PROPOSAL TO ESTABLISH A PROGRAM IN COMPUTER ENGINEERING LEADING TO THE MASTER'S DEGREE EFFECTIVE FALL 2016

SPONSORED BY THE DEPARTMENTS OF COMPUTER SCIENCE AND ELECTRICAL ENGINEERING

APPROVED BY

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Grove School of Engineering Faculty, 10/13/2015

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<td>59</td>
</tr>
</tbody>
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1 Abstract

The Grove School of Engineering (GSoE) launched an undergraduate degree program in computer engineering, jointly administered by the Departments of Computer Science and Electrical Engineering, in 2000. Increasingly, graduates of this program ask about the possibility of enrolling in a Master’s degree program in computer engineering. We propose a unique program at the graduate level in computer engineering, combining key aspects of computing hardware and software. In the last decade, the tri-state area around New York City has had a surge of industry in areas such as telecommunications, computing devices, cloud computing and medicine, requiring expertise in combined applications of hardware and software, which positions graduates of the proposed program as excellent candidates for such opportunities.
2 Executive Summary

We propose a program leading to the degree of master of engineering in the field of computer engineering. It will be offered by the Grove School of Engineering (GSoE) in the City College of New York. It will combine studies in key aspects of computing hardware and software.

Need
The GSoE launched an undergraduate degree program in computer engineering, jointly administered by the departments of Computer Science (CSc) and Electrical Engineering (EE), in 2000. Increasingly, graduates of this program ask about the possibility of enrolling in a master’s degree program in computer engineering. In the last decade, the tri-state area around New York City has had a surge of industry in areas such as telecommunications, computing devices, cloud computing and medicine. These fields require expertise in the combined application of hardware and software. The proposed program will position graduates as excellent candidates for such opportunities.

Curriculum
The 30-credit program will require two core courses (6 credits), one course from each of four focus areas (12 credits), and the remaining coursework (18 credits) from elective courses and a report, project or thesis. At least 50% of the credit must come from courses in an engineering discipline.

Faculty
One of the strengths of the program will be the participation of outstanding faculty. In addition to their teaching responsibilities, the faculty are involved in research grants, university service, professional development, and in the mentoring of undergraduate and graduate students, all in fields related to computer engineering.
Cost
Two new faculty members, one for each department, will dedicate 50% of their time to the proposed graduate program. In the first five years, we project that we will receive approximately 20, 30, 40, 40, and 40 new students respectively. We expect revenues to exceed costs starting in the third year.

Governance
As with the undergraduate program, the governance of the proposed graduate program will be shared by the CSc and EE Departments within the GSoE. The director of the program will be a faculty member from one of those departments, and there is a staff associate director. Curriculum and assessment will be determined by a joint committee from the two departments.
3 Purposes, Goals and Objectives

3.1 Introduction

The Grove School of Engineering (GSoE) launched an undergraduate degree program in computer engineering, jointly administered by the Departments of Computer Science and Electrical Engineering, in 2000. This program has contained an average of 237 students in the Fall terms of 2009–2013. Increasingly, graduates of this program ask about the possibility of enrolling in a master’s degree program in computer engineering. Such masters programs are now commonplace in engineering schools in the United States. Given the growing demand for graduate level instruction in computer engineering, it is time for GSoE to introduce its own master’s degree program in this area.

3.2 Educational Goals

Computer engineering seeks to integrate concepts and methods from electrical engineering and computer science required to develop computer hardware and software. The proposed program would train students in hardware-software integration instead of only software engineering or electrical engineering. This training would encompass the design, development, testing, and evaluation of components, systems, and networks. Emphasis would be placed on current state-of-the-art applications such as networks, computer architecture, image processing, VLSI, assistive technologies, robotics, cloud computing, and embedded computing. Students would be expected acquire the knowledge and skill that would enable them to undertake hardware and software projects encompassing the design of individual microprocessors, personal computers, supercomputers, and networked computers, as well as circuit design.
3.3 Rationale for the Proposed Program

Computer Engineering is well established as a discipline, so the argument for offering a masters degree program hinges on demand for specialists in the field and availability of the resources and skills within GSOE necessary for success. The demand is clear. Rapid and continuing diffusion of computer technology in all areas of modern life has created a need for specialists in computer engineering. The greater New York City area, a natural marketplace for CUNY graduates, has become a center for advanced information technology; it is home to major corporations and organizations in health care, finance, business and computer services, software development, as well as large public authorities such as the New York City Police Department, the Metropolitan Transportation Authority, and many others, all of which are heavily dependent on computer engineering services.

The success of the computer engineering undergraduate program is strong evidence of the ability of GSOE's Electrical Engineering and Computer Science departments to offer a master’s degree program in this area. Most of the courses that would be needed for a master’s degree program are currently offered in one form or another by the two departments. The additional teaching requirements could be met by hiring one additional faculty member in each of the departments.

3.4 Need and Justification

The justification for establishing a new master’s degree program in computer engineering rests with the growth of student interest, increased faculty involvement in the area, extension of the range of graduate programs in GSOE, and encouraging the growth of this field in CUNY.
3.4.1 **Student Demand**

As with other fields, undergraduate majors in computer engineering are often interested in graduate studies to further their immediate career prospects or as a stepping stone on the way to a PhD. See Section 5, Projected Enrollment, for the source data.

3.4.2 **Employment Opportunities**

The Bureau of Labor Statistics projects a 7% increase in job opportunities for computer hardware engineers in the period 2012 to 2022. Those with software skills as well are expected to have an advantage in the labor market. The proposed program would produce graduates with the right combination of skills for the challenging job market of the future.

3.4.3 **CUNY Faculty Involvement and Interest**

Several faculty members in Electrical Engineering and Computer Science are active in the field of computer engineering. Section 6 details the qualifications of the faculty.

<table>
<thead>
<tr>
<th>Areas</th>
<th>Faculty Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Networks</td>
<td>Habib, Kawaguchi, Lee, Mowshowitz, Ravindran, Saadawi</td>
</tr>
<tr>
<td>Computer Architecture</td>
<td>Conner, Gertner, Kim</td>
</tr>
<tr>
<td>Image Processing, Graphics, Vision</td>
<td>Gladkova, Grossberg, Tian, Wei, Wolberg, Zhu</td>
</tr>
<tr>
<td>VLSI, DSP &amp; Devices</td>
<td>Kim, Nguyen, Seo, Zhang</td>
</tr>
<tr>
<td>Assistive Technologies</td>
<td>Tian, Xiao, Zhu</td>
</tr>
<tr>
<td>Robotics &amp; Intelligent Systems</td>
<td>Brass, Uyar, Xiao, Wei, Zhu</td>
</tr>
<tr>
<td>Data Engineering and Cloud Computing</td>
<td>Grossberg, Kawaguchi, Kim, Mowshowitz, Zhang</td>
</tr>
<tr>
<td>Embedded and Mobile Computing</td>
<td>Conner, Gertner, Habib, Kim, Lee, Ravindran, Saadawi, Uyar, Zhu</td>
</tr>
<tr>
<td>Theory of Computing</td>
<td>Brass, Gurvits</td>
</tr>
</tbody>
</table>

3.4.4 **Existing Programs**

All the major private universities in the Greater New York area offer master’s degrees in computer engineering. These include Columbia University, Polytechnic Institute of NYU, and Stevens Institute of Technology. Public universities including SUNY Stony Brook and the New Jersey Institute of Technology also offer such degree programs.
4 Curriculum

4.1 Education Objectives

The objectives of the program are that holders of CCNY’s Master’s of Engineering degree in Computer Engineering will, in their careers,

A. apply scientific and engineering principles, rigorous analysis and creative design in computer engineering to meet the needs of society;
B. communicate clearly and assume leadership roles; and
C. contribute to the field of computer engineering, participate in professional societies, maintain current knowledge in the field, and pursue advanced studies.

The students in Computer Engineering Master’s Program will be offered the option to study in the following areas:

a. **Computer Networks**: IP routing, wireless multimedia networks, optical networks, routing protocols, fiber optic communications;

b. **Computer Architecture**;

c. **Image Processing, Graphics, Vision**;

d. **VLSI, DSP & Devices**: integrated circuits and signal processing hardware;

e. **Assistive Technologies**: human-centered computing, assisted navigation, assisted perception, human-computer interaction, computer accessibility, smart living, prosthetics;

f. **Robotics & Intelligent Systems**: computer vision, pattern recognition, speech recognition, information retrieval, robotics, intelligent transportation system (ITS), sensor networks, multimodal computing, machine learning;

g. **Data Engineering and Cloud Computing**: cyber-infrastructure, cloud computing, high performance computing, distributed computing, cybersecurity, big data, data mining, data management, multimedia, Geographic Information System (GIS);
h. **Embedded and Mobile Computing:** embedded systems, mobile devices, mobile computing, real-time computing, cyber-physical systems, Internet of Things, Systems on the Chip (SoC), self-driving cars;

i. **Theory of Computing.**

### 4.2 Degree Requirements

To satisfy the requirements of the Master of Engineering (M.E.) degree in Computer Engineering, students will select one of the following three options:

1. **Two core courses (6 credits), one course from each of four focus areas (12 credits), four elective courses (12 credits), and a zero-credit independent study report.**

2. **Two core courses (6 credits), one course from each of four focus areas (12 credits), three elective courses (9 credits), and one 3-credit project under the direction of a faculty member.**

3. **Two core courses (6 credits), one course from each of four focus areas (12 credits), two elective courses (6 credits), and a 6-credit thesis, under the direction of a faculty member.**

At least 12 credits from the focus areas and electives must be from an engineering discipline (courses prefixed EE or Engr).

#### A. Core courses:

There will be two core courses defined as follows:

- Advanced Computer Architecture, EE I4400 (prerequisites: CSc 34200 and 34300 or EE 34400 and EE 42500)
- Advanced Algorithms, CSc I0600 (prerequisite: CSc 22000)
B. Focus areas:

1. Hardware

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC I0802</td>
<td>Web/Geographical Information Systems</td>
</tr>
<tr>
<td>CSC I4200</td>
<td>Computer Architecture</td>
</tr>
<tr>
<td>CSC I9606</td>
<td>Concurrent Shared Memory Systems</td>
</tr>
<tr>
<td>EE G3300</td>
<td>Mobile Robotics</td>
</tr>
<tr>
<td>EE I5501</td>
<td>Introduction to Robotics</td>
</tr>
<tr>
<td>EE I5700</td>
<td>Advanced Digital Integrated Circuits</td>
</tr>
<tr>
<td>EE I2500</td>
<td>Advanced Embedded Systems</td>
</tr>
<tr>
<td>EE I 5400</td>
<td>Physical Electronics</td>
</tr>
</tbody>
</table>

2. Networks & Security

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC I4300</td>
<td>Computer Communications</td>
</tr>
<tr>
<td>CSC I4330</td>
<td>Advanced Topics in Internet Programming</td>
</tr>
<tr>
<td>CSC I4722</td>
<td>High Performance Networks</td>
</tr>
<tr>
<td>CSC I4900</td>
<td>Computer Security</td>
</tr>
<tr>
<td>EE F6000</td>
<td>Computer Communication Systems</td>
</tr>
<tr>
<td>EE F6300</td>
<td>Wireless Communication</td>
</tr>
<tr>
<td>EE G7100</td>
<td>Wireless Multimedia Networks</td>
</tr>
<tr>
<td>EE G9400</td>
<td>High Speed Networks</td>
</tr>
<tr>
<td>EE I6600</td>
<td>Communication Protocol Engineering</td>
</tr>
<tr>
<td>EE I6700</td>
<td>IP Routing</td>
</tr>
<tr>
<td>EE I6800</td>
<td>Telecommunication Network Element Engineering</td>
</tr>
<tr>
<td>EE I7000</td>
<td>Networks and Security</td>
</tr>
<tr>
<td>EE I5200</td>
<td>Fiber Optic Communication 1</td>
</tr>
</tbody>
</table>
3. Software Applications

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC I0400</td>
<td>Operating Systems</td>
</tr>
<tr>
<td>CSC I0500</td>
<td>Computer Graphics</td>
</tr>
<tr>
<td>CSC I0600</td>
<td>Fundamental Algorithms</td>
</tr>
<tr>
<td>CSC I0800</td>
<td>Topics: Software Systems</td>
</tr>
<tr>
<td>CSC I0802</td>
<td>Web/Geographical Information Systems</td>
</tr>
<tr>
<td>CSC I0804</td>
<td>Concurrent &amp; Distributed Programming</td>
</tr>
<tr>
<td>CSC I1000</td>
<td>Database Systems 1</td>
</tr>
<tr>
<td>CSC I1500</td>
<td>Artificial Intelligence</td>
</tr>
<tr>
<td>CSC I1600</td>
<td>Natural Language Processing: Text Processing</td>
</tr>
<tr>
<td>CSC I1800</td>
<td>Topics in Artificial Intelligence</td>
</tr>
<tr>
<td>CSC I1900</td>
<td>Pattern Recognition</td>
</tr>
<tr>
<td>CSC I4330</td>
<td>Advanced Topics in Internet Programming</td>
</tr>
<tr>
<td>CSC I6400</td>
<td>Simulation</td>
</tr>
<tr>
<td>CSC I6716</td>
<td>Computer Vision</td>
</tr>
<tr>
<td>CSC I6730</td>
<td>Data Reduction in the Physical Sciences</td>
</tr>
<tr>
<td>CSC I9604</td>
<td>Special Topics in Advanced Data Structures</td>
</tr>
<tr>
<td>CSC I9606</td>
<td>Concurrent Shared Memory Systems</td>
</tr>
<tr>
<td>CSC IA804</td>
<td>Massively Parallel Data Programming</td>
</tr>
<tr>
<td>EE F5300</td>
<td>Digital Signal Processing</td>
</tr>
<tr>
<td>EE G6530</td>
<td>Biologically Inspired Computation</td>
</tr>
<tr>
<td>EE I2200</td>
<td>Image Processing and Recognition</td>
</tr>
<tr>
<td>EE I6600</td>
<td>Communication Protocol Engineering</td>
</tr>
</tbody>
</table>

4. Theory

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSC I0700</td>
<td>Compiler Construction</td>
</tr>
<tr>
<td>CSC I2000</td>
<td>Introduction to Theoretical Computer Science</td>
</tr>
<tr>
<td>CSC I2400</td>
<td>Formal Languages</td>
</tr>
<tr>
<td>CSC I4900</td>
<td>Computer Security</td>
</tr>
<tr>
<td>EE I0100</td>
<td>Probability and Stochastic Processes</td>
</tr>
<tr>
<td>EE I0500</td>
<td>Linear Systems</td>
</tr>
</tbody>
</table>

C. Elective courses:

The elective courses will be available from the areas of faculty expertise listed above, in Section 4.1.
5 Students

5.1 Projected Enrollment

Table 1  Origin of master's students (Fall 2009 – Fall 2014)

<table>
<thead>
<tr>
<th>Origin of Master's students Fall 2009 – Fall 2014</th>
<th>Master's Program</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CSC-MS</td>
</tr>
<tr>
<td>Undergraduate major of incoming students</td>
<td></td>
</tr>
<tr>
<td>CPE-BE</td>
<td>10 (4.1%)</td>
</tr>
<tr>
<td>CSC-BS</td>
<td>14 (5.8%)</td>
</tr>
<tr>
<td>EE-BE</td>
<td>0 (0.0%)</td>
</tr>
<tr>
<td>OTHER MAJORS &amp; OUTSIDE GSOE</td>
<td>217 (90.0%)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>241 (100.0%)</td>
</tr>
</tbody>
</table>

The number of students admitted to the computer science and electrical engineering master's programs from Fall 2009 through Fall 2014 are given in Table 1 as 241 and 294, respectively. Out of 241 students admitted to the computer science master's program, 5.8% (14 students) came from CCNY's undergraduate computer science program. Similarly, 29.9% (88 students) of 294 electrical engineering master's admits came from CCNY's electrical engineering program. On the average, there are about 40–50 students admitted per year to each program.

We will initially admit 20 students to the new program. In years 2 and 3, we expect admissions to increase by around 10 students each year. We expect that in the steady state, we will admit roughly the same number of computer engineering master's students as are admitted to the computer science and electrical engineering programs. The results are shown in Table 2.

Table 2  Estimate of expected population

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>F-T</td>
<td>20</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>P-T</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sub-totals</td>
<td>20</td>
<td>0</td>
<td>30</td>
<td>0</td>
<td>40</td>
</tr>
<tr>
<td>Totals</td>
<td>20</td>
<td>30</td>
<td>40</td>
<td>40</td>
<td>40</td>
</tr>
</tbody>
</table>
5.2 Admission Requirements

Requirements for admission to the master's program in computer engineering will be the same as for typical master's programs in the Grove School of Engineering. The rest of this section is a paraphrase of the 2013–2015 Graduate Bulletin.

The applicant’s scholastic record must show a minimum average of B in the undergraduate field of specialization and an overall undergraduate minimum average of B minus. Applicants are required to complete the Graduate Admissions Application which shall be accompanied by official transcripts from all colleges/universities attended, proof of degree, and two letters of recommendations from faculty. The application can be obtained by visiting the City College website at www.ccny.cuny.edu. Official transcripts of graduate work completed at other institutions, if any, are also required and will be evaluated. All international students with baccalaureate degrees from non-English speaking countries must submit a TOEFL score to be considered for admission. At present, a minimum score of 73 is required for admission.

The admissions process is handled by CCNY’s Office of Admissions. The director and associate director of the program are available to provide additional guidance to applicants as needed.

5.3 Student Support

Computer engineering faculty from the Computer Science and Electrical Engineering Departments will advise students every semester in selecting courses. Students will be assigned to faculty based on their last names. Students will be informed by email and on the program’s web page of the advising process.

Students’ academic standing will be monitored using data supplied by the GSoE’s Office of Academic Affairs. Students who are not in good academic standing will be provided guidance and given conditions of probation that determine whether they can stay in the program.
City College’s Career and Professional Development Institute will provide career counseling and advising, and access to opportunities such as listings of positions offered by employers, career fairs, internships, resumé help, and other resources.
6 Faculty

The main strength of the proposed program lies in the outstanding participating faculty. In addition to their teaching responsibilities, the faculty are involved in research grants, university service, professional development, and in the mentoring of undergraduate and graduate students. As listed in Table 6.1, all faculty members have doctoral degrees.

The areas of expertise relevant to the Computer Engineering graduate program are listed below, along with the names of the associated faculty members:

<table>
<thead>
<tr>
<th>Areas</th>
<th>Faculty Members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Networks</td>
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<td>VLSI, DSP &amp; Devices</td>
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<td>Robotics &amp; Intelligent Systems</td>
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<td>Data Engineering and Cloud Computing</td>
<td>Grossberg, Kawaguchi, Kim, Mowshowitz, Zhang</td>
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</tr>
<tr>
<td>Theory of Computing</td>
<td>Brass, Gurvits</td>
</tr>
</tbody>
</table>

6.1 Participating Faculty and their Qualifications

Computer Science faculty:

Peter Brass studied mathematics in Braunschweig, Germany, 1986-1990, got his PhD there in 1992, held an assistantship in Greifswald. He is a professor of computer science at the City College of New York and member of the doctoral faculty at the Graduate Center of the City University of New York. His research includes geometry and combinatorics, and problems in quantum logics, digital halftoning, sensor networks and robotics.
Izidor Gertner is professor of computer science at the City College of New York and member of the doctoral faculty at the Graduate Center of the City University of New York. Professor Gertner's MDA-supported research activities are in the areas of Automatic Target Recognition, and Hardware/Software co-design of real-time algorithms.

Irina Gladkova holds PhD's in mathematics from the Ukraine Institute of Applied Mathematics and Mechanics and from CUNY. She is Associate Professor of Computer Science at the City College of New York. Prof. Gladkova's research interests include statistical data analysis and applications of machine learning algorithms to remote sensing data.

Michael Grossberg is an assistant professor of computer science at City College of New York and member of the doctoral faculty at the Graduate Center of the City University of New York. He has held teaching and research positions at Columbia University, at the Max Plank Institute for Mathematics in Bonn, and at Hebrew University in Jerusalem. His current interests are in applied machine learning for remote sensing and environmental science as well as data visualization.

Leonid Gurvits is a professor of computer science at the City College of New York and member of the doctoral faculty at the Graduate Center of the City University of New York. He holds a Ph.D. in mathematics from Nizhni Novgorod Lobachevsky University in Russia.

Akira Kawaguchi is professor of computer science, and department chair, at the City College of New York, and member of the doctoral faculty at the Graduate Center of the City University of New York. He has held positions at Mitsubishi Heavy Industries, Bell Laboratories and AT&T Research, having earned his doctorate at Columbia University. His expertise lies in the area of applied database systems and transaction processing systems.

Abbe Mowshowitz is professor of computer science at the City College of New York and member of the doctoral faculty at the Graduate Center of the City University of New York. He has also held academic appointments at the University of Amsterdam and Erasmus University Rotterdam. Since completing his Ph.D at the University of Michigan in 1967, he has been a major contributor to the analysis of complex networks and has participated in the International Technology Alliance research project since 2006.

Kaliappa Ravindran is a Professor of Computer Science at the City College of New York. He has also held appointments as Kansas State University, the Indian Institute of Science) and the Indian Satellite Research Center of Northern Telecom subsequent to completing his Ph.D. in Computer Science at the University of British Columbia. His research interests include service-level management of distributed networks and cloud systems and model-based software integration for embedded systems.
**Jie Wei** is an associate professor of computer science at the City College of New York. His research interests include multi-modal data processing, computer vision, machine learning and medical imaging. He has designed and developed algorithms and systems with both medical and military applications. Recent research has been supported by NIH, NSF, AFOSR, and AFRL. Wei received his Ph.D. from Simon Fraser University in 1999.

**George Wolberg** is a Professor of Computer Science at the City College of New York and member of the doctoral faculty at the Graduate Center of the City University of New York. He received his Ph.D. in Computer Science from Columbia University in 1990. He has published over 60 research papers in image processing, computer graphics, and computer vision, and holds seven U.S. patents.

**Jianting Zhang** is assistant professor of Computer Science at the City College of New York and member of the doctoral faculty at the Graduate Center of the City University of New York. Zhang received his Ph.D. degree (2004) in Computer Science from the University of Oklahoma. Zhang’s research lies in the intersection of large-scale data management and geospatial computing.

**Dr. Zhigang Zhu** is Herbert G. Kayser Chair Professor of Computer Science, The City College of New York (CCNY) and member of the doctoral faculty at The Graduate Center of New York (CUNY). He directs the CCNY Visual Computing Laboratory. His current research includes novel algorithms and systems of stereo mosaics and 3D reconstruction for airborne video surveillance.

**Electrical Engineering Faculty:**

**Professor Roger Dorsinville** is the chair of the Electrical Engineering Department. He holds a Ph.D. in physics from Moscow Lomonosov State University, Russia.

**Professor Michael Conner**'s research is in the field of fast algorithm design and the application of group representations to sequential machines. He teaches a microprocessor lecture class and an embedded systems lab that are very popular with students.

**Prof. Ibrahim Habib**’s area of research is in high-speed telecommunications networks including wireless, optical and IP networks. Some of his major contributions include the application of neural networks and genetic algorithms to problems in traffic engineering of high-speed networks. He is credited with being one of the pioneering researchers who have used these tools to solve otherwise extremely complex research problems.

**Prof. Yingli Tian** is head of the Media lab at CCNY. Her research experience includes target detection and tracking, event and activity analysis, scene understanding, facial expression recognition, human computer interaction, multi-sensor fusion, and machine learning. She is a senior member of IEEE.
Prof. Bruce Kim has been teaching VLSI courses for 20 years. His course materials are current with the latest technologies. He has performed research in MEMS, nanotechnology, nanosensors, biophotonics, microelectronics packaging, biomedical devices, System-on-Chip, RFIC and mixed-signal IC chips. He is a current member on the BOG for the IEEE CPMT Society. He is a fellow of IMAPS and a recipient of the 1997 National Science Foundation CAREER award.

Prof. Jizhong Xiao started the robotics research program at CCNY and is the founding director of CCNY Robotics Lab (website: http://robotics.ccny.cuny.edu) and the Center for Perceptual Robotics, Intelligent Sensors and Machines (PRISM Center). With his leadership, the robotics research has become one of the most active and well-funded research directions in the EE department at CCNY.

Prof. Bruce Kim is an expert and a key contributor to the field of testing of mixed – signal microelectronics devices including nano-sensors for environmental and biomedical applications.

Professor Thao Nguyen’s research is in the areas of signal and image analysis, processing, quantization and coding and over-sampled A/D conversion analysis (Sigma-Delta modulation). Most of his work is devoted to the understanding of A/D conversion using over-sampling techniques and sigma-delta modulators. Prof. Thao Nguyen is credited of being one of the first researchers to use a rigorous mathematical framework to optimize these techniques.

Professor Tarek Saadawi's research interests are telecommunications networks, high-speed networks, multimedia networks, ad hoc networks and packet radio networks. He has published extensively in the area of telecommunications networks. He is a co-author of the book, Fundamentals of Telecommunication Networks, John Wiley & Sons, 1994. Dr. Saadawi is a Former Chairman of IEEE Computer Society of New York City (1986-87). He has received IEEE Region 1 Award, 1987, and the Nippon Telegraph and Telephone (NTT) of America for research on Broadband Telecommunication Networks.

Professor M. Ümit Uyar is the Director of the Computer Engineering program at CCNY. His research interests include Computational Biology, Mobile Ad Hoc Networks, and Artificial Intelligence – Prof. Uyar is a recipient of the CCNY Outstanding Teacher award and a Fellow of the IEEE.

Professor Sang-Woo Seo’s research is in Nano/Micro fabrication processing and novel integration strategies from device levels to layer-by-layer integration for fully integrated lab-on-a-chip systems. He is a rising researcher in the optoelectronic research community. Prof. Seo is the Director of the Electrical Engineering fabrication lab that provides support to materials oriented research across the Grove School of Engineering.

Professor Myung Jong Lee's research interests include wireless sensor networks, ad hoc networks, wireless multimedia networking, and Internet. He is an associate editor for IEEE communications magazine. Dr. Lee currently the chair of IEEE 802.15.5 TG and
former Vice Chair of ZigBee NWK WG. His group also contributed NS-2 module for IEEE 802.15.4, a standard NS-2 distribution widely used for wireless sensor network researches.

Table 3  
Full-Time Faculty

<table>
<thead>
<tr>
<th>Faculty Member Name and Title (include and identify Program Director)</th>
<th>Tenure Status (T, TT, or NTT)</th>
<th>Length of Time (Number of years) at the Institution</th>
<th>Percent Time to Program</th>
<th>List All Earned Degrees &amp; Disciplines (include College/University)</th>
<th>Additional Qualifications: list related certifications/licenses; professional experience; scholarly contributions, etc.</th>
<th>Program Courses to be Taught (Course Number and Title Must be Listed)</th>
</tr>
</thead>
</table>
| Peter Brass                                      | T                           | 12 years                                      | 15%                   | Dr. habil., Math, U. Greifswald, Germany; Ph.D. & M.Sc., Math., Technical U. Braunschweig | Professional Soc.: ACM, ACS  
Research: active  
Awards: CUNY Salute to Scholars, CCNY President’s Award for Outstanding Faculty  
Professional Activities: Organized Geometric Problems in Sensor Nets and Robotics Workshop, Blouin Creative Leadership Summit | CSE 10600 Advanced Algorithms |
| Izidor Gertner                                   | T                           | 20 years                                      | 15%                   | D.Sc. EE/CS Engr., Technion, Israel; Kaunas Polytechnic Institute, Lithuania, MS EE; U. Vilnius, Mathematics | Industry: Network Disk, L3 Comm, EMC Hopkinton, DEC, AT&T Bell Labs, Zoran, RAFAEL (Israel)  
Professional Soc.: IEEE Senior Member, IEEE  
Stands. Cmt, SPIE, Auto. Target Recog. Prog. Cmt  
Defense and Security  
Research: active  
Recent Grants: MDA, AFRL, ONR, US Army Soace and Missile Command  
Awards: CUNY Salute to Scholar, Landau Prize for Distinguished Contribution (Israel), Lady Davis Fellowship the Ben-Acheron Research Prize (Israel) | new course: Advanced Embedded Systems |
| Irina Gladkova                                   | T                           | 16 years                                      | 15%                   | Ph. D. Math, CUNY Graduate Center; Ph. D. Math, Institute of Applied Mathematics and |

Computer Science faculty:

<table>
<thead>
<tr>
<th>Faculty Member Name and Title (include and identify Program Director)</th>
<th>Tenure Status (T, TT, or NTT)</th>
<th>Length of Time (Number of years) at the Institution</th>
<th>Percent Time to Program</th>
<th>List All Earned Degrees &amp; Disciplines (include College/University)</th>
<th>Additional Qualifications: list related certifications/licenses; professional experience; scholarly contributions, etc.</th>
<th>Program Courses to be Taught (Course Number and Title Must be Listed)</th>
</tr>
</thead>
</table>
| Peter Brass                                      | T                           | 12 years                                      | 15%                   | Dr. habil., Math, U. Greifswald, Germany; Ph.D. & M.Sc., Math., Technical U. Braunschweig | Professional Soc.: ACM, ACS  
Research: active  
Awards: CUNY Salute to Scholars, CCNY President’s Award for Outstanding Faculty  
Professional Activities: Organized Geometric Problems in Sensor Nets and Robotics Workshop, Blouin Creative Leadership Summit | CSE 10600 Advanced Algorithms |
| Izidor Gertner                                   | T                           | 20 years                                      | 15%                   | D.Sc. EE/CS Engr., Technion, Israel; Kaunas Polytechnic Institute, Lithuania, MS EE; U. Vilnius, Mathematics | Industry: Network Disk, L3 Comm, EMC Hopkinton, DEC, AT&T Bell Labs, Zoran, RAFAEL (Israel)  
Professional Soc.: IEEE Senior Member, IEEE  
Stands. Cmt, SPIE, Auto. Target Recog. Prog. Cmt  
Defense and Security  
Research: active  
Recent Grants: MDA, AFRL, ONR, US Army Soace and Missile Command  
Awards: CUNY Salute to Scholar, Landau Prize for Distinguished Contribution (Israel), Lady Davis Fellowship the Ben-Acheron Research Prize (Israel) | new course: Advanced Embedded Systems |
| Irina Gladkova                                   | T                           | 16 years                                      | 15%                   | Ph. D. Math, CUNY Graduate Center; Ph. D. Math, Institute of Applied Mathematics and |

Industry: General Dynamics  
Research: active  
Recent Grants: NOAA, DoD | CSC 16730 Data Reduction: Physical Sciences |
<table>
<thead>
<tr>
<th>Faculty Member Name and Title (include and identify Program Director)</th>
<th>Tenure Status (T, TT, or NTT)</th>
<th>Length of Time (Number of years) at the Institution</th>
<th>Percent Time to Program</th>
<th>List All Earned Degrees &amp; Disciplines (include College/University)</th>
<th>Additional Qualifications: list related certifications/licenses; professional experience; scholarly contributions, etc.</th>
<th>Program Courses to be Taught (Course Number and Title Must Be Listed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Grossberg</td>
<td>T</td>
<td>10 years</td>
<td>15%</td>
<td>Ph. D. Math, MIT; B.A. Math, Upen</td>
<td>Research: active</td>
<td>CSC I4330 Advanced Internet Program., Data Science, Data Visualization</td>
</tr>
<tr>
<td>Abbe Mowshowitz</td>
<td>T</td>
<td>31 years</td>
<td>15%</td>
<td>PhD Computer Science, University of Michigan; MA, Computer Science, University of Michigan; MA, Mathematics, University of Michigan; BS, Mathematics, University of Chicago</td>
<td>Industry: Technology Impact Research, Croton Research Group, Human Sciences Research Professional Soc.: ACM, IEEE Research: active Awards: CeTim Chair in Technology Innovation (Netherlands), Tinbergen Chair (Erasmus Univ.), IFIP WG 9.2 (Computers and Social Acct), Member Sigma Xi</td>
<td>CSc I4700: Topics in Computer Communications</td>
</tr>
<tr>
<td>Kaliappa Ravindran</td>
<td>T</td>
<td>18 years</td>
<td>15%</td>
<td>Ph.D. Computer Science, University of British Columbia; M. Eng., Computer Science &amp; Automation, Indian Institute of Science;</td>
<td>Industry: AFRL, NRL, GM, IBM, Philips. Professional Activities: Vice Chair IEEE Comt. On Emerging Topics in Cloud Comm Patents: 1 US patent</td>
<td>CSC 14300: Computer Communications CSC 14722: High Performance Networks CSC 10804:</td>
</tr>
<tr>
<td>Faculty Member Name and Title</td>
<td>Tenure Status (T, TT, or NTT)</td>
<td>Length of Time (Number of years) at the Institution</td>
<td>Percent Time to Program</td>
<td>List All Earned Degrees &amp; Disciplines (include College/University).</td>
<td>Additional Qualifications: list related certifications/licenses; professional experience; scholarly contributions, etc.</td>
<td>Program Courses to be Taught (Course Number and Title Must be Listed)</td>
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<td>----------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Jie Wei</td>
<td>T</td>
<td>16 years</td>
<td>15%</td>
<td>B.Eng., Electronics &amp; Communication Engineering.</td>
<td>Research: active Recent Grants: NRL Awards: Visiting Scientist at GM India Science Lab (India)</td>
<td>Concurrent &amp; Distributed Processing CSC I6400: Topics in System Simulation</td>
</tr>
<tr>
<td>George Wolberg</td>
<td>T</td>
<td>25 years</td>
<td>15%</td>
<td>Ph.D. Computer Science, Simon Fraser University; M.S. Computer Science, Inst. Of Software, Chinese Academy of Sciences; B.S. Computer Science, University of Science and Technology of China</td>
<td>Research: active Recent Grants: NSF, MSKCC, AFL Awards: Best in Physics (Ann. Symp. American Physics Med), CUNY Salute to Scholars, President’s Research Award (Simon Fraser Univ.), Nominee Governors Convocation Award (Simon Fraser Univ.)</td>
<td>CSC I1000 Database, Pattern recognition, Digital libraries</td>
</tr>
<tr>
<td>Jianting Zhang</td>
<td>TT</td>
<td>7 years</td>
<td>15%</td>
<td>Ph.D. Computer Science, Columbia University; M.E Electrical Engineering, Cooper Union; B.E. Electrical Engineering, Cooper Union</td>
<td>Industry: Electrotechnical Lab (Japan), IBM, Fantastic Animation Machine, AT&amp;T Bell Labs Professional Soc.: ACM, IEEE Research: active Recent Grants: DOE, Google, AFRL, ONR, NASA Awards: CUNY Salute to Scholars, NYC Mayor’s Award for Excellence in Science and Technology, NASA Faculty Award, CCNY Outstanding Teaching Award, NSF Presidential Young Investigator Award</td>
<td>Image Processing CSC I10500 Computer Graphics</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>CSC IA804 Massive Parallel Data Processing</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>Faculty Member Name and Title (include and identify Program Director)</th>
<th>Tenure Status (T, TT, or NTT)</th>
<th>Length of Time (Number of years) at the Institution</th>
<th>Percent Time to Program</th>
<th>List All Earned Degrees &amp; Disciplines (include College/University)</th>
<th>Additional Qualifications: list related certifications/licenses; professional experience; scholarly contributions, etc.</th>
<th>Program Courses to be Taught (Course Number and Title Must Be Listed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Michael Conner</td>
<td>T</td>
<td>30 years</td>
<td>15%</td>
<td>Johns Hopkins Univ., B.E.S., Univ. of Maryland, M.S., Ph.D.</td>
<td>Senior Member Research: active Recent Grants: NSF, AFL Awards: CCNY President’s Award for Excellence, Herbert G. Kayser Chair Professor of Computer Science, CUNY Salute to Scholars, Hundred National Excellent Doctoral Thesis (China)</td>
<td>EE-I6700:IP Routing EE-G9400: High Speed Networks</td>
</tr>
<tr>
<td>Roger Dorsinville</td>
<td>T</td>
<td>30 years</td>
<td>10%</td>
<td>Moscow Lomonosov State Univ. (Russia), B.S./M.S., Ph.D (Physics).</td>
<td></td>
<td>Coordinator for new course: Advanced Embedded Systems</td>
</tr>
<tr>
<td>Ibrahim W. Habib</td>
<td>T</td>
<td>26 years</td>
<td>15%</td>
<td>Ain Shams Univ. (Egypt) B.S., Polytechnic Univ. of New York M.S., CUNY (EE), Ph.D.</td>
<td></td>
<td>Department chair; new course: lab for Quantum Information &amp; Computing</td>
</tr>
<tr>
<td>Bruce Kim</td>
<td>T</td>
<td>2 years</td>
<td>20%</td>
<td>Univ. of California, Irvine B.S.; Univ. of Arizona, M.S., Georgia Inst. of Technology, Ph.D. (ECE).</td>
<td></td>
<td>EE-G6911: Adv. Digital Integrated Circuits</td>
</tr>
<tr>
<td>Myung Jong Lee</td>
<td>T</td>
<td>24 years</td>
<td>15%</td>
<td>Seoul National Univ. (Korea), B.S., M.S.; Columbia Univ. (EE),</td>
<td></td>
<td>EE-G7100: Wireless Multimedia Networks EE-F6300: Wireless</td>
</tr>
</tbody>
</table>

**Electrical Engineering faculty**

<table>
<thead>
<tr>
<th>Electrical Engineering faculty</th>
<th>Percentage</th>
<th>Tenure Status</th>
<th>Time at Institution</th>
<th>Department Chair</th>
<th>Industry Experience</th>
<th>Research Experience</th>
<th>Recent Grants/Awards</th>
<th>EE Courses Taught</th>
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</thead>
<tbody>
<tr>
<td>Michael Conner</td>
<td>T</td>
<td>30 years</td>
<td>15%</td>
<td>Johns Hopkins Univ., B.E.S., Univ. of Maryland, M.S., Ph.D.</td>
<td>Senior Member Research: active Recent Grants: NSF, AFL Awards: CCNY President’s Award for Excellence, Herbert G. Kayser Chair Professor of Computer Science, CUNY Salute to Scholars, Hundred National Excellent Doctoral Thesis (China)</td>
<td>EE-I6700:IP Routing EE-G9400: High Speed Networks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Roger Dorsinville</td>
<td>T</td>
<td>30 years</td>
<td>10%</td>
<td>Moscow Lomonosov State Univ. (Russia), B.S./M.S., Ph.D (Physics).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ibrahim W. Habib</td>
<td>T</td>
<td>26 years</td>
<td>15%</td>
<td>Ain Shams Univ. (Egypt) B.S., Polytechnic Univ. of New York M.S., CUNY (EE), Ph.D.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bruce Kim</td>
<td>T</td>
<td>2 years</td>
<td>20%</td>
<td>Univ. of California, Irvine B.S.; Univ. of Arizona, M.S., Georgia Inst. of Technology, Ph.D. (ECE).</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Myung Jong Lee</td>
<td>T</td>
<td>24 years</td>
<td>15%</td>
<td>Seoul National Univ. (Korea), B.S., M.S.; Columbia Univ. (EE),</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Faculty Member Name and Title (include and identify Program Director)</td>
<td>Tenure Status (T, TT, or NTT)</td>
<td>Length of Time (Number of years) at the Institution</td>
<td>Percent Time to Program</td>
<td>List All Earned Degrees &amp; Disciplines (include College/University)</td>
<td>Additional Qualifications: list related certifications/licenses; professional experience; scholarly contributions, etc.</td>
<td>Program Courses to be Taught (Course Number and Title Must Be Listed)</td>
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<td></td>
</tr>
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<td>---</td>
<td></td>
<td></td>
</tr>
<tr>
<td>YingLi Tian</td>
<td>T</td>
<td>7 years</td>
<td>15%</td>
<td>Cairo Univ. (Egypt), B.Sc., M.Sc.; Univ. of Maryland (EE), Ph.D.</td>
<td>Professional Soc.: IEEE Patents: 3 US patents Research: active Recent Grants: ARL, AFRL, US Army War College</td>
<td>EE I2200: Image Processing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jizhong Xiao</td>
<td>T</td>
<td>14 years</td>
<td>15%</td>
<td>East China Inst. of Tech. (China) B.S.; M.S. (EE),</td>
<td>Industry: InnovBot Professional Soc.: IEEE Senior Member, RAS</td>
<td>EE-G3300: Mobile Robotics</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 4  Part-Time Faculty

<table>
<thead>
<tr>
<th>Faculty Member Name and Title (include and identify Program Director)</th>
<th>Tenure Status (T, TT, or NTT)</th>
<th>Length of Time (Number of years) at the Institution</th>
<th>Percent Time to Program</th>
<th>List All Earned Degrees &amp; Disciplines (include College/University)</th>
<th>Additional Qualifications: list related certifications/licenses; professional experience; scholarly contributions, etc.</th>
<th>Program Courses to be Taught (Course Number and Title Must be Listed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T=Tenured TT=Tenure-Track NTT=Non-Tenure-Track</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nanyang Tech. Univ. (Singapore); Michigan State Univ., Ph.D. (ECE), SMCS, CSS Patents: 2 US patents Research: active Recent Grants: NSF Awards: Humboldt Fellowship, NSF Career Award, CCNY Outstanding Mentor, CUNY Salute to Scholars, ICMA 2014 Best students Award, MFI 2012 Best Paper Finalist</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 4** Part-Time Faculty

<table>
<thead>
<tr>
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<th>Length of Time (Number of years) at the Institution</th>
<th>Percent Time to Program</th>
<th>List All Earned Degrees &amp; Disciplines (include College/University)</th>
<th>Additional Qualifications: list related certifications/licenses; professional experience; scholarly contributions, etc.</th>
<th>Program Courses to be Taught (Course Number and Title Must be Listed)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T=Tenured TT=Tenure-Track NTT=Non-Tenure-Track</td>
<td></td>
<td></td>
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</tr>
<tr>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

None.

#### 6.2 Courses and Faculty Teaching Assignments

Courses and faculty teaching assignments are presented in Table 3 in Section 6.1.

#### 6.3 Additional Faculty Needed

Two faculty members will be hired for the new program—one in EE and one in CSc.

Each will devote 50% of their time to the new program.

**Table 5  Faculty to be Hired**
<table>
<thead>
<tr>
<th>Title/Rank of Position</th>
<th>No. of New Positions</th>
<th>Minimum Qualifications</th>
<th>F/T or P/T</th>
<th>Percent Time to Program</th>
<th>Expected Course Assignments</th>
<th>Expected Hiring Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assistant professor</td>
<td>1</td>
<td>Ph.D. in EE</td>
<td>F/T</td>
<td>50%</td>
<td>EE I4400, Advanced Computer Architecture</td>
<td>9/2015</td>
</tr>
<tr>
<td>Assistant professor</td>
<td>1</td>
<td>Ph.D. in CSc</td>
<td>F/T</td>
<td>50%</td>
<td>CSc I0600, Advanced Algorithms</td>
<td>9/2015</td>
</tr>
</tbody>
</table>

### 6.4 Other Personnel

The proposed MSE program will be administered by the Director of the CpE program (Prof. M. Ümit Uyar), assisted by the associate Director (Dr. Sam Fenster) under the overall guidance of the EE and CpE Departments (Chairs Kawaguchi and Dorsinville). The following staff will be available to the proposed program.

**EE Department:** Three full time Lab Technicians (David Santoro, Fernando Hernandez, and Ming Wong) are in charge of the management and maintenance of the hardware and software in the teaching labs. One of them (Ming Wong) is responsible for installing and maintaining the various software packages. Two SOE technicians (Alcides Silva and Dean James) take care of the EE networks and e-mail of the EE Department. In addition, a Higher Education Officer (Mr. Edward Baurin) and two administrative assistants, Ms Jackie Yancey and Ms Natia Oller, provide administrative help to the Department.

**CSE Department:** Two full time Lab Technicians (Dr. Di Yao and Nikita Jaikaran) are in charge of the management and maintenance of the hardware and software in the teaching labs. They are responsible for installing and maintaining the various software packages including Microsoft DreamSpark Academic Alliance program. They are also responsible for the maintenance of the CSE networks, web server, and e-mail server of the CSE Department. In addition, a Higher Education Officer (Dr. Edward Camp) and two administrative assistants, Mr. Luis Camilo and Ms. Crystal Sawyer, provide administrative help to the Department.
# 7 Cost Assessment

## Table 6  
**New Resources**

<table>
<thead>
<tr>
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<th></th>
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<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Full Time Faculty</td>
<td>$141,300</td>
<td>$145,539</td>
<td>$152,816</td>
<td>$160,457</td>
<td>$168,479</td>
</tr>
<tr>
<td>Part Time Faculty</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Full Time Staff</td>
<td>$46,728</td>
<td>$49,064</td>
<td>$51,518</td>
<td>$54,094</td>
<td>$56,798</td>
</tr>
<tr>
<td>Part Time Staff</td>
<td>$44,748</td>
<td>$46,985</td>
<td>$49,335</td>
<td>$51,801</td>
<td>$54,391</td>
</tr>
<tr>
<td>Equipment</td>
<td>$39,500</td>
<td>$9,000</td>
<td>$9,500</td>
<td>$10,000</td>
<td>$34,500</td>
</tr>
<tr>
<td>Laboratories</td>
<td>$50,000</td>
<td>$50,000</td>
<td>$5,000</td>
<td>$5,000</td>
<td>$5,000</td>
</tr>
<tr>
<td>Supplies &amp; Expenses (OTPS)</td>
<td>$16,500</td>
<td>$17,325</td>
<td>$18,191</td>
<td>$19,100</td>
<td>$25,055</td>
</tr>
<tr>
<td>Capital Expenditures</td>
<td>$50,000</td>
<td>$50,000</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>$388,776</td>
<td>$367,914</td>
<td>$286,359</td>
<td>$300,452</td>
<td>$344,225</td>
</tr>
</tbody>
</table>

Note that 50% of faculty costs (salary and startup package for two lines) are attributed to the new program. For details, see Appendix H: Supporting Materials For Expenditures Table (CUNY).

## Table 7  
**Projected Revenues**

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
<td>7.1.1.1.1.1 Tuition Revenue</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>01. From Existing Sources</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>02. From New Sources</td>
<td>$237,200</td>
<td>$355,800</td>
<td>$415,400</td>
<td>$415,400</td>
<td>$415,400</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>$237,200</td>
<td>$355,800</td>
<td>$474,400</td>
<td>$474,400</td>
<td>$474,400</td>
</tr>
</tbody>
</table>

We conservatively assume all students are full-time, in-state residents, and graduate in one academic year. Completion of the degree through part-time enrollment or by non-residents would increase revenues. Each year's tuition revenue is calculated as: (2 semesters) × ($5930/semester) × (number of students). We assume 0% inflation. Per Section 5.1, we project 20, 30, 40, 40, and 40 new students in the first five years.

## Table 8  
**Five Year Financial Projection, CCNY**

<table>
<thead>
<tr>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Net income: revenue − expense</td>
<td>($151,576)</td>
<td>($12,114)</td>
<td>$188,041</td>
<td>$173,948</td>
<td>$130,175</td>
</tr>
</tbody>
</table>
7.2 New Facilities, Equipment, Laboratories and Instructional Support

See Table 6 in Section 7 above for a summary of new revenues and costs. Cost details are in Appendix H: Supporting Materials For Expenditures Table (CUNY).

There will be a new Embedded Systems lab for the new program. In this lab, students will experiment with the latest embedded systems technologies, including those in robotics, image and signal processing, cloud computing, and photonics.
Chapter 8 Evaluation

8.1 Internal

The computer engineering executive committee will closely monitor the performance of the program, and the achievement of the objectives in Section 4.1, using the following methods:

- Enrollment and graduation rates, retention, and graduation times;
- Student-faculty mixers that will also serve as town hall meetings;
- Placement of graduates; and
- Faculty performance, assessed by department observation and CCNY’s standard teaching evaluations.

8.2 External

Before being submitted to the NY State Education Department, the proposed program was reviewed by an external expert, Prof. Joseph R. Cavallaro, Rice U., Dept. of Electrical & Computer Engineering. His review is included in this document as Appendix L: External Evaluation Report. All of his suggestions were incorporated into this document.

The computer engineering executive committee will consult with the following external advisory board on a regular basis:

- Prof. Joseph R. Cavallaro, Rice U., ECE Dept.
- Ali Duale of IBM
- Cem Sahin of MIT Lincoln Labs
- Dr. Quynh Dinh, Senior Software Engineer, MakerBot Industries
- Dr. Erik Grimmelmann, President and CEO, New York Technology Council
- Mr. Gaurav Munjal, Booker Software
9 Governance

The program will be co-chaired by the chairs of the Computer Science (C.Sc.) and Electrical Engineering (E.E.) Departments, currently Akira Kawaguchi and Roger Dorsinville. The director of the program will be a faculty member from one of those departments, currently E.E. professor M. Ümit Uyar.

The associate director of the program, a Higher Education Associate, is currently Dr. Samuel Fenster, who supervises and conducts assessment and advising, writes and disseminates information, is the liaison with faculty of both departments, does graduation checks, and maintains alertness to curriculum issues that require attention, and possible solutions.

The program, like the other programs at CCNY’s Grove School of Engineering, is administered in cooperation with the school’s Office of Academic Affairs, supervised by Associate Dean Ardie Walser.

Assessment is done, and curriculum changes are proposed and voted on, by the Computer Engineering committee, which consists of an equal number of faculty members from the E.E. and C.Sc. departments, including the director of the Cp.E. program. The committee is chaired by the director and contains both co-chairs. Currently the committee contains, in addition, the following faculty:

- Bruce Kim, E.E. Dept.
- Ümit Uyar, E.E. Dept.
- Jizhong Xiao, E.E. Dept.
10 Appendix A: Course Descriptions For Required Courses

10.1 EE Courses:

Core course:

New course EE I4400: Advanced Computer Architecture
The goal of this course is to teach the students the major structural components of computer architecture and the quantitative analysis and evaluation of modern computing systems, such as the selection of appropriate benchmarks to reveal and compare the performance of alternative design choices in system design. Prereq: EE 34400 and EE 42500; or CSc 34200 and CSc 34300. 3 hr./wk.; 3 cr.

Elective courses:

ENGR H8500: Project Management
The practical aspects of total engineering project management are discussed and a functional approach for present and future project managers to assure project performance is presented. The course emphasizes the key role of project managers to assure project completion on time and within cost and quality requirements. Techniques of project planning, budgeting, contracting and control are emphasized. 3 hr./wk.; 3 cr.

ENGR H7600: Engineering Business Law
Environmental law (E.L.) and Contract law (C.L.) are major components. The E.L. portion deals with salient features, particularly important to engineers, of the Clean Air Act, the Clean Water Act and the Resource Conservation and Recovery Act. The C.L. portion deals with engineers’ liabilities, contracts and breaches thereof, bids, bonds, subcontracts, assignments, extra work disputes and arbitration. 3 hr./wk.; 3 cr.
New course EE I2500: Advanced Embedded Systems
This course presents the advanced topics in embedded systems for computer engineering. The course will have applications in image processing, robotics, communications and similar topics. Three or four topics will be covered. An expert for each topic will introduce the current problems and specific needs in the field. Design and implementation components will follow based on these requirements. Students will work as teams of 2-3 persons for each project. They will learn the skills to acquire information about a specific topic in computer engineering and build an embedded system to address these needs. Prereq: EE 42500. 3 hr./wk.; 3 cr.

New course EE I5700: Advanced Topics in Digital Integrated Circuits
This course presents the advanced topics in digital integrated circuits for computer engineering. Low-power and high-performance design issues in modern CMOS processes are discussed. The challenges of technology scaling are covered and state of the art technologies and solutions at different levels of abstraction are discussed from systems to circuits. This course will include hands-on approaches to hardware cyber security attacks and Internet of Things (IoT). Topics may include side channel attacks, differential power analysis, hardware Trojans design, acoustic analysis, EM logging and hardware counterfeiting. Class projects are an integral part of this course. Prereq: EE 45700. 3 hr./wk.; 3 cr.

EE I5200: Fiber Optic Communications I
An overview of the fundamental components of an optical fiber link. Degradation, attenuation, and distortion mechanisms in fibers. LED and laser sources. Detectors and receivers. Analog and digital modulation formats. Performance analysis. 3 hr./wk.; 3 cr.

EE I5300: Digital Signal Processing
The finite Fourier transform, cyclic convolution, digital filters, Z-transform. Design of algorithms computing the finite Fourier transform and cyclic convolution, Cooley-Tukey and Winograd algorithms and other topics as appropriate. 3 hr./wk.; 3 cr.

EE I6000: Computer Communication Systems
Queueing theory, Markovian networks, message packet and circuit switching, assignment of link capacities and flows, routing algorithms, stability, flow control and error control. Introduction to data networks and internet, OSI/ISO model, data link layer protocols: HDLC, PPP, 802.3, TCP and flow control, queuing systems M/M/1, M/G/1, Markovian Systems, principles of IP routing algorithms. Prereq: EE I0100. 3 hr./wk.; 3 cr.

EE I6300: Wireless Communications
Cellular systems: frequency reuse, co-channel and adjacent channel interference, capacity improvement. Wireless channel characteristics: long term fading, short term fading. Diversity techniques: space, frequency, time, polarization. Combining techniques. Digital modulation techniques: DPSK, QPSK, p/4QPSK, QAM, MSK, GMSK. Multiple Access Techniques for wireless communications: FDMA, TDMA, CDMA. Personal Communication Services. Current standards of PCS and cellular systems. Other topics may be added as appropriate. 3 hr./wk.; 3 cr.

EE I6800: Telecommunications Network Element Engineering
The main objective of this course is to provide an introduction to a broad spectrum of network and element level management protocols, software entities, and information databases. Students will gain theoretical and practical knowledge of SNMP management concepts to prepare them for their industrial or academic careers. Topics include management network architectures, protocols, modeling, information databases, network management applications (such as Configuration, Fault, and Performance management), and telecommunications management network fundamentals. Pre/Co-requisite: EE460 (or equivalent). 3 hr./wk.; 3 cr.

EE I5600: Advanced Mobile Robotics
This course is an in-depth study of state-of-the-art technologies and methods of mobile robotics. The course consists of two components: lectures on theory and course projects. Lectures will draw from textbooks and current research literature with several reading discussion classes. In the project component of this class, students will do computer simulations or implement algorithms on mobile robot platforms at the CCNY Robotics Lab. The primary topics include control architectures, motion planning, localization and mapping, navigation, adaptation and learning, and multi-robot systems. Prereq: EE I5500. 3 hr./wk.; 3 cr.

EE I6400: Computer-Aided Digital VLSI Circuits Design
This course presents a systematic approach to the design of full-custom, very and ultra large scale integration (VLSI and ULSI) circuits, utilizing state-of-the-art electronic design automation (EDA) commercial engineering software – the Cadence Design System. It is to cover three major areas: CMOS Processing Technologies, High Performance Circuit Design techniques and Practices, Advanced EDA CAD Software Applications, coupled with relatively large scale (>one-million transistors) design projects. Prereq: EE 44100, EE 44400 and EE 45700 (or equivalent). 3 hr./wk.; 3 cr.

EE G6530: Biologically Inspired Computation for Engineering Problems
This course introduces modern optimization techniques mimicking biological principles such as survival of the fittest, behavior of ants and flocks of birds. These techniques become especially relevant for optimization problems when there is no known analytical solution. This course illustrates application of bio-inspired techniques to solve realistic engineering problems in many fields including telecommunication, transportation, robotics, and others. Pre-/coreqs: EE I0100; knowledge of linear systems and basic programming skills. 3 hr./wk.; 3 cr.

EE I7500: Wireless Multimedia Networks
Advances in wireless communications, especially in the area of bandwidth and mobility, made it possible for users to communicate using multi-media, ranging from low rate applications as in wireless sensor networks to high rate applications as in HDTV. This course emphasizes current and future wireless networking technologies to support a wide range of applications, including WPAN, WLAN, WMAN, and WWAN. It also presents the convergence of various networks and services. Discussion covers technical issues from Physical layer to Application Layer, as well as a few contemporary issues of wireless communication networks. Prereq: EE I6000. 3 hr./wk., 3 cr.

EE I9400: High Speed Networks
Fundamentals of high-speed transport network (SONET, ATM 10GB Ethernet). Principles of IP optical networks including optical cross-connects (OXC) and WDM. Case studies of next generation networks architecture and protocols are studied. Prereq: EE I6000 or Instructor’s approval. 3 hr./wk.; 3 cr.

EE I0100: Probability and Stochastic Processes
Probability space, outcomes and events, random variables, distribution and density functions, limit theorems, functions of random variables, discrete and continuous stochastic processes, mean square estimation and prediction problems. 3 hr./wk.; 3 cr.

EE I0500: Theory of Linear Systems
Review of time and frequency domain analysis of continuous and discrete linear systems. Extension to time varying cases. States and state variables. Matrix formulation and general solutions. State transition matrix, adjoint systems; stability, observability, and controllability. Minimal realization. 3 hr./wk.; 3 cr.

EE I2200: Image Processing
Image acquisition and representation of monochromatic and color images. Data compression techniques for image transmission including predictive and transform coding. Practical compression techniques, including progressive transmission, JPEG and MPEG. Prereq: EE I5300 and EE I0100. 3 hr./wk.; 3 cr.

EE I5500: Introduction to Robotics
Introduction: historical development of robotic systems, research perspectives; Robot Manipulators: Homogeneous representation, robot kinematics and dynamics models, path and trajectory planning, robot motion control; Mobile Robots: kinematics model and dynamic model of wheeled mobile robots, motion planning and trajectory generation, navigation and mapping; Robot Sensing: visual and non-visual sensors. Prereq: EE 37100. 3 hr./wk.; 3 cr.

EE I6100: Integrated Circuits: Design and Fabrication I
Introduction to physics of IC processing: epitaxial growth, diffusion, oxidation, ion implantation, evaporation, and sputtering. Bipolar IC processing function, oxide and air isolation, analog IC design, OP amps and other circuits. MOS processing: metal and poly gate and self aligned structure, CMOS. Digital IC design. Analysis of ECL, T2L, I2L and MOS logic design. 3 hr./wk.; 3 cr.

EE I6200: Principles of Photonics Engineering
Principles and CAD tools for the design of photonics systems and devices. Topics from ray tracing, lens design, optical imaging systems design and analysis, interferometry, Fourier optics,
fibers, and waveguides, optical detectors, videodiscs, spectroscopy. Prereq: EE 33300. 3 hr./wk.; 3 cr.

**EE I6600: Communications Protocol Engineering**
Open systems interconnection (OSI) reference model, modeling communication protocols using finite and extended finite state machines, formal languages for protocol specification, real-life protocol specifications, verification of communication protocols, conformance testing methods, synchronization issues in testing, test representation languages. Prereq: EE I6000 or EE 46000. 3 hr./wk.; 3 cr.

**EE I6700: IP Routing**
Principles of IP routing protocols: OSPF, RIP, BGP, IP addressing, and LSAs. Analysis of connection oriented networks protocols such as MPLS and VLANS. RSVP signaling protocol, DiffServ, IntServ models. Methods of traffic engineering in IP network. Prereq: EE I6000 or instructor approval. 3 hr./wk.; 3 cr.

**EE I6800: Telecommunication Network Element Engineering**
This course provides an introduction to a broad spectrum of network and element level management protocols, software entities, and information databases. Students will gain theoretical and practical knowledge of network management concepts. Topics include management network architectures, protocols, modeling, information databases, network management applications (such as Configuration, Fault, and Performance Management), and telecommunications management network fundamentals. Prereq: EE 46000. 3 hr./wk.; 3 cr.

**EE I7000: Networks And Security**
The first half of the course will cover multiple access schemes and various LAN technology as well as IP protocol and TCP. The Second half of the course will cover network security including cryptography, symmetric-key and public key-encryption, digital signatures, management of public keys and communications security. Pre-req: EE I6000 or instructor approval. 3 hr./wk.; 3 cr.

**EE I8300: Fiber Optic Communications II**
Basic building blocks of an all optical network with particular emphasis on optical amplifiers including both Semiconductor Optical Amplifiers (SOAs) and Erbium-Doped Fiber Amplifiers
(EDFAs). System architecture for: I) the point-to-point link, II) the single station-to-multistation multipoint network, and III) the any-to-any connected network. Wavelength-Division Multi-Access (WDMA) and Time-division Multi-access networks (TDMA). Prereq: EE 15200. 3 hr./wk.; 3 cr.

**EE 18500: Optical Signal Processing**

### 10.2 CSc Courses:

**Core course:**

**CSc 10600. Advanced Algorithms**
This course covers basic data structures and advanced algorithm design techniques. Topics: Data structures, priority queues, binary search trees, balanced search trees. Btrees. Algorithm design and analysis techniques illustrated in searching and sorting: heapsort, quicksort, sorting in linear time, medians and order statistics. Design and analysis techniques: dynamic programming, greedy algorithms. Graph algorithms: elementary graph algorithms (breadth first search, depth first search, topological sort, connected components, strongly connected components), minimum spanning tree, shortest path. String algorithms. Geometric algorithms. Linear programming. Brief introduction to NP completeness. Prereq: CSc 22000 or equivalent. 3 hr./wk.; 3 cr.
Elective courses:

**CSc I4200. Advanced Computer Architecture**
This course provides students with an understanding of computer-hardware subsystems, digital design strategies and fundamental computer-performance and capacity-improvement techniques. Combinational and sequential circuits are developed for the essential building blocks of computers. Binary number systems are presented in both human and computer algorithms. Quantitative principles of computer design of parallel computing will be represented, including: Instruction-level parallelism (ILP). Exploiting ILP using Dynamic Scheduling, multiple issue, and speculation. Issues in thread-level parallelism using ILP. Multiprocessors and thread-level parallelism. Symmetric shared memory architectures. Distributed shared memory multiprocessors. Memory hierarchy design. Virtual machines. Advanced topics in storage systems.
Prereqs: CSc 34200/34300 or equivalent. 3 hr./wk.; 3 cr.

**CSc I4633. Multimedia/Multimodal Computing**
Algorithms and software that interactively process, analyze and understand digital audio, image, animation and video. Topics covered include digital audio formats and conversion factors affecting sound quality, digital image formats and conversion, image compression and factors affecting image quality, digital video formats and compression methods, videoconferencing and interactive media, and multimodal human-computer interaction (via face, gesture, speech and emotion recognition). This course will also briefly discuss human audio and vision perceptive science and explore how the brain hears and sees the world, thus including introductory on computational neuroscience, auditory, motion, color and several other topics. Prereqs: CSc 32200 and good programming knowledge. 3 hr./wk.; 3 cr.

**CSc I1900. Machine Learning and Data Mining**
This course aims to provide a comprehensive overview of recent advance in machine learning and data mining to analyze big data. Selected topics include big data clustering and classification, anomaly and fraud detection, time-series analysis, big graph mining,
and massive-scale data analytics; as well as case studies in social networks analysis, healthcare, business intelligence, etc. Prerequisites: CSc 44800 or equivalent, and knowledge of Linear Algebra. 3 hr./wk.; 3 cr.

**CSc I0400 Operating Systems**

Underlying theoretical structure of operating systems; input-output and storage systems, data management and processing; assembly and executive systems, monitors; multiprogramming. Prereq: CSc 33200 or an equivalent undergraduate course. 3 hr./wk.; 3 cr.

**CSc I0700 Compiler Construction**

Techniques involved in analysis of source languages and generation of efficient object code. Parsing methods, storage allocation, programming language semantics, optimization techniques, interpreters, study of existing compilers and their special features. Prereq: CSc 22000 and CSc 30400 or equivalent. 3 hr./wk.; 3 cr.

**CSc I0800 Topics in Software Systems**

Selected topics of current interest. Recent offerings have included computer games, concurrent and distributed processing, search technologies, internet programming and information management. Prereq: CSc 33200 or equivalent. 3 hr./wk.; 3 cr.

**CSc I1000 Database Systems I**

An introduction to database architecture. Levels of abstraction in a database system, physical data organization, abstract data models, relational database systems, and their query language. Prereq: CSc 22000 and CSc 33200 or equivalent. 3 hr./wk.; 3 cr.

**CSc I1100 Database Systems II**

Logical models for database management systems, especially relational, hierarchical and network. Case studies illustrating their implications for applications system development. Physical implementation of advanced data and storage structures. Prereq: CSc I1000 or equivalent. 3 hr./wk.; 3 cr.
CSc I1400 Parallel Algorithms
Techniques of efficient program design. Analysis of parallel algorithms chosen from information storage and retrieval, graph theory, pattern matching, matrix operations, etc. as to their time, space, and other resource requirements. Lower bounds for the intrinsic computational difficulty of some of these programs. Prereq: CSc 22000 and CSc 30400 or equivalent. 3 hr./wk.; 3 cr.

CSc I1500 Artificial Intelligence
The study of how to make the computer behave intelligently. State-space methods of problem solving, heuristic search techniques, representation and use of knowledge, mechanical theorem proving, psychological implications. Examples of game playing, problem solving, or other systems. Prereq: CSc 22000 and CSc 30400 or equivalent. 3 hr./wk.; 3 cr.

CSC I1600, Natural Language Processing: Text
Methods for processing English texts and dialogues on the computer. Parsing, transformational analysis, semantic analysis, interfacing; examples of natural language systems for carrying on dialogues and performing tests. Prereq: CSc 44800, or CSc I1500 or equivalent. 3 hr./wk.; 3 cr.

CSc I1800 Topics in Artificial Intelligence
Selected topics from expert systems, automated systems and robotics; automated reasoning; computer vision. Prereq: CSc 44800 or CSc I1500 or equivalent. 3 hr./wk.; 3 cr.

CSC I2000, Introduction to Theoretical Computer Science
Fundamental concepts from logic, models of computation, and complexity theory. Scope and limitations of various formalisms. The Chomsky hierarchy of languages and machines. Basic ideas for recursive functions. Impact on programming systems. Prereq: CSc 30400 or equivalent. 3 hr./wk.; 3 cr.
CSC I2400, Formal Languages
Classification of languages by grammars and automata. The Chomsky hierarchy: regular, context free, context sensitive and recursively enumerable languages and their associated grammars and automata. Closure properties for families of languages. Decision problems for grammars and automata. Prereq: CSc 30400 or CSc I2000 or equivalent. 3 hr./wk.; 3 cr.

CSc I4300 Computer Communication

CSc I4330 Advanced Topics in Internet Programming
The first part of the course will deal with platform independent software and data for Internet programming. The second part will address Web Services–messaging over standard web protocols. Students will be exposed to current technologies and standards. Topics discussed may include: distributed objects and remote invocation, messaging, name services, security. Prereq: CSc 22100 or equivalent. 3 hr./wk.; 3 cr.

CSc I4900 Computer Security
An introduction to the principles and practices of computer security in various computing environments. Conventional encryption systems and classical cryptography. Confidentiality using conventional encryption. Public key encryption and protocols for authentication and digital signatures. Recent cryptanalytic attacks on conventional and public key systems. Intruders, viruses, and trusted systems. Firewalls and internetwork
security. A survey of applications and problems arising in contemporary computer security. Prereq: CSc 30400 and CSc 22000 or equivalent. 3 hr./wk.; 3 cr.

**CSc I6400, Simulation**
Simulation methodology, design, and analysis of simulation experiments. Generation and testing of random variates. Variance reduction techniques. Simulation languages. Analysis of queuing models on computer systems simulation. Prereq: CSc 22000 and CSc 21700 or equivalent. 3 hr./wk.; 3 cr.

**CSc I6730 Data Reduction in Physical Sciences**
A course in the reduction of data sets gathered by government agencies (NOAA and NASA). Data comes from satellite remote sensing and other atmospheric and oceanographic measuring systems. Prereq: Permission of the instructor. 3 hr./wk.; 3 cr.

**CSc I6716: Computer Vision**
Computer vision has a rich history of fundamental work on color, stereo and visual motion, which has dealt with the problems of color image understanding, 3D reconstruction from multiple images, and structure from motion from video sequences. Recently, in addition to these traditional problems, the stereo and motion information presented in multiple images or a video sequence is also being used to solve several other interesting problems, for example, large-scale scene modeling and rendering, video mosaicing, video segmentation, video compression and transmission, video manipulation, mobile vision, and first person vision. The best successful vision systems that computer vision researchers can learn from are human vision systems. Therefore this course will also briefly discuss human vision science and explore how the brain sees the world, thus including introductory on computational neuroscience, motion, color and several other topics. Prereqs: CSc 22000 or equivalent. 3 hr./wk.; 3 cr.
CSc IA804: High Performance Computing Using GPUs
This course is designed to introduce enthusiastic students to GPGPU computing technologies and their applications in both numeric computation and discrete data structures and algorithms. Prerequisite: The course is open to both CSc and Engineering graduate students AND senior undergraduate students (with GPA >2.75).
11 Appendix B: Syllabi For New Courses

CORE COURSE 1

New course: EE I4400 Advanced Computer Architecture

Credits: 3
Prerequisites: EE 34400 and EE 42500; or CSc 34200 and CSc 34300.


Description: The goal of this course is to teach the students the major structural components of computer architecture and the quantitative analysis and evaluation of modern computing systems, such as the selection of appropriate benchmarks to reveal and compare the performance of alternative design choices in system design.

Topics Covered:
- Instruction set architecture, Pipelining
- Memory Hierarchy
- Instruction Level Parallelism
- Data-level Parallelism
- Single Instruction Multiple Data, Graphics Processing, Multiple Instruction Multiple Data
- Memory Systems
- Multiprocessor Systems
CORE COURSE 2

CSc I0600 Advanced Algorithms

Instructor: Prof. Peter Brass

Credits: 3

Prerequisites: CSc 2200

Description: This course covers algorithmic problems and design techniques.

Topics:

- Graph exploration
- shortest paths in graphs and geometric settings
- minimum spanning trees and Steiner trees
- maximum flows
- linear programming and the simplex algorithm
- randomized incremental algorithms
- dynamic programming algorithms
- string matching and edit distance
- arithmetic on large integers and the discrete Fourier transform
- NP-completeness and the Satisfiability Problem
- approximation algorithms
- online algorithms
- competitiveness

Homeworks: four implementation homeworks, each of which is typically around 500 lines.
SYLLABI FOR NEW ELECTIVE COURSES FROM EE:

New course: EE 12500 — Advanced Embedded Systems
Prerequisite: EE 425
Textbook: Class notes and recently published papers in the field.
Grading: Midterm and final exams; class projects.
Course description: This course presents the advanced topics in embedded systems for computer engineering. The course will have applications in image processing, robotics, communications and similar topics. Three or four topics will be covered. Each topic will be introduced with the current problems and specific needs in the field. Students will learn the skills necessary to acquire information about a specific topic in computer engineering and design an embedded system to address these needs.
Week 1: Introduction to embedded system building tools and techniques.
Week 2: Introduction of a selected task in image processing
Weeks 3-5: Embedded system specification, design and implementation for the image processing task
Week 6: Introduction of a selected task in robotics
Weeks 7-9: Embedded system specification, design and implementation for the robotics task
Week 10: Introduction of a selected task in communications, cyber-security, information assurance, and network security.
Weeks 11-14: Embedded system specification, design and implementation for the task
Final Exam: All materials covered in the course.
New course: EE 15700 — Advanced Digital Integrated Circuits

Pre-requisites: EE 457: Digital Integrated Circuits or equivalent course. Students should have basic knowledge of logic circuits and digital CMOS electronics.

Instructor: Bruce Kim


Class notes: Lecture notes will be made from the latest leading conferences in the field by industry leaders. Some guest lecture notes will be available.

Technical Journals and Conferences:
1) IEEE Journal of solid-state circuits
2) International Conference of Solid-State Circuits (ISSCC)
3) IEEE Transactions on Very large Scale Integration Systems
4) IEEE International Conference on VLSI Design
5) Symposia on VLSI Technology and Circuits
6) IEEE International Conference on Computer Design

Grading: Homework 20%, Projects 40%, Exams 30%, Project Presentations 10%.

Course description: (3 Credits) This course presents the advanced topics in digital integrated circuits for computer engineering. Low-power and high-performance design issues in modern CMOS processes are discussed. The challenges of technology scaling are covered and state of the art technologies and solutions at different levels of abstraction are discussed from systems to circuits. This course will include hands-on approaches to hardware cyber security attacks and Internet of Things (IoT). Topics may include side channel attacks, differential power analysis, hardware Trojans design, acoustic analysis, EM logging and hardware counterfeiting. Class projects are an integral part of this course.

Week 1: Introduction to CMOS digital circuits.
Week 2: Low power VLSI circuit design issues.
Weeks 3-4: High performance circuits for modern microprocessors.
Week 5: High Density hardware design for 3D stacked memory chips.
Weeks 6-7: Cyber Hardware Security Introduction, Ethics, Hacking
Week 8-9: Hard Disk Attacks, Acoustic Analysis, Cryptographic Algorithms
Weeks 10: Introduction to Side Channel Attacks
Weeks 11: Hardware Trojans in IC Design Flow, Trojan Power Analysis and Testing
Weeks 12: Design Flow and Insertion of Trojan Virus in Hardware
Weeks 13: IC Hardware Counterfeiting
Weeks 14: Introduction to internet of Things (IoT), Final Project Presentations
EE G6530 Biologically Inspired Computation for Engineering Problems

Pre-/Co-requisites: I0100 (knowledge of linear systems and basic programming skills)
Instructor: Prof. M. Ümit Uyar, office: T672, ext: 5632
Text: Class notes prepared by the instructor and recently published papers in the field.
Grading: Projects 30%, Midterm 30%, Final Exam 40%.

Course description: This course introduces modern optimization techniques mimicking biological principles such as survival of the fittest, behavior of ants and flocks of birds. These techniques become especially relevant for optimization problems when there is no known analytical solution. This course illustrates application of bio-inspired techniques to solve realistic engineering problems in many fields including telecommunication, transportation, robotics, and others.

Weeks 1-2: Introduction to biologically inspired computational techniques.
Weeks 3-4: General form of Genetic Algorithms (GAs) – selection, crossover and mutation operations
Weeks 4-5: Application of GAs to topology control problems of mobile ad hoc networks
   Midterm Exam: GA and its applications
Weeks 6-7: Particle Swarm Optimization (PSO)
Weeks 8-9: Applications of PSO in telecommunication networks
Weeks 10-11: Differential Evolution (DE)
Weeks 12-14: Applications of DE to optimization problems
   Final Exam: Cumulative.
SYLLABI FOR NEW ELECTIVE COURSES FROM CSc:

New course: **Introduction to Quantum Information and Computing**

Instructor: Professor Leonid Gurvits (The City College of New York)
Prerequisite: TBD

The efforts of several generations of physicists, mathematicians and lately computer scientists had managed to distill the main purely mathematical concepts of new, fascinating, emerging area of research called Quantum Information and Computing. Even though the ultimate goal/dream is to build a reliable functioning quantum computer, there are already as practical applications (mainly in cryptography and metrology) as well amazing new insights on the nature of quantum mechanics and very cool theoretical applications to hard classical problems.

This course in quantum information and computation is aimed at postgraduate as well as senior undergraduate engineering, computer science, math and physics/chemistry students. Not only the students will learn rather sophisticated concepts, results and algorithms in the quantum realm, but additionally (and perhaps more importantly) they will get a different (hopefully even more clear) view on the "classical" problems most of them are working on.

This course will be taught mostly with blackboard lectures. Expect a very rigorous approach: most of the statements will be formally proved (albeit with new and much more transparent proofs).

Topics will include:
- “quantum” probability theory (positive semidefinite matrices vs vectors with nonnegative coordinates, traces vs marginal distribution, completely positive trace preserving operators vs stochastic matrices),
• description of physically realisable quantum circuits in the discrete and continuous time (Lindblad’s operators),
• quantum entropy and mutual information,
• very deep geometric and complexity theoretic treatment of quantum entanglement,
• teleportation and dense coding;
• Simon’s, Shor’s and Grover’s algorithms;
• elements of Quantum Linear Optics;
• quantum optical algorithms.

The students interested in control theory/signal processing will learn several new matrix tools/tricks, students interested in machine learning will see how the kernels are used in physics (linear quantum optics), math students will learn new proof techniques and get a firmer grasp of convex geometry, computer science students will see how the complexity theory can advance (or kill) new technologies, art students will learn another form of art and beauty.
CSc 10802 Web-based Geographical Information System (Web-GIS)

3 Credits, Tu/Th 3:30-4:45
Instructor: Dr. Jianting Zhang
Dept. of Computer Science, City College

Prerequisites: 1) Graduate standing at the CUNY AND one of the following: A) CSc21200 Data Structures or equivalent; OR B) Introduction to GIS with strong programming skills and permission from the instructor.

Descriptions: Online mapping services, such as Google Map and Microsoft Bing Map, have had significant impacts on our daily lives over the past decade. It has been estimated that more than 80% of the information has a geographical component. Web-based Geographical Information Systems (Web-GIS) integrate Spatial Databases, GIS and Web technologies to manage and process geographical information in a Web environment. The course includes the following units:

- Spatial concepts and representation of spatial objects
- Spatial query languages and query processing
- Spatial access methods (spatial indexing)
- Geospatial Web services: Standards and Practices
- Web-GIS architectures and realizations
- Introduction to parallel processing of large-scale geospatial data

Learning Goals: This course will introduce students to a new field of managing and processing geographical data in a Web environment, which is not only technically challenging but also practically useful. Through working on individual assignments and a large term project of considerable technical depth, students are expected to expose themselves to the forefront of research and development in the field. Furthermore, students have a chance to apply their software engineering knowledge in a large project full of technical challenges. By the end of the course, students will: (1) Understand the concepts, principles, technologies and best practices in geospatial data management and Web-GIS through lecturing. (2) Receive valuable hands-on experiences in research and applications through a large group-based term project. (3) Gain deeper insights into the design and implementation of real world software engineering. (4) Be better prepared for the career opportunities in GIS and Web-based programming.
Grading Policies:

- Attendance and participation: 10%
- Homework assignments (2-3): 30%
- Midterm: 20%
- Term (group) project: 40%

Logistics:

- Office Hours: Tu/Th 11am-12pm
- Instructor email: jiazhang@ccny.cuny.edu
- Instructor Phone#: 212-650-6175
- Course Website: CUNY Blackboard

Textbook & References

- No textbooks are required. Slides and links to course material will be provided on Blackboard before or shortly after classes.
CSC I6716  Computer Vision
Instructor and course coordinator: Zhigang Zhu

Part 0. Introduction and Human Vision
0-1. Introduction
0-2. Human Eyes and Visual Brain
0-3. Depth and Color

Part I. 2D Computer Vision Basics
I-1. Image Formation: Digital Image Basics (Assignment 1)
I-2. Image Enhancement
I-3. Edge Detection (Assignment 2)

Part II. 3D Computer Vision
II-1. Camera Models
II-2. Camera Calibration (Assignment 3)
II-3. Stereo Vision (Assignment 4)
II-4. Visual Motion

Part III. Advanced Topics, Exam, and Project Presentations
III-1. Video Mosaicing and Panoramic Stereo Imaging
III-2. Exam on Human and Computer Vision
III-3. Student Project Presentations
Massively Data Parallel Programming on GPUs

CSc IA804, 3 Credits

Mondays, 4:50 – 7:20 pm Instructor: Dr. Jianting Zhang
Dept. of Computer Science, City College
jzhang@cs.ccny.cuny.edu, 212-650-6175

General Computing on Graphics Processing Unit (GPGPU) technologies are playing increasingly important roles in large-scale data processing in the forthcoming parallel computing era. Compared with multi-core CPUs, GPUs have a much larger number of processing cores (~103) and concurrent threads (~105) which make them significantly different from CPUs that currently support much fewer processing cores (~101) and concurrent threads (<102). In addition, commodity GPU memory bandwidth (~102 GB/s) is more than an order of magnitude higher than that of CPUs (~101 GB/s) and three orders higher than that of disks (~102 MB/s). The high-performance in conjunction with high affordability ($500-$3,000) make GPGPUs ideal for BigData applications in both personal and cluster computing environments.

This course is designed to introduce enthusiastic students with GPGPU computing technologies and their applications in both numeric computation and discrete data structures and algorithms. The course (tentatively) includes the following units. Guest lectures by professions and a tour to CUNY High Performance Computing Center (CUNY HPCC) are also planned.

- Introduction to parallel computing: Multi-Core CPUs, many-core GPUs and cluster computing
- SIMD/SIMT based data parallel computing model and GPGPU computing
- Compute Unified Device Architecture (CUDA) programming basics
- High-level Data Parallel Primitives: Thrust, cudpp and other libraries
- GPGPU for numeric computation: vector/matrix multiplications
- GPGPU for image/signal processing: convolution, transformation and coding
- GPGPU for discrete data structures and algorithms: grid-file and tree based indexing and query processing of multidimensional data

Textbook & References
· No textbooks are required but references are provided (with online PDF/audio/video resources)
· Slides and links to research articles will be provided before classes (through Blackboard system).
· Reference 2: W. Hwu (eds) GPGPU Computing Gems (both Jade and Emerald editions).

Prerequisites and Logistics:

· The course is open to both CSc and Engineering graduate students AND senior undergraduate students (with GPA >2.75).
· Reasonable proficiency in programming and enthusiasm in high performance computing are essential. Previous experiences with C/C++ is preferred but not required.
· All other individuals interested in the course: please contact the instructor for assistance.
· Remote accesses to GPU hardware and software will be provided by the instructor. Students are also encouraged (but not required) to apply free CUNY HPCC accounts.
· Students are encouraged to look into related course offering at Coursera (https://class.coursera.org/hetero-2012-001/) before enrollment.
# 12 Appendix C: Program Scheduling (SED Form)

**Table 9**  
Progress for a typical student in two terms

- Indicate **academic calendar** type: _Semester_ _Quarter_ _Trimester_ _Other_  
  (describe)

- Label each term in sequence, consistent with the institution’s academic calendar (e.g., Fall 1, Spring 1, Fall 2)
- Use the table to show **how a typical student may progress through the program**; copy/expand the table as needed.

<table>
<thead>
<tr>
<th>Term: Fall 1</th>
<th>Course Number &amp; Title</th>
<th>Credits</th>
<th>New</th>
<th>Prerequisite(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core 1: EE I4400, Advanced Computer Architecture</td>
<td>3</td>
<td>yes</td>
<td>CSc 34200 &amp; CSc 34300; or EE 34400 &amp; EE 42500</td>
<td></td>
</tr>
<tr>
<td>Core 2: CSc I0600, Advanced Algorithms</td>
<td>3</td>
<td>no</td>
<td>CSc 22000</td>
<td></td>
</tr>
<tr>
<td>Elective 1: EE I5300, Digital Signal Processing</td>
<td>3</td>
<td>no</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Software Applications area: CSc I6716, Computer Vision</td>
<td>3</td>
<td>no</td>
<td>CSc 22000</td>
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</tr>
<tr>
<td>Theory area: EE I0100, Prob &amp; Stoch Proc</td>
<td>3</td>
<td>no</td>
<td>none</td>
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</table>

**Term credit total:** 15

<table>
<thead>
<tr>
<th>Term: Spring 1</th>
<th>Course Number &amp; Title</th>
<th>Credits</th>
<th>New</th>
<th>Prerequisite(s)</th>
</tr>
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<tbody>
<tr>
<td>Zero-credit report</td>
<td></td>
<td>0</td>
<td>no</td>
<td>none</td>
</tr>
<tr>
<td>Elective 2: CSc I0400, Operating Systems</td>
<td>3</td>
<td>no</td>
<td>CSc 33200</td>
<td></td>
</tr>
<tr>
<td>Elective 3: EE G6530, Biolgcly Inspr Cmptn</td>
<td>3</td>
<td>no</td>
<td>Coreq: EE I0100</td>
<td></td>
</tr>
<tr>
<td>Elective 4: CSc I4300, Computer Communication</td>
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<td>no</td>
<td>CSc 34200, CSc 34300, &amp; CSc 32200</td>
<td></td>
</tr>
<tr>
<td>Hardware area: EE I5501, Intro To Robotics</td>
<td>3</td>
<td>no</td>
<td>EE 37100</td>
<td></td>
</tr>
<tr>
<td>Networks &amp; Security area: CSc I4900, Computer Security</td>
<td>3</td>
<td>no</td>
<td>CSc 30400 &amp; CSc 22000</td>
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</tr>
</tbody>
</table>

**Term credit total:** 15

<table>
<thead>
<tr>
<th>Program Totals:</th>
<th>Credits: 30</th>
</tr>
</thead>
</table>

**New**: indicate if new course  
**Prerequisite(s)**: list prerequisite(s) for the noted courses

Identify any comprehensive, culminating element(s) (e.g., thesis or examination), including course number if applicable: *Zero-credit report.*
### Table 10  
Progress for a typical student in three terms

<table>
<thead>
<tr>
<th>Term: Fall 1</th>
<th>Course Number &amp; Title</th>
<th>Credits</th>
<th>New</th>
<th>Prerequisite(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core 1:</td>
<td>EE 14400, Advanced Computer Architecture</td>
<td>3</td>
<td>yes</td>
<td>CSc 34200 &amp; CSc 34300, or EE 34400 &amp; EE 42500</td>
</tr>
<tr>
<td>Core 2:</td>
<td>CSc 10600, Advanced Algorithms</td>
<td>3</td>
<td>no</td>
<td>CSc 22000</td>
</tr>
<tr>
<td>Elective 1:</td>
<td>EE 15300, Digital Signal Processing</td>
<td>3</td>
<td>no</td>
<td>none</td>
</tr>
<tr>
<td></td>
<td><strong>Term credit total:</strong></td>
<td><strong>9</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Term: Spring 1</th>
<th>Course Number &amp; Title</th>
<th>Credits</th>
<th>New</th>
<th>Prerequisite(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Software Applications area:</td>
<td>CSC 16716, Computer Vision</td>
<td>3</td>
<td>no</td>
<td>CSc 22000</td>
</tr>
<tr>
<td>Theory area: EE I0100, Prob &amp; Stoch Proc</td>
<td>3</td>
<td>no</td>
<td>none</td>
<td></td>
</tr>
<tr>
<td>Elective 2:</td>
<td>CSc I0400, Operating Systems</td>
<td>3</td>
<td>no</td>
<td>CSc 33200</td>
</tr>
<tr>
<td>Elective 3:</td>
<td>EE G6530, Biolgcly Inspr Cmptn</td>
<td>3</td>
<td>no</td>
<td>Coreq: EE I0100</td>
</tr>
<tr>
<td></td>
<td><strong>Term credit total:</strong></td>
<td><strong>12</strong></td>
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</table>

<table>
<thead>
<tr>
<th>Term: Fall 2</th>
<th>Course Number &amp; Title</th>
<th>Credits</th>
<th>New</th>
<th>Prerequisite(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zero-credit report</td>
<td></td>
<td>0</td>
<td>no</td>
<td>none</td>
</tr>
<tr>
<td>Elective 4: CSC I4300, Computer Communication</td>
<td>3</td>
<td>no</td>
<td>CSc 34200, CSc 34300, &amp; CSc 32200</td>
<td></td>
</tr>
<tr>
<td>Hardware area: EE I5501, Intro To Robotics</td>
<td>3</td>
<td>no</td>
<td>EE 37100</td>
<td></td>
</tr>
<tr>
<td>Networks &amp; Security area: CSC I4900, Computer Security</td>
<td>3</td>
<td>no</td>
<td>CSc 30400 &amp; CSc 22000</td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Term credit total:</strong></td>
<td><strong>9</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Program Totals: | Credits: 30 | Identify any comprehensive, culminating element(s) (e.g., thesis or examination), including course number if applicable: Zero-credit report. |

**New:** indicate if new course  
**Prerequisite(s):** list prerequisite(s) for the noted courses
13 Appendix D: Faculty Teaching Assignments (SED Form)

See Table 3 in Section 6.1.

14 Appendix E: Faculty To Be Hired (SED Form)

See Section 6.3.

15 Appendix F: New Resources Table (CUNY)

See Table 6 in Section 7.

16 Appendix G: Projected Revenue Table (CUNY)

See Table 7 in Section 7.
### DIRECT OPERATING EXPENSES

<table>
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<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Full Time Faculty Overload (incl. Summer)</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>• One new faculty member for each of CSc &amp; EE, 50% time for each:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>New Full Time Faculty Base Salary (list separately)</td>
<td>$81,645</td>
<td>$84,094</td>
<td>$88,299</td>
<td>$92,714</td>
<td>$97,350</td>
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<tr>
<td>New Full Time Faculty Overload (incl. Summer)</td>
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<td>$18,687</td>
<td>$19,622</td>
<td>$20,603</td>
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<tr>
<td>New Faculty Re-assigned Time (list separately)</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
<td>$0</td>
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<tr>
<td>Full Time Employee Fringe Benefits (41.6%)</td>
<td>$41,512</td>
<td>$42,757</td>
<td>$44,895</td>
<td>$47,140</td>
<td>$49,497</td>
</tr>
<tr>
<td>Total</td>
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<td>$145,539</td>
<td>$152,816</td>
<td>$160,457</td>
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<tr>
<td>Full Time Staff Base Salary (list separately):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>• secretary</td>
<td>$33,000</td>
<td>$34,650</td>
<td>$36,383</td>
<td>$38,202</td>
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<tr>
<td>Full Time Staff Fringe Benefits (41.6%)</td>
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<td>$14,414</td>
<td>$15,135</td>
<td>$15,892</td>
<td>$16,686</td>
</tr>
<tr>
<td>Total</td>
<td>$46,728</td>
<td>$49,064</td>
<td>$51,518</td>
<td>$54,094</td>
<td>$56,798</td>
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### PART-TIME STAFF

<table>
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<tr>
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<tbody>
<tr>
<td>Part Time Staff Base Salary (list separately):</td>
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<tr>
<td>• teaching assistants</td>
<td>$20,000</td>
<td>$21,000</td>
<td>$22,050</td>
<td>$23,153</td>
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<td>Faculty Replacement Costs (replacement of full-time faculty - e.g. on release time - with part-time faculty)</td>
<td>$0</td>
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<td>$0</td>
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<tr>
<td>Graduate Assistants</td>
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<td>• 2 new, for expected increased enrollment</td>
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<td>$16,800</td>
<td>$17,640</td>
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<td>$0</td>
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<td>Part Time Employee Fringe Benefits (24.3%)</td>
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<td>$46,985</td>
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### EQUIPMENT

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<td>Computer Hardware</td>
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<tr>
<td>Other (Specify) (Supplies)</td>
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### LABORATORIES

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<tbody>
<tr>
<td>Laboratory Equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Embedded system lab equipment</td>
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<td>Other (list separately)</td>
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### SUPPLIES AND EXPENSES (OTPS)

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<th>2026</th>
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<td>Travel and Conferences</td>
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<td>$1,654</td>
<td>$1,736</td>
<td>$1,823</td>
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<td>Equipment Repair and Maintenance</td>
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<td>$1,654</td>
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<td><strong>New Total Supplies and OTPS Expenses</strong></td>
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### CAPITAL EXPENDITURES

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<td>Other (list separately):</td>
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<td>• Startup for one CSc and one EE new faculty is $200,000. 50% of this cost is devoted to the new program.</td>
<td>$50,000</td>
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<td><strong>Total</strong></td>
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18 Appendix I: Five Year Financial Projection (CUNY Table)

See Table 8 in Section 7.
19 Appendix J: Evaluation Report Form (Non Teacher Education Graduate Program) (CUNY Form)

An external evaluation report by Prof. Joseph Cavallaro of Rice University is included in Section 21.1 of Appendix L: External Evaluation Report. We then give our responses and the changes to that we made to the document in Section 21.2.
20 Appendix K: Articulation Agreement(s) (CUNY)

We will not immediately implement any articulation agreements for the proposed program.
21 Appendix L: External Evaluation Report

21.1 Evaluation Report for the Program Proposal

Institution: THE CITY COLLEGE OF THE CITY UNIVERSITY OF NEW YORK
Evaluator(s): Professor Joseph R. Cavallaro, Rice University
Program title: PROGRAM IN COMPUTER ENGINEERING
Degree title: MASTER'S DEGREE
Date of evaluation: September 20, 2015

I. Program

1. Assess program purpose, structure, and requirements as well as formal mechanisms for program administration and monitoring.

   The program purpose, structure and requirements are well addressed in the program proposal. However, the mechanisms for administration and monitoring could use further clarification. For instance, will there be a special admissions committee for this program and will this selection be done by faculty or staff only? Furthermore, will there be a faculty advising committee with members from both departments? It may be challenging for students to select appropriate courses to complete the program in the recommended time, since students' preparation in either hardware or software may be unbalanced.

2. Comment on the special focus of this program, if any, as it relates to the discipline.

   The overall focus of the program is very appropriate for the discipline of computer engineering. However, for balance between hardware and software knowledge, more hardware courses would further strengthen the hardware restrictive electives "focus" category. Additionally, there is concern that the
success of the program hinges on the recruitment of junior faculty, especially, faculty to teach the hardware core course. There is some risk to this approach. It is also not clear from the course numbering why "regular" computer architecture CSC I4200 is considered a focus area elective, yet Advanced Computer Architecture EE I4400 is a required core course for all. This seems to be reversed and also CSC I4200 is not a pre-requisite for EE I4400. Furthermore, in the list of computer science electives on page 34, CSC I4200 is labeled "Advanced" Computer Architecture. As this reviewer is not familiar with the EE and CSC courses and numbering at CCNY, this labeling on the core hardware course could lead to confusion by future students.

3. Comment on the plans and expectations for continuing program development and self-assessment.

Although it is indicated that there are no current plans to seek program accreditation through an organization such as ABET, the overall program "objectives" and student and course "outcomes" are not clearly stated. Expected objectives and outcomes are useful to be defined as well as student teaching evaluations and exit interviews. Collecting this information as is often done in undergraduate ABET accredited programs provides reference points for continual improvement. I suggest that these elements be included for the program if they are already defined for the EE and CSC master’s programs at CCNY.

4. Assess available support from related programs.

The support from related programs seems reasonable. There is good use of existing Electrical Engineering and Computer Science courses as electives for the proposed program. One issue that was not clear was the impact of new additional students in the proposed computer engineering program on the size of these existing courses. It is not clear if the additional students will require the creation
of additional sections of these electives. Enrollment limits and available room for students in the elective classes was not described.

5. (Only for programs requiring master plan amendment.) What is the evidence of need and demand for the program locally, in the State, and in the field at large? What is the extent of occupational demand for graduates? What is the evidence that demand will continue?

The need and demand for the proposed program was clearly explained and well justified. Computer engineering is in demand and there are needs in the New York area for Master's degree students in this topic area of hardware and software.

II. Faculty

6. Evaluate the faculty, individually and collectively, in regard to training, experience, research and publication, professional service, and recognition in the field.

The list of faculty, both individually and collectively, is impressive and very capable to lead this proposed program. In terms of the course selections, there is concern over the limited core and focus courses in electrical engineering and the lack of hardware courses. In addition, there is limited number of computer science theory and electrical engineering theory focus courses compared to the network and software courses.

7. Assess the faculty in terms of size and qualifications. What are plans for future staffing?

The size and qualifications of the faculty seem appropriate for the proposed program. As indicated earlier, it will be important to successfully recruit faculty for several key courses. There is some risk to success to add junior faculty to this
key role in the program. All of the faculty are capable, but additional faculty in hardware design will strengthen the program.

8. Evaluate credentials and involvement of adjunct and support faculty.

The program proposal does not indicate adjunct or support faculty will be involved in the program.

III. Resources

9. Comment on the adequacy of physical resources and facilities, e.g., library, computer, and laboratory facilities; practica and internship sites; and support services for the program, including use of resources outside the institution.

Further details would help with assessment of the facilities. It appears that more laboratory facilities would be useful to develop the proposed program. Experiential learning in hardware and software projects will be important and this is not clearly described, eg., FPGA and embedded system labs (ARM, etc., based.) Also courses and projects that focus on developing teamwork skills will be important for students as they begin their careers. It is not clear if a capstone design project will be developed. Therefore it would be useful if the proposal identified which courses have lab and teamwork components.

10. (Only for programs requiring master plan amendment.) What is the institution's commitment to the program as demonstrated by the operating budget, faculty salaries, and the number of faculty lines relative to student numbers and workload.

The presented budget is perhaps reasonable. It is not clear if this will greatly increase the teaching load of the existing faculty as the current sizes of courses and available seats is not detailed. It would not be appropriate to dilute the quality
of existing classes by adding more students if the existing classes are at capacity. Most of the budget support is for the 50% hires. It is not clear if the home departments of EE and CS will commit to the remaining 50%. It is not clear if EE and CS will need additional support from the central university administration for the remaining 50% support. Also, support for laboratory facility enhancement and laboratory equipment is not clear. As mentioned above, practical experience in hardware and embedded software laboratories would greatly strengthen the proposed program. Some projects are described in the new course EE I2500 Advanced Embedded Systems, but the $50K laboratory expense is detailed as optical equipment which does not appear to be critically appropriate to computer engineering.

IV. Summary Comments and Additional Observations

11. Summarize the major strengths and weaknesses of the program as proposed with particular attention to feasibility of implementation and appropriateness of objectives for the degree offered. Include any further observations important to the evaluation of this program proposal and provide any recommendations for the proposed program.

In summary, the major strengths are the importance and demand for a program in computer engineering in the New York area. There is a good plan for integration in the program. Also there is a good choice of courses on the software side of the proposed program. In terms of concerns and areas for further study and possible improvement, there is a need for more hardware courses in the "focus area" category as there are many more options in the network & security and the software focus areas. This leads to some imbalance in the course offerings. Also, it is not clear how focus area and elective courses were selected. For example, EE G5700 Advanced Digital Integrated Circuits is a focus area course while EE I5700 Advanced Topics in Digital Integrated Circuits is listed as a new course and elective. It is not
clear if this is the same class or a different class as the mix of letters and numbers and the course numbering convention at CCNY was not clearly described.

Faculty led student advising and admissions committees could be more clearly defined as
students will need advising for course selection in a multi-disciplinary program such as computer engineering. Some discussion on coordination with career services for student placement would be useful. Finally, program objectives and student and course outcomes could be formalized, along with details on assessment mechanisms such as teaching evaluations, town hall meetings, and student exit surveys.
21.2 Responses to the External Evaluation Report

Evaluator’s item I.1:
- We have added a paragraph to section 5.2 clarifying the admission process.
- Faculty from both departments will advise students in selecting courses. We have added a new section to address this, Section 5.3: Student Support.

Evaluator’s item I.2:
- We have added EE 5400 Physical Electronics in the Hardware focus area. Students can also gain hardware experience from many choices of the required course in the Networks and Security focus area, for example High Speed Networks (EE G9400), Wireless Communication (EE F6300), or Fiber Optic Communication 1 (EE I5200).
- The program does not hinge on new hardware faculty. Existing faculty can teach the hardware core course, Advanced Computer Architecture (EE I4400), for example Profs. Kim, Conner or Uyar.
- The EE master's course is called Advanced Computer Architecture (EE I4400) because there is an undergraduate EE course in computer architecture, Digital Computer Systems (EE 34400). CSc I4200, Computer Architecture, has no prerequisite relationship with EE I4400, and therefore they are independent.

Evaluator’s item I.3:
- Neither the EE nor CSc master's programs list specific program objectives or outcomes. If in the future there is an initiative across GSoE master's programs to list such outcomes, the computer engineering program will do so as well.

Evaluator’s item I.4:
- There are 22 existing sections per term, with 5-7 empty seats out of 25. This means that 256 seats are available. In the steady state (year 3 and beyond), 40 students taking 10 courses over two terms require 400 section seats, so 144 section seats will be needed. This is 5.8 additional sections, distributed over two
departments and two terms, which is 1.5 additional sections per department per term.

Evaluator’s item II.6:

- See the response to this point in item I.2 above.
- The Electrical Engineering and Computer Science Departments have extensive expertise in software and networking, so we have many course options in those areas. But the students in the computer engineering master's program will only be required to take one of these courses in each focus area, regardless of the number of options. We believe that the total number of hardware and theory courses is enough.

Evaluator’s item II.7:

- See the response to this point in item I.2 above.

Evaluator’s item III.9:

- As in the Electrical Engineering and Computer Science master's programs, teamwork and lab exposure are not explicitly indicated. But many of the focus and elective courses incorporate labs and teamwork. For example, EE I6600, EE I6800 and EE G3300 each have several projects, each requiring teams of 4-5 students. The new Embedded Systems courses, EE I2500, comprises three large projects, to be completed by students in teams. The program does not require a capstone design course.

Evaluator’s item III.10:

- Regarding the capacity of course sections, see the response to this point in item I.4 above.
- GSoE has expressed strong support for the proposed program with a commitment to two new faculty positions, each of which will dedicate 50% of their time to the program. If any of these positions are not filled when the program starts, industry experts will be temporarily utilized.
• Under the Laboratories heading in Appendix H, we have explicitly stated that the $50K lab expense is targeted to the embedded systems lab.

Evaluator’s item IV.11:

• We have corrected the course number to E5700. We are grateful for the correction.
• The new section 5.3, Student Support, describes the support services offered to master's students by the Career and Professional Development Institute.
• In Section 8.1, Internal Evaluation, we now mention CCNY’s standard evaluation processes, including faculty teaching observation and course evaluation surveys.