3. The university should establish a formal relationship between the Programming Instruction Unit and the School of Computer Science and Engineering.

4. The school should create an industrial affiliates program and set up an industrial advisory board.

3. Mission and Goals

<u>Observations and findings</u>

Computer Science has a substantial opportunity both to grow and to replace retiring faculty. While the strategic plan had numeric goals, there was no explicit strategy for computer science beyond an expressed desire to hire the best person available. While this is a reasonable short-term strategy, some serious thinking is required to plan the areas in which computer science should grow in the next ten years.

<u>Recommendation</u>

Short term [~ within 1 year]:

The school must develop a strategic plan identifying and prioritizing the areas of growth in which the Computer Science Department plans to hire.

4. Study Programs

<u>Observations and findings</u>

The undergraduate program in Computer Science is considered among the best in the country, but it has grown very quickly over the past decade, without receiving adequate resources to support that growth. The number of new students enrolled by the University Admission Office consistently exceeds the department's target, laying additional stress on the undergraduate program. As a result, mandatory classes, which also attract many students from outside computer science, are often very large.

Size is the problem of many practice sessions as well. The faculty guideline states that there should be one practice session per 30 students, however classes exceed this number regularly. This mismatch results in a declining learning experience for the students, manifested among others in low class attendance. The committee understands that additional resources have recently been allocated to the school, but this has not significantly improved the situation.

The committee was concerned about the high attrition rate in the undergraduate program. Given that computer science students are among the best students admitted to the university, one would expect the drop-out rate to be lower. The data presented also suggest a high attrition rate in the MSc program. There is not enough data to understand the full extent of the problem, and what actions are required. The committee is pleased to note that some corrective actions have been undertaken by the school.

The committee noted some gaps in the undergraduate curriculum relative to the CHE standards[5]. There is insufficient coverage of the subject of programming

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[5] As stated in the CHE standards for studies in Computer Science, attached as Appendix 3.

languages and the mandatory student experience in applications projects and in software engineering is weak.

<u>Recommendations</u>

Short term [~ within 1 year]:

1. The university and the department must undertake a systematic effort to understand the undergraduate attrition problem, including the number of students who drop out of computer science across the length of the program, their reasons for dropping out and where they go. In particular, how many students who finish the first semester graduate within six years?

2. The school must undertake a systematic effort to understand the MSc attrition problem, including the number of students who drop out of the program, and their reasons for dropping out.

3. The school must ensure that mandatory courses are in compliance with the CHE requirements, by including adequate coverage of programming languages, software engineering and an application project.

Intermediate term [~ within 2-3 years]:

1. The university must ensure there is adequate funding to cover the number of students enrolled in computer science.

2. The school must meet the faculty guideline level for the size of practice sessions.

5. <u>Human Resources / Faculty</u>

<u>Observations and findings</u>

The Computer Science Department has a high-quality faculty that consists of distinguished scholars. The department is in a position to secure substantially more European funding. In addition to the financial benefits, such funding would enhance the department's prestige and visibility, making it easier to attract high-quality faculty and students.

Academic staff of this caliber should also have national and international distinctions such as ACM, IEEE, AAAI fellows and similar honors. Such distinctions play an increasingly important role in international academic rankings.

The committee was impressed with the excellent administrative staff that provide such strong support for the students.

Recommendations

Short term [~ within 1 year]:

Within a year, the department must institute an honors committee to promote nominations of faculty members for recognition such as ACM, IEEE, and AAAS Fellow and/or Academia Europea, or other international honors.

Intermediate term [~ within 2-3 years]:

The school must make a systematic and persistent effort to compete for European funding.

6. Students

Observations and findings

The committee was highly impressed with the students of the department across all programs, who appeared to be academically strong, articulate and highly ambitious.

The teaching load for graduate students varies dramatically, and in some cases seems too high. Also, there did not seem to be any school-wide attempt to monitor and ensure graduate student progress. This is often done by a school-wide graduate committee charged with this responsibility.

While the undergraduate students have established an organization that communicates regularly with the department, the graduate students have not done so. Such an organization is an important component of a high-quality graduate program, both for improving communication with the department, and for enhancing the social atmosphere.

Recommendations

Short term [~ within 1 year]:

1. The school must establish a mechanism to monitor and ensure graduate student progress.
2. The school should establish guidelines for PhD student teaching loads and ensure they are met.
3. The school should encourage the graduate students to organize.

7. Teaching and Learning Outcomes

Observations and findings

There seems to be no established process of assessing teaching (other than student survey) or laying out and tracking learning outcomes in each one of the programs. Some courses have stated learning outcomes, but the learning outcomes for the different programs have not been articulated.

Recommendation

Short term [~ within 1 year]:

The school should set in place a process to define and reflect on the attainment of outcomes in a planned, periodic manner.

8. Research

<u>Observations and findings</u>

The Hebrew University of Jerusalem Computer Science program ranks among the top computer science academic units in the world. The committee believes the school is in a position to secure substantially more European funding.

<u>Recommendation</u>

<u>Intermediate term [~ within 2-3 years]:</u>

See recommendation under section 5.

9. Infrastructure

<u>Observations and findings</u>

The infrastructure is excellent.

10. Self-Evaluation Process

<u>Observations and findings</u>

The school made a good effort in their self-evaluation to obtain input from a variety of sources.

Chapter 4: Summary of Recommendations and Timetable
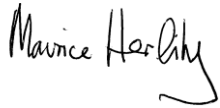
Short term [~ within 1 year]:

1. The university should establish structures, such as joint positions and joint programs, to facilitate synergistic interaction between computer science and other disciplines.
2. The school should continue its efforts to hire from a diverse range of technical areas in computer science.
3. The university should establish a formal relationship between the Programming Instruction Unit and the School of Computer Science and Engineering.
4. The school should create an industrial affiliate program and set up an industrial advisory board.
5. The school must develop a strategic plan identifying and prioritizing the areas of growth in which Computer Science department plans to hire.
6. The university and the department must undertake a systematic effort to understand the undergraduate attrition problem, including the number of students who drop out of computer science across the length of the program, their reasons for dropping out and where they go. In particular, how many students who finish the first semester graduate within six years?
7. The school must undertake a systematic effort to understand the MSc attrition problem, including the number of students who drop out of the program, and their reasons for dropping out.
8. The school must ensure that mandatory courses are in compliance with the CHE requirements, by including adequate coverage of programming languages, software engineering and an application project.
9. Within a year, the department must institute an honors committee to promote nominations of faculty members for recognition such as ACM, IEEE, and AAAS Fellow and/or Academia Europea, or other international honors.
10. The school must establish a mechanism to monitor and ensure graduate student progress.

11. The school should establish guidelines for PhD student teaching loads and ensure they are met.

12. The school should encourage the graduate students to organize.

13. The school should set in place a process to define and reflect on the attainment of outcomes in a planned, periodic manner.

Intermediate term [~ within 2-3 years]:

1. The university must ensure there is adequate funding to cover the number of students enrolled in computer science.

2. The school must meet the Faculty guideline level for the size of practice sessions.

3. The school must make a systematic and persistent effort to compete for European funding.
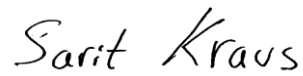
Signed by:

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Prof. Maurice Herlihy
Committee Chair

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Prof. Robert L. Constable

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Prof. Dmitry Feichtner-Kozlov

_____ _____
Prof. Kraus Sarit

_____
Prof. Joe Turner, Jr.

_____
Prof. Moshe Vardi

Appendix 1: Letter of Appointment

12.5.2013
Jerusalem

Professor Maurice Herlihy
Computer Science Department
Brown University
USA

Dear Professor Herlihy,

The Israeli Council for Higher Education (CHE) strives to ensure the continuing excellence and quality of Israeli higher education through a systematic evaluation process. By engaging upon this mission, the CHE seeks to enhance and ensure the quality of academic studies, provide the public with information regarding the quality of study programs in institutions of higher education throughout Israel, as well as ensure the continued integration of the Israeli system of higher education in the international academic arena.

As part of this most important endeavor we reach out to world-renowned scientists to help us meet the critical challenges confronting Israeli higher education by extending our invitation to participate in an international evaluation committee. This process represents an opportunity to assess the current state of the field and plan for the future. This systematic process of quality assessment also establishes a framework for the interactive consultative process taking place between scientists around the globe regarding common academic dilemmas.

It is with great pleasure that I hereby appoint you to serve as chair of the Council for Higher Education's Committee for the Evaluation of Computer Science. The composition of the Committee will be as follows: Professor Maurice Herlihy, Committee Chair, Professor Moshe Vardi, Professor (Emeritus) Joe Turner Jr., Professor Robert L. Constable, Professor Sarit Kraus, Professor David Dobkin, and Professor Dmitry Feichtner-Kozlov.

Ms. Yael Herzstein will coordinate the Committee's activities.

In your capacity as Chair of the Evaluation Committee, you will be requested to function in accordance with the enclosed appendix.

I deeply appreciate your willingness to join us in this crucial enterprise.

I wish you much success in your role as the Chair of this most important committee.

Sincerely,

Dr. Avital Stein
Director General,
The Council for Higher Education

Enclosures: Appendix to the Appointment Letter of Evaluation Committees

cc: Ms. Michal Neumann, The Quality Assessment Division
         Ms. Yael Herzstein, Committee Coordinator

Appendix 2: Site Visit Schedule

Computer Science - schedule of site visit
Hebrew University of Jerusalem

Sunday, May 18, 2014 – building B, Rotberg Buildings, room 316

Time	Subject	Participants
08:45-09:30	Opening session with the heads of the institution and the senior staff member appointed to deal with Quality Assessment	Prof. Menahem Ben Sasson- President Prof. Asher Cohen – Rector Prof. Barak Medina Mount Scopus, Minhala Building, Second Floor (room 506), University Campus
09:30-10:00	*Travel time to Campus Safra*	
10:00-10:45	Meeting with the Dean of the Faculty of Natural Sciences	Prof. Yigal Erel
10:45-11:30	Meeting with the Chair of the Department of Computer Science	Prof. Jeff Rosenschein
11:30-12:30	Meeting with senior academic staff*	Prof. Daphna Weinshall Prof. Nati Linial Prof. Michael Ben -Or Prof. Amnon Shashua Prof. Orna Kupferman Dr. Tommy Kaplan Dr. Aviv Zohar
12:30-13:15	Lunch (in the same room)	
13:15-14:00	Tour of facilities: labs, classrooms, library, offices	
14:00-14:45	Meeting with Junior academic staff *	Shaull Almagor Nir Rosenfeld Dvir Aran Eva Kelman Noam Elron Inbar Huberman
14:45-15:30	Meeting with Adjunct academic staff *	Mark Shovman Ohad Falik Amnon Dekel

Monday, May 19, 2014 - building B, Rotberg Buildings, room 316

Time	Subject	Participants
09:00-09:45	Meeting with Undergraduate Students**	
09:45-10:30	Meeting with Master Students** (Teaching assistants- Graders)	
10:30-11:15	Meeting with Ph.D. students** (Teaching assistants)	
11:15-12:00	Meeting with Alumni	
12:00-13:00	Lunch and Closed door meeting of the Committee	
13:00-13:30	Closing meeting with heads of Faculty	Prof. Jeff Rosenschein Prof. Daphna Weinshall
13:30-14:00	*Travel time to Mount Scopus*	
14:00-14:30	Closing meeting with heads of institution	Prof. Menahem Ben Sasson- President Prof. Asher Cohen – Rector Prof. Barak Medina

* The heads of the institution and academic unit or their representatives will not attend these meetings.
** The visit will be conducted in English with the exception of students who may speak in Hebrew and anyone else who feels unable to converse in English.

Appendix 3: CHE standards for studies in Computer Science

CHE decision of 17.7.08 regarding standards for Computer Science Studies

Bachelor's Degree Programs

A. Graduates

1. In determining these criteria, the committee felt that it would be beneficial to define the "final product", or the ideal graduate of a Computer Science bachelor's degree program:

2. A graduate has an in-depth understanding of Computer Science Theory, Computational Theory, Computational Mathematics, and staunch mathematical knowledge.

3. A graduate has broad knowledge in Computer Science applications (programming languages, software engineering, operations systems and computer design).

4. A graduate is capable of joining development teams in computer-related high-tech industries.

5. A graduate is able to carry out computer-based industrial projects.

6. A graduate is competent in applied analytics, and is capable of developing and integrating effective algorithms in software systems.

7. A graduate has independent study skills and can prepare Computer Science presentations.

8. A graduate is aware of the effects of computerization on individuals, organizations and on society, as well as its ethical, legislative and political ramifications.

9. Excellent graduates are capable of continuing their studies in master's degree programs.

10. To assure that their graduates attain these capabilities, bachelor's degree programs must adhere to the following criteria:

B. Curricula

Programs must include required courses as well as an adequate selection of elective courses.

1. Required (core) courses should include:

- Advanced-level mathematics courses, taught by experienced <u>Ph.D.-level</u> mathematics professors. These should include: Discrete Mathematics, Calculus, Algebra and Introduction to Probability.

- Courses in Computer Science Theory, including: Automata Theory (or a similar subject), Data Structure, Algorithmic Theory and Computational Theory.

- At least one seminar and one applications project that includes accepted industry development processes.

- Applied Computer Science courses in Programming Languages, Software Engineering, Operating Systems, Computer Design and Logical Content.

2. The program should offer as many elective courses as possible in Computer Science and related fields (Economics, Management, Mathematics), as well as Humanities courses, to provide a well-rounded education.

3. The programs should encourage independent study.

C. Students, Teaching and Learning

1. Institutions must adhere to the CHE admissions regulation requiring a matriculation certificate.

2. Students who matriculated in mathematics at a 3-unit level will not be admitted unless they complete (passing a final exam) a preparatory course at the 4 or 5-unit level.

3. "Conditional" admissions should not comprise more than 10% of all admissions.

4. Departments will present detailed support programs for weak students admitted on special terms.

5. Departments will determine rigorous requirements for continuing studies, and coherent diploma eligibility guidelines.

6. Departments will maintain adequate teaching assistant staff, and present detailed programs for providing students with feedback and appropriate laboratory experience.

7. At least 80% of required courses will be taught by full-time faculty.

D. Faculty

1. New programs will require at least six senior Ph.D.-level faculty members; three at the program's inception and an additional two to three before the program start its third "cycle" of admissions and as a condition for final/permanent accreditation.

2. Programs will not get final/permanent accreditation if they lack the requisite number of full-time faculty members to teach at least 80% of the required courses.

3. The student-to-faculty ratio will not exceed 50:1 at colleges and 25:1 at research universities.

D. Infrastructure

The institutions must provide adequate facilities for all programs and faculty research – laboratories, appropriate computers, adequate technical support, up-to-date libraries, fully equipped classrooms, secretarial staff and adequate, fully-equipped faculty office space.

Master's Degree Programs

A. Graduates - General

1. Demonstrates good Self Study Abilities.

2. Has depth and systematic understanding of knowledge in academic discipline.

3. Has comprehensive theoretical and applied knowledge in a wide range of Computer Science topics.

B. Graduates – Research-based Master's Degree

1. Able to undertake independent research and present outcomes in writing.
2. Able to use full range of learning resources relevant to the research topic.
3. Has depth and systematic understanding of knowledge in academic discipline.
4. Excellent graduates should be able to continue their studies toward doctoral degrees.

C. Non-Research Master's Degrees

These programs will be offered predominantly at colleges, while universities will offer non-research master's degree programs only to students who can not complete their research projects, or to excellent students whose research results permit continuing directly to doctoral degree programs.
Non-research master's degree programs "produce" graduates with a broad knowledge base and a high level of applications experience, who are increasingly in demand in today's complex computer science market.

The committee found that the grade average in master's degree programs (research and non-research) at all of the universities is exceedingly high. To solve this problem, the committee recommends that at least 50% of required courses in master's degree programs should be advanced graduate-level courses.

The Council for Higher Education approved detailed requirements for accreditation of non-research master's degree programs (the decision taken on July 15, 2003 is attached). All these in addition to the following criteria:

1. Programs should include a major (year-long) applications project.
2. Master's degree students will be required to submit a final paper and/or pass a qualifying exam, to cover all of the Computer Science subjects studied.
3. At least 70% of the required courses in master's degree programs will be advanced graduate-level courses.

D. Research-based Master's Degree Programs

The Council for Higher Education approved detailed requirements for accreditation of research-based master's degree programs at non-university institutions of higher education (the decision taken on October 10, 2004 is attached). All these in addition to the following criteria:

1. Research-based master's degree programs at academic institutions will not be approved unless the faculty includes, at colleges - at least ten full-time senior faculty members at Ph.D. level and involved in active research, and at universities, twenty faculty members with these qualifications.

2. Departments will establish academically acceptable approval procedures for research proposals, and follow-up and final approval procedures.

3. Thesis advisors will be Ph.D.-level faculty members at the rank of Lecturer at least.

4. The total number of advisees (master's and doctoral candidates) per faculty member will be limited to 5-7. Exceptional cases must be approved by special committee.

5. At least 70% of the required courses in master's degree programs will be advanced graduate-level courses.