



UNC CHARLOTTE

Office of the Chancellor

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December 2, 2019

Dr. Kimberly van Noort
Vice President for Academic Programs and Instructional Strategy
University of North Carolina
Post Office Box 2688
Chapel Hill, North Carolina 27515-2688

Dear Kim:

Enclosed is UNC Charlotte's Request to Establish a M.S. in Computer Engineering. The proposed program serves the emerging need for computer engineers in the growing computer hardware and software industry and will be delivered in day, evening and blended (online/in-person) formats to allow professionals the opportunity to pursue the degree part-time.

Thank you for your consideration of this request. Provost Lorden or I would be pleased to respond to any questions that you may have.

Cordially,

Philip L. Dubois
Chancellor

cc: Joan F. Lorden, Provost and Vice Chancellor for Academic Affairs
Bob Johnson, Dean, William States Lee College of Engineering
Rollinda Thomas, Associate Vice President for Academic Programs





THE
UNIVERSITY OF
NORTH CAROLINA
SYSTEM

Request to Establish New Academic Degree Program

The following approvals must be obtained prior to sending the Request to Establish a New Academic Degree Program to the UNC System Office.

Institution: University of North Carolina at Charlotte

Degree Program Title (e.g. M.A. in Biology): MS in Computer Engineering

Reviewed and Approved By (Name and title only. No signature required in this section.)

Check box to indicate participation in review. (Provost is required.)

- Provost:** Joan F. Lorden
- Faculty Senate Chair (as appropriate):** Joel Avrin, Faculty Council President
- Graduate Council (as appropriate):** Concepcion Godev, Chair of the Graduate Council
- Undergraduate or Graduate Dean (as appropriate):** Thomas Reynolds, Dean of the Graduate School
- Academic College Dean:** Robert E. Johnson, Dean of The Williams States Lee College of Engineering
- Department Chair:** Asis Nasipuri, Chair of Electrical & Computer Engineering
- Program Director/Coordinator:** Valentina Cecchi, Grad Program Director, Electrical & Computer Engineering

New Academic Program Process

New academic programs are initiated and developed by the faculty members. Approval of the Request to Establish a New Academic Degree Program must be obtained from department chairs and college deans or equivalent administrators before submission to the UNC System Office review.

Directions: Please provide a succinct, yet thorough response to each section. Obtain the Provost's signature and submit the proposal to the UNC System Vice President for Academic Program, Faculty, and Research, for review and approval by the UNC System Office. Once the Request to Establish is approved, UNC System Office staff can submit the proposal for review and approval by the UNC Board of Governors.

Request to Establish a New Academic Degree Program

Institution	University of North Carolina at Charlotte
Joint Degree Program (Yes or No)? If so, list partner campus.	No
Degree Program Title (e.g. M.A. in Biology)	M.S. in Computer Engineering
CIP Code and CIP Title (May be found at National Center for Education Statistics)	14.0901 - Computer Engineering, General
Require UNC Teacher Licensure Specialty Area Code (Yes or No). If yes, list suggested UNC Specialty Area Code(s).	No
Proposed Delivery Mode (campus, online, or site-based distance education). Add maximum % online, if applicable.	Campus
If requesting online delivery, indicate if program (or one or more courses) will be listed in UNC Online.	n.a.
If requesting site-based delivery, indicate address(es), city, county, state, and maximum % offered at site.	n.a.
Proposed Term to Enroll First Students (e.g. Spring 2019)	Fall 2020

Do the following sections of your previously submitted and approved Letter of Intent to Develop a New Academic Degree Program document require any change or updated information? If yes, note the items and explain.

Category	Yes or No	Explanation (if applicable)
SACSCOC Liaison Statement	No	
Review Status (campus bodies that reviewed and commented on Letter of Intent)	No	

Program Summary	No	
Student Demand	No	
Societal Demand	No	

I. Program Planning and Unnecessary Duplication:

- a. List all other public and private four-year institutions of higher education in North Carolina currently operating programs similar to the proposed new degree program, including their mode of delivery. Show a four-year history of enrollments and degrees awarded in similar programs offered at other UNC institutions (using the format below for each institution with a similar program). Programs at UNC institutions may be found on the UNC System [website](#).

Currently, the only institution of higher education in North Carolina that offers a Master’s program in Computer Engineering is North Carolina State University (NCSU). Duke University and NC A&T offer Master’s in ECE with a concentration in Computer Engineering. However, there is no other M.S. program in Computer Engineering in the western part of North Carolina that can meet the needs of the rapidly growing tech industry in the region. The history of enrollments and degrees awarded in NCSU’s Master’s program in Computer Engineering, as obtained from the Graduate Director of Electrical and Computer Engineering (ECE) at NCSU are shown below:

Institution	North Carolina State University (NCSU)			
Program Title	Master of Science Computer Engineering			
	Year 2013	Year 2014	Year 2015	Year 2016
Enrollment (Fall)	94	89	161	180
Degrees Awarded	76	86	82	108

- b. Describe what was learned in consultation with other programs regarding their experience with student demand and job placement. Indicate how their experiences influenced your enrollment projections.

Consultations were initiated with Dr. Paul Franzon, the NCSU Electrical and Computer Engineering Department Graduate Coordinator, and Dr. Daniel Stancil, Head of the NCSU Electrical and Computer Engineering Department, regarding the proposed M.S. in Computer Engineering (MSCPE) program and their experiences on NCSU’s Master’s program in Computer Engineering. All interactions have been positive and encouraging. They agreed that offering similar degrees at both institutions would not cause a reduction for either program. They added that few students from the Charlotte region pursue the M.S. degree in Computer Engineering from NCSU.

NCSU's experiences indicate that demand for M.S. in Computer Engineering graduates is very high, with 25% of the graduates finding jobs in their local area (Research Triangle Park, NC). Another 25% find employment in Silicon Valley, and the remainder across the rest of the country. At least 80% of the graduates have job offers before they graduate, and at least 95% are employed within six months after graduation. Their M.S. in Computer Engineering enrollment is 20% domestic and 80% international students. Although no specific information was obtained about job opportunities for Master's students over those with BS, the Bureau of Labor Statistics makes the following projections in favor of job prospects for computer hardware engineers:

“Employment of computer hardware engineers is projected to grow 5 percent from 2016 to 2026 ... demand may grow for hardware engineers as more industries outside of the computer and electronic product manufacturing industry begin to research and develop their own electronic devices ... some large firms or specialized jobs may require a master's degree in computer engineering”¹.

Based on the growth in enrollment of M.S. in Computer Engineering students at NCSU and the observation of increased interest in computer engineering courses within the MS in Electrical Engineering at UNC Charlotte, we expect that the proposed MSCPE program will have initial enrollment of at least one-half of that at NCSU.

- c. Identify opportunities for collaboration with institutions offering related degrees and discuss what steps have been or will be taken to actively pursue those opportunities where appropriate and advantageous.

The proposed MSCPE program at UNC Charlotte and the existing Computer Engineering program at NCSU have the potential for mutual benefit by enabling UNC Charlotte students to take limited number of online courses from NCSU. In addition, MSCPE graduates from UNC Charlotte can add to the pool of potential Ph.D. applicants to NCSU focusing on Computer Engineering. Computer Engineering faculty in these two institutions will also have the opportunity to collaboratively teach similar courses.

Students enrolled in the proposed MSCPE program would also be able to take a limited number of courses from the Computer Science program in the College of Computing and Informatics (CCI) at UNC Charlotte that are not available in ECE. Examples of complementary topics include Cyber Security, Data Analytics, Algorithms and Data Structures, and Programming Languages. Discussions with Dr. Bojan Cukic, Chair of the Department of Computer Science at CCI on this matter has also been most encouraging. Dr. Cukic indicated that the CS Department is experiencing a sharp rise in their Master's student enrollments and the proposed MSCPE program would provide their students with additional opportunities for coursework.

¹ Bureau of Labor Statistics, U.S. Department of Labor, *Occupational Outlook Handbook*, Computer Hardware Engineers, on the Internet at <https://www.bls.gov/ooh/architecture-and-engineering/computer-hardware-engineers.htm> (visited June 04, 2019).

- d. Present documentation that the establishment of this program would not create unnecessary program duplication. In cases where other UNC institutions provided similar online, site-based distance education, or off-campus programs, directly address how the proposed program meets unmet need.

The proposed MSCPE program will be offered in-person only, therefore it is not expected to have a significant impact on NCSU's Engineering Online program. As stated above, the UNC Charlotte program will take advantage of the online courses transmitted from NCSU and will allow UNC Charlotte students to take these courses for credit towards their UNC Charlotte MSCPE degree. This opportunity has been echoed and encouraged by the NCSU ECE Graduate Coordinator.

- e. Admission. List the following:

- i. Admissions requirements for proposed programs (indicate minimum requirements and general requirements).

All applicants must meet UNC Charlotte Graduate School's general requirements for admission to a Masters' program at UNC Charlotte. In addition to meeting the general requirements, admission to the MSCPE program is dependent on the applicant's demonstrated evidence of academic preparation and motivation to pursue graduate studies in the chosen field of study, as perceived from the application package. These are evaluated on the basis of the following:

Academic preparation:

An earned undergraduate degree in Electrical and Computer Engineering or a closely related field of engineering or sciences is required. The applicant should have a proven track record with an undergraduate GPA of 3.0 or better on a 4.0 scale. Additional academic credentials, such as other attempted post-baccalaureate studies undertaken, if applicable, may also be submitted.

Applicants with baccalaureate degrees in fields other than Electrical and Computer Engineering (e.g. physics, mathematics, computer science, etc.) may be considered for admission, if satisfactory evidence on the aptitude to pursue graduate studies in Electrical and Computer Engineering is demonstrated. If additional preparatory courses are required, such courses should be taken before applying for MSCPE.

- ii. Documents to be submitted for admission (listing):

The following documents must be submitted in order to complete an application to the MSCPE program:

GRE scores: Applicants must earn satisfactory scores on the quantitative and verbal

sections of the GRE. GRE requirements will be waived for:

- Applicants who have an undergraduate degree from an ABET accredited U.S. institution and have at least three years of post-graduation industry experience in the related field.
- Recent UNC Charlotte undergraduate graduates with a minimum GPA of 3.25.

TOEFL scores: International students from non-English speaking countries should also obtain the minimum required score on the Test of English as a Foreign Language (TOEFL). The minimum requirements for TOEFL at UNC Charlotte are 83 for the Internet-based test, 220 for the computer-based test, and 557 for the paper-based test. Other official English proficiency tests such as MELAB and IELTS may also be acceptable, as explained in the Graduate School's admissions page.

Letters of recommendation: Applicants must provide three letter of recommendation, preferably from faculty members who are aware of the applicant's academic performance.

Statement of purpose: The applicant must write an essay stating the intended area of study, the motivation for selection of that area, future goals, and any other information that reflects the applicant's objective for applying to the M.Cp.E. program.

f. Degree requirements. List the following:

- i. Total hours required. State requirements for Major, Minor, General Education, etc.

The MSCPE degree will require successful completion of 30 approved graduate credits. The MSCPE degree may be completed by either the **Thesis** or **Non-Thesis** options. In the Thesis Option, students must complete 9 credit hours of thesis research and 21 credit hours of coursework. Alternatively, students may complete the requirements of a Master's degree under the Non-Thesis Option by taking 30 credit hours of coursework only, or by taking 27 credit hours of coursework along with 3 credits of individualized project work.

- ii. Other requirements (e.g. residence, comprehensive exams, thesis, dissertation, clinical or field experience, "second major," etc.).

The degree requirements for the proposed MSCPE program, for all options, are summarized below:

Degree Requirements for Thesis

1. Plan of Study - students must meet with their advisor to formulate a plan of study and get the committee's approval. The plan of study must be submitted after completing at least 9 but no more than 18 credit hours.

2. Satisfactory completion of 30 credit hours of approved graduate credits in major or related area of study including 9 credit hours of thesis. Not more than 6 credit hours may be taken from outside the Department of Electrical and Computer Engineering.
3. Admission to Candidacy
4. Thesis Defense - a copy of the thesis should be distributed to each member of the program committee at least two weeks prior to the defense. Students should make a public announcement of the defense within the department to allow attendance by interested faculty members and students of electrical and computer engineering.

Degree Requirements for Non-Thesis/Project

1. Plan of Study - students must meet with their advisor to formulate a plan of study and get the committee's approval. The plan of study must be submitted after completing at least 9 but no more than 18 credit hours.
2. Satisfactory completion of 30 credit hours of approved graduate credits. At least 24 credit hours of courses must be from the ECE department.
3. A student must take three credits of individualized project that will require a written report and an oral presentation.
4. Admission to Candidacy
5. Students must pass an oral exam during the presentation of the project that is administered by the program advisory committee.

Degree Requirements for Non-Thesis/Comprehensive Examination

1. Plan of Study - students must meet with their advisor to formulate a plan of study and get the committee's approval. The plan of study must be submitted after completing at least 9 but no more than 18 credit hours.
2. Satisfactory completion of 30 credit hours of approved graduate coursework. At least 24 credit hours of courses must be from the ECE department.
3. Admission to Candidacy
4. Students must pass a written comprehensive that is administered by the department. Students receive two chances to successfully pass the comprehensive examinations.

- g. Enrollment. Estimate the total number of students that would be enrolled in the program during the first year of operation and in each delivery mode (campus, online, site, etc.)

The proposed MSCPE program is tailored towards imparting knowledge and skills that are of growing demand in the Charlotte region, the state of North Carolina, as well as the nation. The program will prepare students for careers such as hardware engineers, software developers,

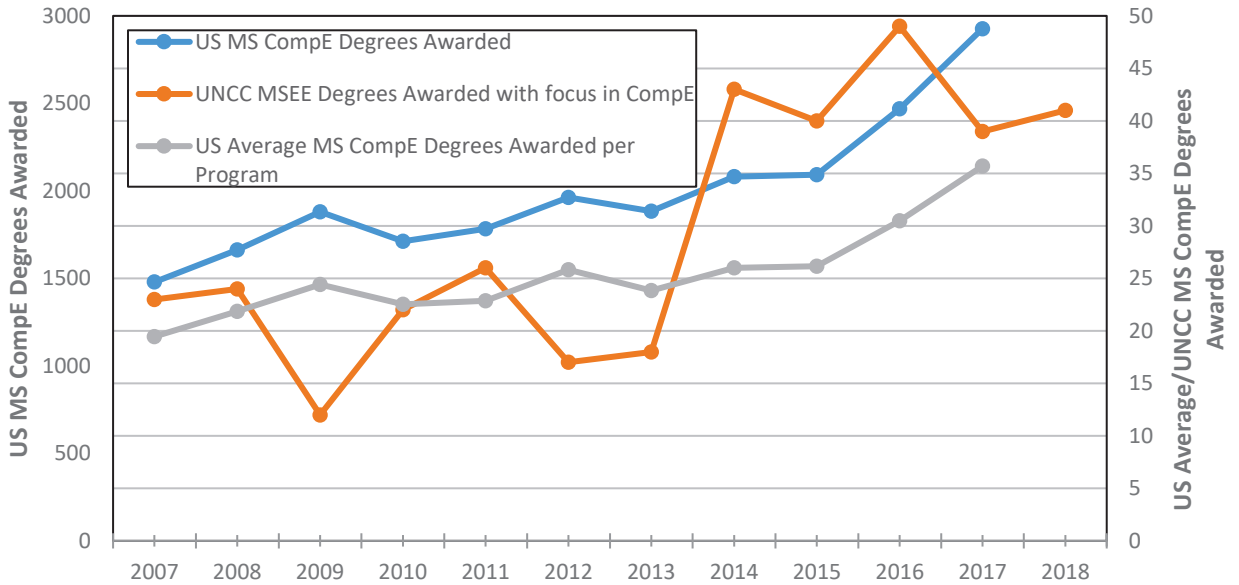


Figure 1: UNC Charlotte and US Average Masters Degrees Awarded in computer engineering.

application developers for smart phones and tablets, cloud-based computing, edge and fog computing, embedded systems developers, networking engineers, and many others. The demand for these professions is expected to continue increasing with emergence of new application domains such as autonomous vehicles, smart appliances, AI and machine learning systems, and high-speed communication networks. The Charlotte region being one of the fastest growing areas in technology in the nation, it is expected that the enrollment in the proposed MSCPE program will sharply reflect this growth pattern.

The trend in growing interest in this area is reflected on the rising number of students interested in computer engineering topics in ECE, both at the graduate and undergraduate levels. Figure 1 illustrates that the number of MSEE students that graduated with a focus in the computer engineering area grew at a rate that is higher than the national average in the last ten years. A similar trend of growing interest in computer engineering is observed at the undergraduate level as well (see Figure 2).

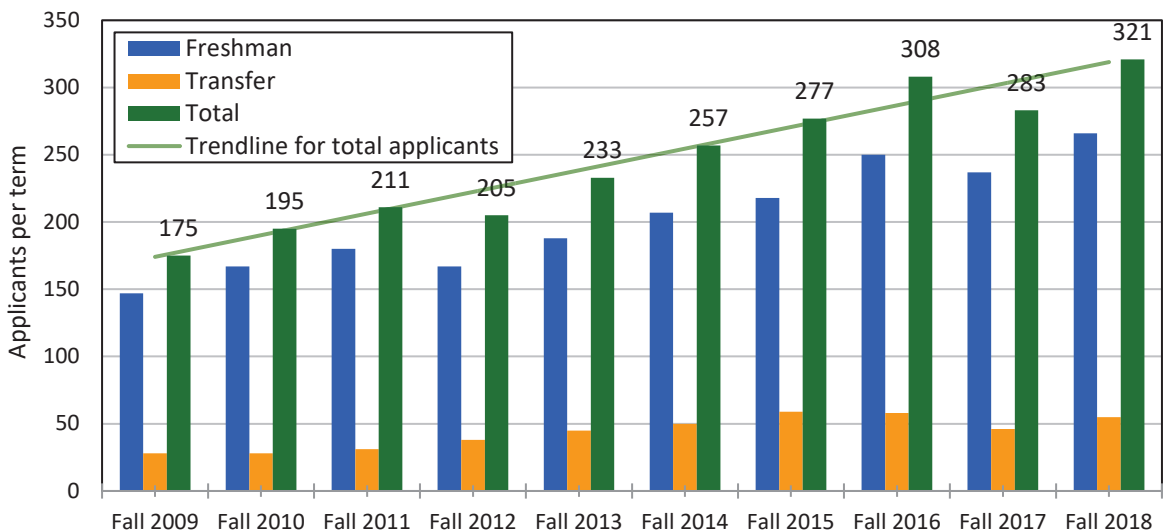


Figure 2: Number of Applicants to the BS in Computer Engineering (BSCPE) Program at UNC Charlotte.

The ECE Department has an Early Entry program that allows exceptional undergraduate students to take advantage of faster completion of the MSEE degree immediately following the BSEE or BSCPE program. It is envisioned that the increasing interest of undergraduate students in computer engineering will also reflect on the proposed MSCPE enrollments.

Enrollment in the MSEE program has typically varied between 150 – 200 in the past five years. Based on the observation that approximately half of the current students have interest in computer engineering and that such interest is increasing consistently, the estimated number of students enrolled in the proposed MSCPE program is represented as follows:

	Campus	Online	Site	Full-Time	Part-Time
Year 1	90	n/a	n/a	80	10
Year 4	118	n/a	n/a	98	20

h. For graduate programs only, please also answer the following:

Grades required	Minimum GPA of 3.0 required. Courses graded as C must be offset by an equal number of graduate level credits graded as A.
Amount of transfer credit accepted	Up to six hours of approved graduate level credits may be transferred.
Language and/or research requirements	Thesis option requires MS thesis research that must be successfully defended and approved by the thesis committee. The MS project requires successful defense and approval of the committee. The course-only option requires students to pass a written comprehensive examination.
Any time limits for completion	All requirements of the MSCPE degree must be completed within seven calendar years, beginning from the student’s first term in the program.

- II. For all programs, provide a degree plan showing the sequence of courses to be taken each year. List courses by title and number and indicate those that are required. Include an explanation of numbering system. Indicate new courses proposed. A possible format is offered below as an example. If your institution uses a different format that provides the required information, it may be submitted instead.

The proposed MSCPE program requires successful completion of 30 graduate credits as approved by the student’s graduate advisor. This can be done using one of three options: (a) the thesis option, where the student completes 9 hours of thesis and 21 credits of coursework, (b) the project option, where the student completes 3 hours of individual study and projects and 27 credits of coursework, and (c) comprehensive examinations option, where the student completes 30 credits of course work and passes a comprehensive written examination. All options require students to take three courses, referred to as the “core curriculum” for MSCPE. The core curriculum includes Computer Architecture

(ECGR5181), Advanced Embedded Systems (ECGR5101) and Data Communications and Networking II (ECGR5187).

A comprehensive list of courses that count for credit towards the proposed MSCPE degree is provided in the table below. Note that each listed course contributes 3 credits towards the required 30 graduate credits. Course number 6090 is reserved for “special topics” courses that will also serve the MSCPE program. Given sufficient student interest, special topics courses will be assigned a unique course number per university policy.

Course No.	Course Title	Required (Y/N)	New (Y/N)	Brief Description (If New Course)
ECGR5181	Computer Architecture	Y	N	N/A (Existing Course)
ECGR5101	Advanced Embedded Systems	Y	N	N/A (Existing Course)
ECGR5187	Data Communications and Networking-II	Y	N	N/A (Existing Course)
ECGR5146	Introduction to VHDL	N	N	N/A (Existing Course)
ECGR5196	Robotics	N	N	N/A (Existing Course)
ECGR5124	DSP	N	N	N/A (Existing Course)
ECGR5103	Applied Computer Graphics	N	N	N/A (Existing Course)
ECGR5133	VLSI System Design	N	N	N/A (Existing Course)
ECGR5100	Research Tools and Techniques in CPE	N	N	N/A (Existing Course)
ECGR5180	Internet-of-Things	N	N	N/A (Existing Course)
ECGR6185	Embedded Commercial Product Design	N	N	N/A (Existing Course)
ECGR6189	Wireless Sensor Networks	N	N	N/A (Existing Course)
ECGR6120	Wireless Communication	N	N	N/A (Existing Course)
ECGR6119	Applied AI	N	N	N/A (Existing Course)
ECGR6188	Fundamentals of Wireless Systems & Protocols	N	N	N/A (Existing Course)
ECGR6181	Embedded Operating Systems	N	N	N/A (Existing Course)
ECGR6182	Advanced Embedded Operating Systems	N	N	N/A (Existing Course)
ECGR6090	Big Data and Mobile Distributed Computing	N	Y	Taught multiple times as special topics. Proposed as new course ECGR6172
ECGR6090	Heterogeneous Computing Systems	N	Y	Taught multiple times as special topics. Proposed as new course ECGR6174
ECGR6090	Hardware Security and Trust	N	Y	Taught multiple times as special topics. Proposed as new course ECGR6173

ECGR6090	Mobile Robot Sensing, Mapping, & Exploration	N	Y	Taught multiple times as special topics. To be proposed as new course.
ITCS6151	Intelligent Robotics	N	N	N/A (Existing Course)
ITCS6152	Robot Motion Planning	N	N	N/A (Existing Course)
ITCS6114	Algorithms and Data Structures	N	N	N/A (Existing Course)

Courses not included in the above list, including new and Special Topics courses on computer engineering, may be eligible, with approval from the student's graduate advisor. Also, online courses offered through the NCSU Engineering Online program would be eligible. A listing of these courses can be found at:

<https://www.engineeringonline.ncsu.edu/programs-and-courses/course-catalog/>

The following table shows examples of the three paths for completing a MSPCE degree: (1) Sample degree plan with the thesis option (Student A), (2) Sample degree plan with the project option (Student B), and (3) Sample degree plan with the comprehensive exam option (Student C).

Credits	Student A (Thesis)	Student B (Project)	Student C (Comprehensive Exam)
Year 1			
3	ECGR5181 Comp. Arch (Req.)	ECGR5181 Comp. Arch (Req.)	ECGR5181 Comp. Arch (Req.)
3	ECGR5101 Adv. Embedded (Req.)	ECGR5101 Adv. Embedded (Req.)	ECGR5101 Adv. Embedded (Req.)
3	ECGR5187 Networks II (Req.)	ECGR5187 Networks II (Req.)	ECGR5187 Networks II (Req.)
3	ECGR5133 Wireless Sensor Networks	ECGR5103 Comp. Graphics	ECGR5133 VLSI Design
3	ECGR5196 Robotics	ECGR5124 Dig. Sig. Proc.	ECGR5146 VHDL
Total: 15			
Year 2			
3	ECGR6119 Applied AI	ECGR6119 Applied AI	ECGR6181 Emb. Op. Sys.
3	ITCS6151 Intell. Robotics	ECGR6174 Hetero. Comput.	ECGR6185 Emb. Product Design
3	ECGR6991 Thesis Research	ECGR6188 Wireless Design	ECGR6173 Hardware Sec.
3	ECGR6991 Thesis Research	ECGR6189 Wireless Sensor Networks	ECGR6189 Wireless Sensor Networks
3	ECGR6991 Thesis Research	ECGR6890 Indiv. Project	ECGR6120 Wireless Comm.
Total: 30			Passing Grade on the Comprehensive Exam (Req.)

III. Faculty

- a. (For undergraduate and master's programs) List the names, ranks and home department of faculty members who will be directly involved in the proposed program. The official roster forms approved by SACSCOC may be submitted. For master's programs, state or attach the criteria that faculty must meet in order to be eligible to teach graduate level courses at your institution.

The proposed MSCPE program will be administered and offered entirely by the ECE department. The following list includes ECE graduate faculty members who will be primarily involved in the development, implementation and execution of the program, teaching courses, administrative duties, and advising graduate students:

- James Conrad, Professor, ECE
 - Areas of Interest: Embedded Systems, Robotics
 - Courses taught: ECGR 5101: Advanced Embedded Systems, ECGR 5196: Robotics
- Ari Mukherjee, Associate Professor, ECE
 - Areas of Interest: Big Data and Mobile Distributed Computing, Internet-of-Things
 - Courses taught: ECGR 5090: Special Topics: Internet of Things, ECGR 5090: Special Topics: Big Data and Mobile Distributed Computing, ECGR 5133: VLSI Systems Design
- Arun Ravindran, Associate Professor, ECE
 - Area of Interest: Embedded OS
 - Courses taught: ECGR 6181/8181: Embedded Operating Systems, ECGR 5090/6090: Special Topics: Advanced Embedded OS
- Fareena Saqib, Assistant Professor, ECE
 - Area of Interest: Hardware Security
 - Courses taught: ECGR 5146: Intro to VHDL, ECGR 5090: Special Topics: Hardware Security and Trust
- Ron Sass, Professor, ECE
 - Area of Interest: Reconfigurable Systems
 - Courses taught: ECGR 5100: Research Tools & Tech in Comp Eng, ECGR 6090/8090: Special Topics: Reconfigurable Computing
- Hamed Tabkhi, Assistant Professor, ECE
 - Area of Interest: Computer Architecture
 - Courses taught: ECGR 5181: Computer Architecture, ECGR 6090/8090: Special Topics: Heterogeneous Computing
- Chen Chen, Assistant Professor, ECE
 - Area of Interest: Deep Learning
 - Courses taught: ECGR 6119/8119: Applied Artificial Intelligence
- Asis Nasipuri, Professor, ECE
 - Area of Interest: Wireless Networks

- Courses taught: ECGR 5187: Data Communications and Networking-II, ECGR 6120/8120: Wireless Communications
- Andrew Willis, Associate Professor, ECE
 - Area of Interest: Computer Graphics
 - Courses taught: ECGR 5103: Applied Computer Graphics, ECGR 5124: Digital Signal Processing
- Linda Xie, Professor, ECE
 - Area of Interest: Wireless Systems and Protocols
 - Courses taught: ECGR 6188/8188: Fundamentals of Wireless Systems and Protocols
- Tom Weldon, Associate Professor, ECE
 - Area of Interest: Digital Signal Processing
 - Courses taught: ECGR 5124: Digital Signal Processing
- Tao Han, Assistant Professor, ECE
 - Area of Interest: Wireless Systems and Protocols
 - Courses taught: ECGR 6188/8188: Fundamentals of Wireless Systems and Protocols, ECGR 6120/8120: Wireless Communications
- Ahmed Arafa, Assistant Professor, ECE
 - Area of Interest: Wireless Communication and Information Theory
 - Courses taught: ECGR 4422/5122 Random Processes and Optimal Filtering

All graduate faculty at UNC Charlotte must demonstrate evidence of sustained involvement in the graduate program and commensurate growth in his/her profession in order to be eligible to teach graduate level courses. The criteria used for appointment and reappointment of graduate faculty include:

- Participation in graduate-level instruction (assessment through course and peer evaluations).
- Active involvement with graduate education through service on advisory committees as well as being thesis or dissertation advisor.
- Continued appropriate scholarship and/or involvement in research (assessed by publications, service in technical committee and as reviewers, and submitting research proposals).

The existing courses being offered in the Computer Systems thrust area, are sufficient for the proposed MSCPE program, and there is no need at this time for additional course development.

- b. (For doctoral programs) List the names, ranks, and home department of each faculty member who will be directly involved in the proposed program. The official roster forms approved by SACSCOC may be submitted. Provide complete information on each faculty member's education, teaching and research experience, research funding, publications, and experience directing student research including the number of theses and dissertations directed.

Not applicable

- c. Estimate the need for new faculty for the proposed program over the first four years. If the teaching responsibilities for the proposed program will be absorbed in part or in whole by the present faculty, explain how this will be done without weakening existing programs.

All courses included in the proposed MSCPE program are currently included in the ECE curriculum and are being offered on a regular basis. Hence, the teaching responsibilities for the proposed program will be absorbed in whole by the present faculty. Graduate faculty members from other thrust areas in the ECE department who will be teaching some of the courses in the MSCPE curriculum will not have any increased course load because they regularly teach those courses for the current MSEE program in the ECE department. Additional faculty members will be required as enrollments grow in future years.

- d. Explain how the program will affect faculty activity, including course load, public service activity, and scholarly research.

The proposed program does not involve addition of new courses. Hence, it will not significantly affect course load or research activities of faculty. Introduction of the proposed MSCPE program will involve additional administrative work, primarily for student services support and program assessment. These tasks will be primarily handled by the ECE Graduate Director and the new Graduate Student Advisor.

IV. Delivery Considerations. Provide assurances of the following (not to exceed 250 words per lettered item):

- a. *Access* (online, site-based distance education, and off-campus programs). Students have access to academic support services comparable to services provided to on-campus students and appropriate to support the program, including admissions, financial aid, academic advising, delivery of course materials, and placement and counseling.

The proposed MSCPE program will be offered in-person only.

- b. *Curriculum delivery* (online and site-based distance education only). The distance education technology to be used is appropriate to the nature and objectives of the program. The content, methods and technology for each online course provide for adequate interaction between instructor and students and among students.

Not applicable because the MSCPE program will be offered in-person only.

- c. *Faculty development* (online and site-based distance education only). Faculty engaged in program delivery receive training appropriate to the distance education technologies and techniques used.

Not applicable because the MSCPE program will be offered in-person only.

- d. *Security* (online and site-based distance education only). The institution authenticates and verifies the identity of students and their work to assure academic honesty/integrity. The institution assures the security of personal/private information of students enrolled in online courses.

Not applicable because the MSCPE program will be offered in-person only.

V. Library

- a. Provide a statement as to the adequacy of present library holdings for the proposed program to support the instructional and research needs of this program.

Current library holdings are adequate to support student research for this program. Students have access to relevant databases including *Compendex*, *Inspec*, *Web of Science*, *IEEEXplore*, *ScienceDirect*, *ACM Digital Library*, *Computer and Information Systems Abstracts* and many others. The library owns hundreds of thousands of e-books from Springer, Wiley, Elsevier, Cambridge and other publishers, mostly science and engineering subject matter, in addition to a growing print collection.

The library has current online subscriptions to thousands of journal titles in this area.

- b. If applicable, state how the library will be improved to meet new program requirements for the next four years. The explanation should discuss the need for books, periodicals, reference material, primary source material, etc. What additional library support must be added to areas supporting the proposed program?

The library offers responsive support to research needs of the department. Faculty and graduate student researchers can contact the engineering librarian directly for one-time purchase materials that are needed. For ongoing subscriptions needed, the librarian will work with faculty in the department to prioritize and make requests of the library and university to support new research materials needed to propel the work forward.

- c. Discuss the use of other institutional libraries.

The library has a well-received Interlibrary Loan (ILL) department. It is the highest rated service that the library offers. Faculty, students, and staff can make requests through an easy-to-use web interface, with the capability of auto-filling from any of our databases. Book chapters, conference proceedings, and journal articles are scanned and delivered electronically from other institutions as PDF files within 24-48 hours. Print books are mailed and delivered within 5 business days. Any materials that the library is unable to borrow from other libraries will be purchased if available for sale.

- d. For doctoral programs, provide a systematic needs assessment of the current holdings to meet the needs of the program.

N/A

VI. Facilities and Equipment

- a. Describe facilities available for the proposed program.

Faculty involved in the proposed MSCPE program are currently leading the following Computer Systems Labs in the ECE department: Edge Computing Lab (Drs. Tabkhi and Ravindran), Cyber-Physical Systems Lab (Dr. Mukherjee), Wireless Communications and Networking Lab (Drs. Arafa, Han, Xie, and Nasipuri), Embedded Systems and Robotics Lab (Dr. Conrad), Reconfigurable Systems Lab and the Computer Vision Lab (Drs. Willis and Chen).

Since the Computer Systems courses outlined in the table above are currently being taught using the hardware and computing equipment available in the Computer Systems Labs, at this time we do not anticipate requiring additional facilities and equipment for the proposed MSCPE program.

- b. Describe the effect of this new program on existing facilities and indicate whether they will be adequate, both at the commencement of the program and during the next decade.

The proposed MSCPE program will not require additional investments in facilities and equipment. The faculty, courses offered by the faculty, and the corresponding infrastructure will grow organically during the next decade, and the MSCPE program will be a natural beneficiary.

- c. Describe information technology and services available for the proposed program.

In addition to the UNC Charlotte Information and Technology Service, the College of Engineering and the ECE department is supported by Mosaic, which provides reliable, secured and software rich environment through numerous Mosaic labs, office desktops, and remote workstations via a server pool: Mosaic Anywhere. Mosaic maintains the entire range of engineering software, along with the database management system, which is required for teaching all courses pertinent to the MSCPE program. In addition to that, the lead faculty maintain software relevant to the MSCPE courses in their respective Computer Systems Labs.

- d. Describe the effect of this new program on existing information technology and services and indicate whether they will be adequate, both at the commencement of the program and during the next decade.

The proposed MSCPE program will not require additional course introduction or software installation and management in the near future, and hence, will not impact the existing information technology infrastructure or service.

VII. Administration

- a. Describe how the proposed program will be administered, giving the responsibilities of each department, division, school, or college. Explain any inter-departmental or inter-unit administrative plans. Include an organizational chart showing the "location" of the proposed new program.

The proposed MSCPE program will be administered through the ECE Department. ECE's Graduate Program Director will be responsible for overseeing the coordination of program management, including admissions, orientation, advising, registration, degree compliance, and student support. ECE's graduate student support advisor will be responsible for assisting the Graduate Director for execution of tasks. The ECE Graduate Committee, comprising elected faculty from different technical thrust areas of the department, will provide advisory support to the Graduate Director. The Graduate Director will work with the UNC Charlotte Graduate School on overall administration of the proposed program. Administrative support, including student correspondence, registration support, forms, maintenance of student records, degree compliance checks, assistantship contracts, scholarships, and recruitment assistance, will be provided by ECE's Graduate Advisor (Advisor-2). An organization chart is depicted in Figure 4.

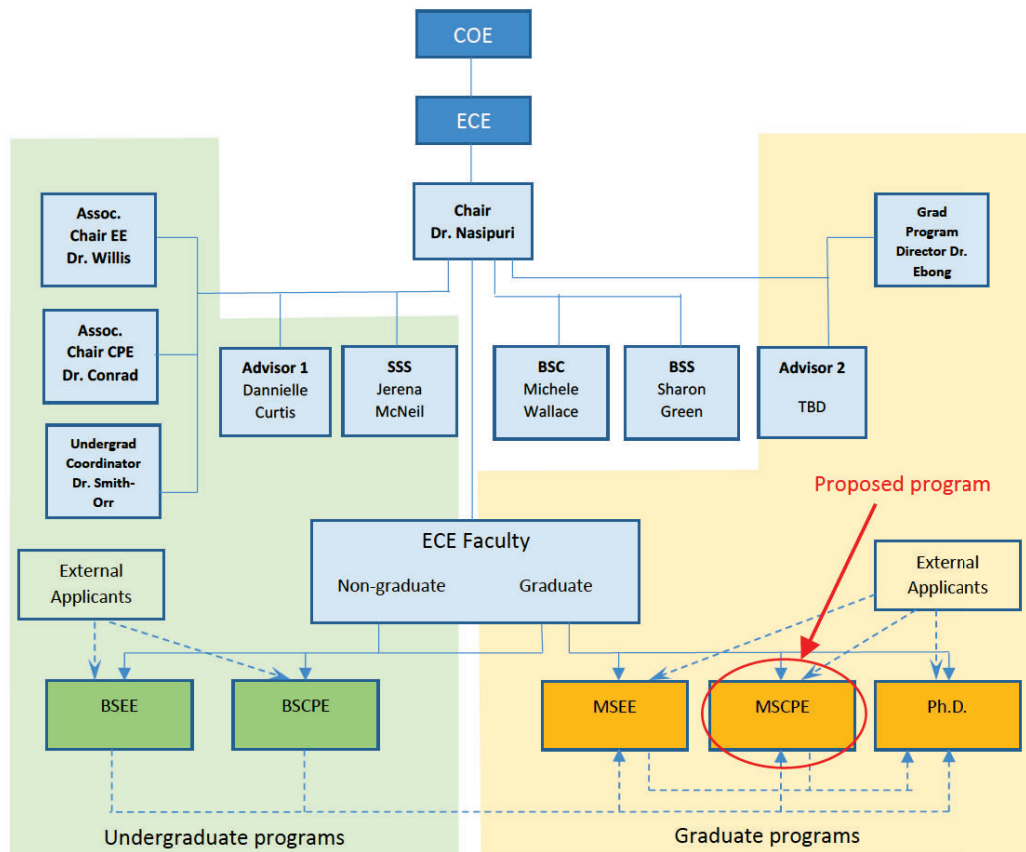


Figure 4: Organization chart depicting the location of the proposed MSCPE program in ECE.

- b. For joint programs only, include documentation that, at minimum, the fundamental elements of the following institutional processes have been agreed to by the partners:
- i. Admission process
 - ii. Registration and enrollment process for students
 - iii. Committee process for graduate students
 - iv. Plan for charging and distributing tuition and fees
 - v. Management of transcripts and permanent records
 - vi. Participation in graduation
 - vii. Design of diploma

Not applicable.

VIII. Additional Program Support

- a. Will additional administrative staff, new master's program graduate student assistantships, etc. be required? If so, please briefly explain in the space below each item, state the estimated new dollars required at steady state after four years, and state the source of the new funding and resources required.

None required at this point.

IX. Accreditation and Licensure

- a. Where appropriate, describe how all licensure or professional accreditation standards will be met, including required practica, internships, and supervised clinical experiences.

The proposed MSCPE program does not lead to licensure and is not professionally accredited.

- b. Indicate the names of all accrediting agencies normally concerned with programs similar to the one proposed. Describe plans to request professional accreditation.

- c. If the new degree program meets the SACSCOC definition for a substantive change, what campus actions need to be completed by what date in order to ensure that the substantive change is reported to SACSCOC on time?

The proposed program is not a substantive change, based on the SACSOC definition.

- d. If recipients of the proposed degree will require licensure to practice, explain how program curricula and title are aligned with requirements to "sit" for the licensure exam.

Not applicable.

X. Supporting Fields

- a. Discuss the number and quality of lower-level and cognate programs for supporting the proposed degree program.

Students admitted to the proposed MSCPE program will be required to have all lower-level coursework and academic preparation for being successful in the program. No supporting lower-level programs or cognate programs are required to support the proposed program.

- b. Are other subject-matter fields at the proposing institution necessary or valuable in support of the proposed program? Is there needed improvement or expansion of these fields? To what extent will such improvement or expansion be necessary for the proposed program?

Although not necessary, students enrolled in the proposed MSCPE program will benefit from taking courses related to computer engineering from other disciplines such as Computer Science, Software Information Systems, and Mathematics. The proposed MSCPE curriculum has the option of allowing students to take up to two courses (6 credits) from outside the ECE department, which are considered valuable to the plan of study, as determined by the student's academic advisor.

XI. Additional Information. Include any additional information deemed pertinent to the review of this new degree program proposal.

XII. Budget

- a. Complete and insert the Excel budget template provided showing incremental continuing and one-time costs required each year of the first four years of the program. Supplement the template with a budget narrative for each year.

The incremental cost for the proposed MSCPE program for each of the first four years has been attached. The additional expenses to support the proposed program will be met with expected revenue from differential tuition, i.e. incremental College of Engineering (COE) tuition increment that is applicable to all graduate students in COE, reallocation of present institutional resources, and estimated enrollment increase funds as determined using the UNC enrollment change funding model. Details are provided in the Narrative sections of the attached budget sheet.

- b. Based on the campus' estimate of available existing resources or expected non-state financial resources that will support the proposed program (e.g., federal support, private sources, tuition revenue, etc.), will the campus:
 - i. Seek enrollment increase funds or other additional state appropriations (both one-time and recurring) to implement and sustain the proposed program? If so, please elaborate.

The program will request appropriate enrollment increase funding through the yearly budget review process conducted by the college and academic affairs. The increase in enrollment and corresponding increase in Student Credit Hours (SCH) are reviewed in the Deans office and examined in light of the UNC System Office funding formula in preparing requests. These funds, if available, will be used to hire additional faculty in computer engineering to support additional teaching and research.

ii. Require differential tuition supplements or program-specific fees? If so, please elaborate.

1. State the amount of tuition differential or program-specific fees that will be requested.

Students enrolled in the proposed MSCPE program will be required to pay a Graduate Tuition Increment fee of \$110 per credit hour for each semester, consistent with all other graduate students in the College of Engineering (COE) at UNC Charlotte.

2. Describe specifically how the campus will spend the revenues generated.

The Dean of COE is responsible for determining the utilization of the revenue from tuition increment money, which is usually used to support graduate assistantships and maintain research laboratories in the COE. As indicated in the attached budget, the tuition increment money (differential tuition) received from students enrolled in the MSCPE program, if available, will be used primarily to support Graduate Teaching Assistantships (TA). A portion of this money will also be used to upgrade graduate laboratories, such as computing and research equipment in graduate laboratories.

3. Does the campus request the tuition differential or program-specific fees be approved by the Board of Governors prior to the next Tuition and Fee cycle?

Yes, the campus requests a tuition increment for the proposed MSCPE consistent with COE's current policy.

- c. If enrollment increase funding, differential tuition, or other state appropriations noted in the budget templates are not forthcoming, can the program still be implemented and sustained and, if so, how will that be accomplished? Letters of commitment from the Chancellor and/or Chief Academic Officer should be provided.

The proposed MSCPE program can be implemented and sustained if incremental funds from enrollment increase and tuition increment money are not available. These funds, if available, have been proposed to be used for increasing faculty and TA support. Without additional funding sources the program would be limited in size, the frequency of course offerings would be reduced, and the overall pace of growth for the program would be slowed.

XIII. Evaluation Plans

- a. What student learning outcomes will be met by the proposed program and how will student proficiency be measured? These items may be updated as necessary to meet student and program needs.

Program Student Learning Outcomes	Measurement Instrument	Criteria for Proficiency (score, percentage, level of
-----------------------------------	------------------------	---

		performance, etc.)
Students analyze and evaluate advanced topics in engineering.	<ul style="list-style-type: none"> • Thesis option: Thesis Written Report (WR1a – WR1j) + Thesis Oral Presentation (OP1a – OP1j) • Project option: Project Written Report (WR1a – WR1j) + Thesis Oral Presentation (OP1a – OP1j) • Coursework option: Exam (EX1a – EX1d) 	<ul style="list-style-type: none"> • Reports (WR) and Presentations (OP): 90% of the students meet or exceed requirements (> 26/36 or 72%) • Exams (EX): 90% of students pass the exam with a grade of 80 or higher (17/21 or 81%)
Students effectively communicate technical information.	<ul style="list-style-type: none"> • Thesis option: Thesis Written Report (WR2a – WR2c) + Thesis Oral Presentation (OP2a – OP2c) • Project option: Project Written Report (WR2a – WR2c) + Thesis Oral Presentation (OP2a – OP2c) • Coursework option: Exam (EX2a – EX2c) 	<ul style="list-style-type: none"> • Reports and Presentations: 100% of students meet or exceed requirements (= 6/6 or 100%) • Exams: 90% of students pass the exam with a grade of 80 or higher

- b. The plan and schedule to evaluate the proposed new degree program prior to the completion of its fourth year of operation (to include types of measurement, frequency, and scope of program review).

The new program will be evaluated annually based on the Program Student Learning Outcomes stated above. Written Reports and Oral Presentations will be reviewed by all members of the students' advisory committee and Exam instruments will be evaluated by faculty members responsible for setting and evaluating the comprehensive written examinations. These data will be collected for all graduating students. Evaluation results will be reviewed by members of ECE's Graduate Committee overseen by the Graduate Program Director.

XIV. Attachments. Attach the final approved Letter of Intent as the first attachment following this document.

- Approved Letter of Intent
- Budget spreadsheet for years 1 – 4.
- Letter of consultation from Carl Fisher, Chairman of ECE Advisory Board.
- Letter of consultation from Dr. Bojan Cukic, Professor and Chair of the Department of Computer Science, UNC Charlotte.
- Letter of consultation from Dr. Paul Franzon, Professor and Director of Graduate Programs, Department of Electrical and Computer Engineering, NC State University

This proposal to establish a new program has been reviewed and approved by the appropriate campus committees and authorities.

Position Title	Signature	Date
Chancellor	<i>Phil. Nuhon</i>	12/2/19
Chancellor (Joint Partner Campus)		
Provost	<i>Jean F. Loden</i>	12/2/19



THE
UNIVERSITY OF
NORTH CAROLINA
SYSTEM

Letter of Intent to Develop New Academic Degree Program

The following approvals must be obtained prior to sending the Letter of Intent to Develop a New Academic Degree Program to the UNC System Office.

Institution The University of North Carolina at Charlotte

Degree Program Title (e.g. M.A. in Biology) M.S. in Computer Engineering

Reviewed and Approved By (Name and title only. No signature required in this section.)

Check box to indicate participation in review. (Provost is required.)

- Provost:** Joan F. Lorden, Provost and Vice Chancellor for Academic Affairs
- Faculty Senate Chair (as appropriate):** Rich Leeman, Faculty Council President
- Graduate Council (as appropriate):** Christine Haynes, Chair of Graduate Council
- Undergraduate or Graduate Dean (as appropriate):** Dr. Thomas Reynolds, The Dean of the Graduate School
- Academic College Dean:** Dr. Robert E. Johnson, Dean of The William States Lee College of Engineering
- Department Chair:** Dr. Asis Nasipuri, Chair of the Electrical & Computer Engineering Department
- Program Director/Coordinator:** Dr. Aba Ebong, Grad Program Director, Electrical & Computer Engineering

New Academic Proposal Process

New academic programs are initiated and developed by the faculty members. Approval of the Letter of Intent to Develop a New Academic Degree Program must be obtained from department chairs and college deans or equivalent administrators before submission to the UNC System Office review.

Directions: Please provide a succinct, yet thorough response to each section. Obtain the Provost's signature and submit the proposal via the PREP system to the UNC System Vice President for Academic Programs, Faculty, and Research, for review and approval by the UNC System Office. Once the Letter of Intent to Develop is approved, the institution can begin work on the formal Request to Establish a New Degree Program.

Letter of Intent to Develop a New Academic Degree Program

Institution	University of North Carolina at Charlotte
Joint Degree Program (Yes or No)? If so, list partner campus.	No
Degree Program Title (e.g. M.A. in Biology)	M.S. in Computer Engineering
CIP Code and CIP Title (May be found at National Center for Education Statistics)	14.0901 - Computer Engineering, General
Require UNC Teacher Licensure Specialty Area Code (Yes or No). If yes, list suggested UNC Specialty Area Code(s).	No
Proposed Delivery Mode (campus, online, or site-based distance education). Add maximum % online, if applicable.	Campus
Proposed Term to Enroll First Students (e.g. Spring 2019)	Fall 2019
List other programs in the UNC System (may be found at UNC System website)	MS in Computer Engineering

SACSCOC Liaison Statement: *(Provide a brief statement from the University SACSCOC liaison regarding whether the new program is or is not a substantive change.)*

The new degree is not a substantive change, as it uses existing, approved courses from the M.S. in Electrical Engineering and a limited number of approved courses from other Master's programs at UNC Charlotte, and it does not require new equipment, facilities, financial resources, faculty, and library/learning resources. Therefore, neither SACSCOC notification nor approval is required.

Program Summary: *(Briefly describe the proposed program and summarize the overall rationale.)*
Maximum of 1,000 words.

Include the following in your narrative:

- Ways in which the proposed program is distinct from others already offered in the UNC System (use the 4-digit CIP as a guide). Information on other programs may be found on the UNC System [website](#).
- How this program supports specific university and UNC System [missions](#).
- Collaborative opportunities with other UNC institutions as appropriate.

The proposed Master of Science in Computer Engineering (MSCPE) program is designed to impart advanced knowledge on current and future generation computer hardware and software technologies. Specifically, the proposed program is structured to emphasize the broad areas of (1) Computer Architecture and Hardware Design, (2) Computer Systems and Applications Software, and (3) Distributed and Real-time Computer Systems. The proposed program requires successful completion of at least 30 approved graduate credits, which may be completed under the thesis, project, or the coursework options. Students enrolled in the MSCPE program will be required to take a set of three core courses (9 credits), at least two depth courses from any one of three focus areas (6 credits), and remaining courses as electives from other areas, as approved by the student's advisor. All courses included in the focus areas are currently available and are already offered on a regular basis by the Electrical and Computer Engineering (ECE) Department or related departments at UNC Charlotte. The MSCPE program will be offered in day, evening, and hybrid (online/in-person) instructional formats. Full-time students will be able to complete the program within two years. The evening and online courses will allow professionals in the workplace to pursue a part-time MS degree in Computer Engineering.

The MSCPE program will complement the Master of Science in Electrical Engineering (MSEE) program that is offered by the ECE Department at the William States Lee College of Engineering (COE). Currently, the MSEE program serves four broad areas within ECE: (1) Communications, Controls, and Signal Processing; (2) Computer Systems; (3) Devices, Circuits, and Systems; and (4) Power Systems. Rapid advancements in the field of computer engineering over the past few decades has led to an increasing demand for computer engineers. This in turn generated increasing interest of graduate students to specialize in this sub-discipline within the existing MSEE program. The proposed MSCPE program will include core, depth, and elective courses specific to computer engineering that will serve this growing need in the Computer Systems sub-discipline more effectively – both in terms of curriculum specialization and in meeting industry workforce demands. In effect, establishing this new degree program will lead to two distinct Master's programs in the ECE Department. This will foster growth in graduate enrollment without requiring additional resources, enable more efficient course and curriculum development, streamlined student advising, and lead to more effective workforce development.

As detailed below, the proposed degree program is closely aligned with the goals described in "Higher Expectations: The Strategic Plan for the University of North Carolina (2017-2022)"¹

- **Critical Workforce:** The proposed MSCPE program will attract graduate students in a high-demand STEM field, contributing to regional workforce needs in the Charlotte region and beyond.
- **Research Productivity:** Computer engineering is still a fast-evolving field, and faculty and students in this area are continuously engaging in new research directions. The MSCPE program will support the growing interest of graduate students to be involved with research projects and scholarship in computer engineering.
- **Human Capital:** Computer Engineering is currently a very active area within ECE, which comprises a large portion of its graduate students. The trend is also noticed at the undergraduate level and students are increasingly following their undergraduate degrees with a Master's degree. The ECE Department has hired several new faculty members in computer engineering recently to cope with this increase in student enrollment. The proposed MSCPE program will help in faculty as well as student retention in this area.
- **Affordability:** The proposed program will not require new resources as the corresponding courses and faculty are already being taught on a regular basis. However, the development of a new program that enables students to concentrate in the rapidly growing area of computer engineering will provide a higher value of their efforts and financial investments.

Currently, the only institution in the UNC System that offers an MS in Computer Engineering is North Carolina

¹ <https://www.northcarolina.edu/strategic-planning>

State University (NCSU). NCSU’s MS in Computer Engineering includes specializations in Computer Architecture, Networking, Software, and VLSI Systems. North Carolina A&T offers an MSEE degree with a concentration in Computer Engineering. However, these institutions are located far from the Charlotte region. Further, the emphasis on integrated hardware-software systems is a unique feature of UNC Charlotte’s proposed MSCPE program.

The proposed MSCPE program at UNC Charlotte and the existing Computer Engineering program at NCSU have the potential for being mutually benefited by enabling UNC Charlotte students to take a limited number of online courses from NCSU in areas such as VLSI Design, while NCSU students could take the systems-oriented courses offered at UNC Charlotte. In addition, MSCPE graduates from UNC Charlotte can add to the pool of potential Ph.D. applicants to NCSU focusing on Computer Engineering. Additionally, Computer Engineering faculty in these two institutions could also collaborate on jointly developing curriculum material.

The proposed MSCPE program also leverages strengths of the existing MS in Computer Science offered by the College of Computing and Informatics (CCI) at UNC Charlotte. Specifically, currently offered courses in Cybersecurity, Artificial Intelligence, Algorithms and Data Structures will be appropriate electives in the proposed MSCPE degree program. In turn, CCI students could take the computer hardware-oriented courses offered by the proposed program.

Student Demand: *(Provide evidence of student demand. Discuss the extent to which students will be drawn from a pool of students not previously served by the institution. Maximum length 1,000 words.)*

Enrollments in ECE’s graduate programs have increased markedly over recent years, although the Master’s student enrollment has experienced a drop since 2016. The recent drop in enrollment is primarily due to declining numbers of international applicants to the Master’s program, which has been experienced by institutions of higher education nationwide². Specifically, between Fall 2010 to 2015, the total graduate enrollment in ECE increased by 78%, of which the enrollment in the MSEE program increased by more than 115%, as demonstrated in Figure 1. The MSEE enrollment dropped by nearly 25% over the next two years, with the Ph.D. enrollment remaining relatively unchanged. However, the total graduate enrollment in 2017 is still over 43% higher than that in 2010, which includes a 70% increase in the MSEE program enrollment over this time. Moreover, the number of MSEE

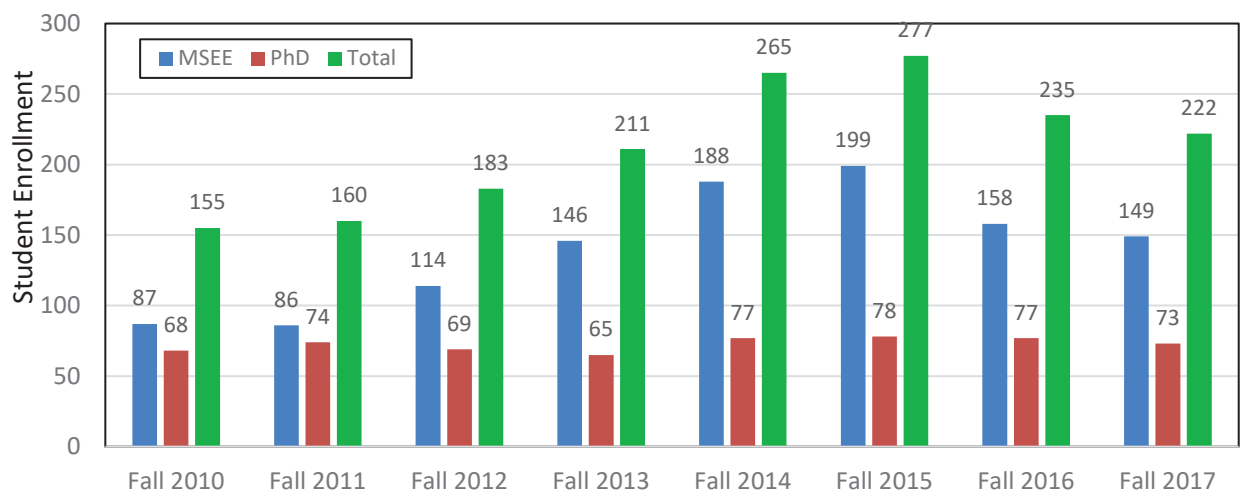


Figure 1: Graduate program enrollments in ECE at UNC Charlotte.

² “International Student Numbers Decline”, by Elizabeth Redden, Inside Higher Ed, January 22, 2018.

students with a focus in computer engineering continued to grow at a rate that is higher than the national average over this period, as indicated in Figure 2.

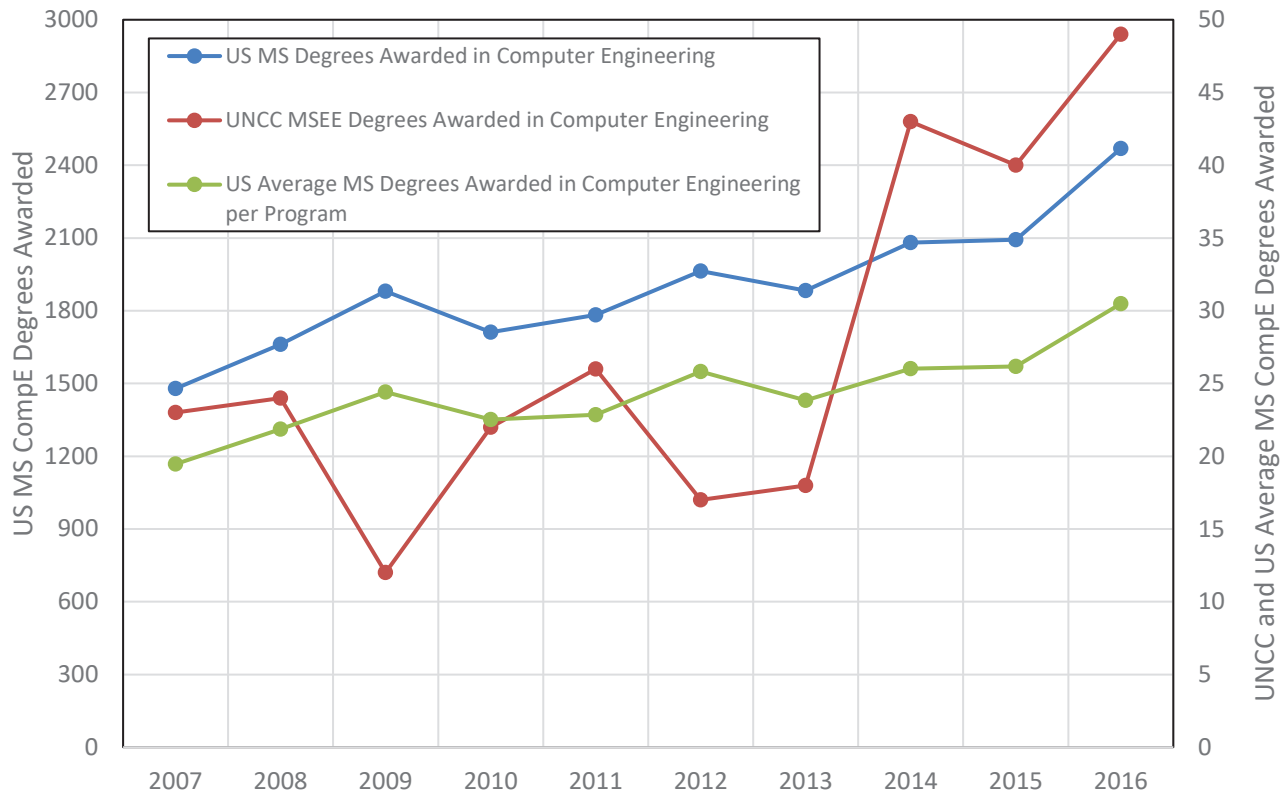


Figure 2: Annual Masters' degrees awarded in computer engineering courses. (Source: ASEE)

A similar trend of growing interest in computer engineering is also observed at the undergraduate level in the ECE Department, as indicated in Figure 3. The ECE Department has an Early Entry program that allows exceptional undergraduate students to take advantage of faster completion of the MSEE degree immediately following the BSEE or BSCPE program. It is envisioned that the increasing interest of undergraduate students in computer engineering will also reflect on the proposed MSCPE enrollments.

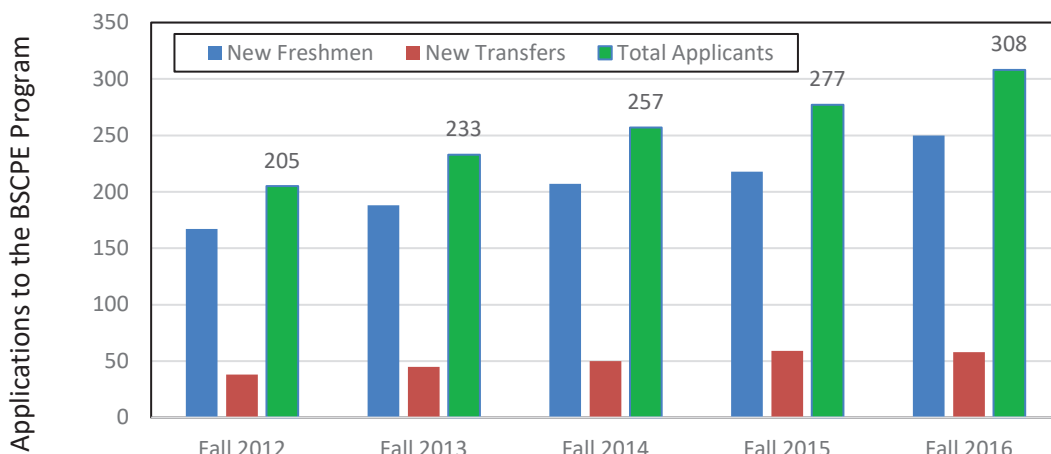


Figure 3: Number of applicants to the Bachelor of Science in Computer Engineering (BSCPE) program at UNC Charlotte.

To assess the level of interest of graduate students currently enrolled in the MSEE program in an MS in Computer Engineering, a limited student survey was conducted in fall 2017 in one of the graduate courses in the ECE Department (ECGR-6181: Embedded Operating Systems). The survey included the question “Would you prefer that your M.S. degree be titled M.S. in Computer Engineering, instead of M.S. in Electrical Engineering as it is now?”. Of the 37 respondents, 76% responded “yes”, 14% said that they would prefer MSEE, and another 5% said that it did not make any difference. The survey also included the option to provide the reason for their answers. Significant responses in favor of adding an MSCPE program include: “degree title should match the student’s interest in computer engineering”, “better job opportunities”, “more appropriate professional title for students interested in robotics”, and “embedded systems interest is best described by computer engineering and not electrical”.

Based on the above, it is clear that the proposed MSCPE program will draw students from the increasing pool of applicants who are interested in the growing computer hardware and software industry, such as microcontroller design and programming, advanced computer systems architecture, robotics, real time systems, mobile devices, hardware security, the Internet of Things, and others. The demand for graduates trained in these advanced topics is expected to grow in future. While the applicants to the proposed MSCPE program may draw away some applicants who would otherwise consider the MSEE program, the MSCPE program will have a much higher appeal to those interested in a career in computer engineering, and hence help increase the total number of Master’s applications in both programs.

Societal Demand: *(Provide evidence of societal demand and employability of graduates from each of the following source types. Maximum length 1,000 words)*

- Labor market information (projections, job posting analyses, and wages)
 - Specific to North Carolina (such as [ncworks.gov](#), [nctower.com](#), or outside vendors such as [Burning Glass](#))
 - Available from national occupational and industry projections (such as the [U.S. Bureau of Labor Statistics](#))
- Projections from professional associations or industry reports
- Other (alumni surveys, insights from existing programs, etc.)
 - Labor market information (projections, job posting analyses, and wages)
 - specific to North Carolina (such as [ncworks.gov](#), [nctower.com](#), outside vendors such as [Burning Glass](#))
 - available from national occupational and industry projections (such as BLS).

Specific to North Carolina

Charlotte is most often associated with banking rather than technology. However, from 2006 to 2016, technology-based employment in Charlotte increased by 62%. From 2014 to 2016, Charlotte was recognized as one of the fastest growing cities in terms of technology in the nation with an 18% increase in jobs. This 10-year growth in technology employment in the metro area includes a 23% increase in the number of workers in STEM occupations that are heavily populated by computer engineering professionals nationwide.

This rapid job growth and strong recent momentum, driven partly by health care and environmental technology, ranks Charlotte as the second fastest growing technology area in the country after Silicon Valley, and ahead of Raleigh and Denver. In the past ten years, the region has added 7,400 jobs in two key high-tech business services sectors: custom programming and systems design services, along with nearly 700% growth in software publishing employment.

According to the Charlotte Chamber of Commerce, more than 44,000 people work in technology occupations in the Charlotte region. These core technology occupations draw heavily from the education objectives of the proposed MSCPE program, and include software publishers, data processing and hosting, computer systems design, computer networking and communications, cloud computing, financial technologies, and other related services (Table 1).

Table 1: Computer Engineering Related Jobs and Employment Numbers in Charlotte

Job Title	Number Employed
Computer Systems Analyst	8500
Application Developers	7500
Computer Support Specialists	5400
Hardware Engineers	4600
Systems Software Developers	4400
Network and System Administrators	3100
Network Support Specialists	1900
Computer Programmers	2700
Information Security Analysts	1800
Computer Network Architects	1600
Database Administrators	1000
Computer and Information Systems Managers	130
Others	600

(Source: Bureau of Labor Statistics 2015)

Table 2 shows the jobs in computer engineering related fields currently in North Carolina according to nworks.gov. The occupations listed in the table are specific to those that require skill sets covered by the educational objectives of the proposed MSCPE program. The last column of the table is a direct metric of the demand of MSCPE graduates in this state. Note that a value of less than 1 always implies a high demand for graduates in a specific occupation, and an overwhelming majority of the rows have fewer potential candidates than job opening.

Available from national occupational and industry projections (such as BLS)

Employment of software developers is projected to grow 24% from 2016 to 2026, much faster than the average for all occupations. Employment of applications developers is projected to grow 30%, and employment of systems developers is projected to grow 11%. Employment of computer hardware engineers is projected to grow 5% from 2016 to 2026, about as fast as the average for all occupations.

The need for new applications on smart phones and tablets, cloud-based computing, and the emerging areas of edge and fog computing and autonomous vehicles will help increase the demand for applications software developers. As the number of people who use digital platforms increases over time, demand for systems developers will grow (see Table 3). For example, more embedded computer systems are being built into consumer electronics such as cell phones, autonomous vehicles, smart appliances, and smart edge sensors/actuators. Concerns over threats to computer security could result in more investment in security software and hardware to protect computer networks and electronic devices. Job prospects will be best for applicants with knowledge of

design and internet search firms increased the North Carolina population by 60%. Job growth in these industries has remained robust, with North Carolina posting the fifth largest job gain in these sectors among all states in 2016. Charlotte's professional and technology services sector added 5,600 jobs over the past year, an increase of 8.2%. Raleigh posted the seventh strongest growth in the information sector, which includes software publishing, internet search and data processing.

The Research Triangle has long been the center for technology employment in North Carolina with a tech workforce of 34,500 workers. The strongest growth over the past six years has been in computer systems design and software, where firms added 6,900 jobs and 4,000 jobs from 2010 to 2016, respectively. While the Triangle is served by programs at NC State, the demand is sufficiently large and growing that additional graduates would benefit the State. Charlotte Metro Area's current pool of tech workers stands at about 47,150 and is rapidly growing (Charlotte Observer, January 2018). With the rapid growth in tech employment, more tech education programs will be needed, especially at the graduate level.

For Doctoral Programs Only:

Describe the following (maximum length 2,000 words):


- The research and scholarly infrastructure in place (including faculty) to support the proposed program.
- Method of financing the proposed new program (including extramural research funding and other sources) and indicate the extent to which additional state funding may be required.
- State the number, amount, and source of proposed graduate student stipends and related tuition benefits that will be required to initiate the program.

N/A

Contact: (List the names, titles, e-mail addresses and telephone numbers of the person(s) responsible for planning the proposed program.)

Position Title	Name	E-mail Address	Telephone
Professor and Chair, ECE	Asis Nasipuri	anasipur@uncc.edu	704-687-8418
Professor, Associate Chair of Computer Engineering	James Conrad	jmconrad@uncc.edu	704-687-8597
Professor	Ron Sass	rsass@uncc.edu	704-687-8196
Associate Professor	Arun Ravindran	aravindr@uncc.edu	704-687-8427

This Letter of Intent to Plan a New Program has been reviewed and approved by the appropriate campus authorities.

Position Title	Signature	Date
Provost		1/9/2019
Provost (Joint Partner Campus)		

SUMMARY OF ESTIMATED ADDITIONAL COSTS FOR PROPOSED PROGRAM

INSTITUTION	University of North Carolina at Charlotte	DATE	9-May-19
Program (CIP, Name, Level)	14.0901, Computer Engineering, General		
Degree(s) to be Granted	M.S. in Computer Engineering	Program Year	Year 1 (2020-2021)
Differential tuition requested per student per academic yr	\$1,800		
Projected annual FTE students	10		
Projected annual differential tuition	\$18,000		
Percent differential tuition for financial aid	25%		
Differential tuition remainder	13500		

ADDITIONAL FUNDS REQUIRED - BY SOURCE

	Reallocation of Present Institutional Resources	Projected Differential Tuition	Enrollment Increase Funds	Other New Allocations (Identify)	Total
EPA/SPA Regular Salaries					
Professional Advisor (Position #1924)	\$ 18,750.00	\$ -	\$ -	\$ -	\$ 18,750.00
EPA Academic Salaries					
1 New faculty			\$ 96,000.00		\$ 96,000.00
Graduate Director stipend	\$ -	\$ -	\$ 10,000.00	\$ -	\$ 10,000.00
Social Security	\$ 1,434.00	\$ -	\$ 7,344.00	\$ -	\$ 8,778.00
State Retirement	\$ 2,484.00	\$ -	\$ 12,720.00	\$ -	\$ 15,204.00
Medical Insurance	\$ 2,136.00	\$ -	\$ 6,104.00	\$ -	\$ 8,240.00
Graduate Stipends					
Graduate Teaching Assistantships (3 at \$18.5K)		\$ 4,500.00	\$ 51,000.00	\$ -	\$ 55,500.00
Supplies and Materials					
(Identify)	\$ -	\$ -	\$ -	\$ -	\$ -
Current Services					
(Identify)	\$ -	\$ -	\$ -	\$ -	\$ -
Travel	\$ -	\$ -	\$ 4,500.00	\$ -	\$ 4,500.00
Communications	\$ -	\$ -	\$ -	\$ -	\$ -
Printing and Binding	\$ -	\$ -	\$ 1,500.00	\$ -	\$ 1,500.00
Advertising	\$ -	\$ -	\$ 1,000.00	\$ -	\$ 1,000.00
Fixed Charges	(Identify)	\$ -	\$ -	\$ -	\$ -
Capital Outlay (Equipment)					
Laboratory equipment	\$ 15,000.00	\$ 13,500.00		\$ -	\$ 28,500.00
Libraries	\$ -	\$ -	\$ -	\$ -	\$ -
TOTAL ADDITIONAL COSTS	\$ 39,804.00	\$ 18,000.00	\$ 190,168.00	\$ -	\$ 247,972.00

Narrative:

The projected number of students enrolled in the MSCPE program in Year-1 is expected to be 90. We expect that approximately 80 of these students will be drawn from the MSEE program, and the increase in total enrollment of MS students (MSEE + MSCPE) due to the addition of the MSCPE program in Year-1 will be 10, which is the number included in Line 6. This is equivalent to an increase of approximately 180 SCH in Year-1, assuming that each student registers for full time (3 courses) i.e. 9 credits per semester. A corresponding amount of Enrollment Increase funds has been assumed for Year-1, i.e. $180/90 \cdot 17 = 1.99$ new instructional positions, which is \$190K assuming \$95K salary per faculty position.

SUMMARY OF ESTIMATED ADDITIONAL COSTS FOR PROPOSED PROGRAM

INSTITUTION	University of North Carolina at Charlotte	DATE	9-May-19
Program (CIP, Name, Level)	14.0901, Computer Engineering, General		
Degree(s) to be Granted	M.S. in Computer Engineering	Program Year	Year 2 (2021-2022)
Differential tuition requested per student per academic yr	\$1,800		
Projected annual FTE students	17		
Projected annual differential tuition	\$30,600		
Percent differential tuition for financial aid	25%		
Differential tuition remainder	22950		

ADDITIONAL FUNDS REQUIRED - BY SOURCE

	Reallocation of Present Institutional Resources	Projected Differential Tuition	Enrollment Increase Funds	Other New Allocations (Identify)	Total
EPA/SPA Regular Salaries					
Professional Advisor (Position #1924)	\$ 18,750.00	\$ -	\$ -	\$ -	\$ 18,750.00
EPA Academic Salaries					
1 New faculty			\$ 96,000.00		\$ 96,000.00
Graduate Director stipend	\$ -	\$ -	\$ 10,000.00	\$ -	\$ 10,000.00
Social Security	\$ 1,463.00	\$ -	\$ 7,491.00	\$ -	\$ 8,954.00
State Retirement	\$ 2,534.00	\$ -	\$ 12,974.00	\$ -	\$ 15,508.00
Medical Insurance	\$ 2,179.00	\$ -	\$ 6,226.00	\$ -	\$ 8,405.00
Graduate Stipends					
Graduate Teaching Assistantships (5 at \$18.5K)		\$ 7,650.00	\$ 84,850.00	\$ -	\$ 92,500.00
Supplies and Materials					
(Identify)	\$ -	\$ -	\$ -	\$ -	\$ -
Current Services					
(Identify)	\$ -	\$ -	\$ -	\$ -	\$ -
Travel	\$ -	\$ -	\$ 5,000.00	\$ -	\$ 5,000.00
Communications	\$ -	\$ -	\$ -	\$ -	\$ -
Printing and Binding	\$ -	\$ -	\$ 2,000.00	\$ -	\$ 2,000.00
Advertising	\$ -	\$ -	\$ 1,000.00	\$ -	\$ 1,000.00
Fixed Charges	(Identify)	\$ -	\$ -	\$ -	\$ -
Capital Outlay (Equipment)					
(Identify)	\$ -	\$ 22,950.00	\$ 76,000.00	\$ -	\$ 98,950.00
Libraries	\$ -	\$ -	\$ -	\$ -	\$ -
TOTAL ADDITIONAL COSTS	\$ 24,926.00	\$ 30,600.00	\$ 301,541.00	\$ -	\$ 357,067.00

Narrative:

The projected number of additional students enrolled in the MSCPE program in Year-2 is 17, which includes a projected increase of 7 the second year.

Enrollment increase of 17 students amounts to an increase of approximately 306 SCH in Year-2, assuming full time enrollment of 9 cr per student per semester. This is equivalent to enrollment increase funds for 306/90.17=3.4 new instructional positions, which accounts for 3.4x95K=\$322K of Enrollment Increase funds in Year-2, assuming \$95K annual salary per faculty member.

SUMMARY OF ESTIMATED ADDITIONAL COSTS FOR PROPOSED PROGRAM

INSTITUTION	University of North Carolina at Charlotte	DATE	9-May-19
Program (CIP, Name, Level)	14.0901, Computer Engineering, General		
Degree(s) to be Granted	M.S. in Computer Engineering	Program Year	Year 3 (2022-2023)
Differential tuition requested per student per academic yr	\$1,800		
Projected annual FTE students	25		
Projected annual differential tuition	\$45,000		
Percent differential tuition for financial aid	25%		
Differential tuition remainder	33750		

ADDITIONAL FUNDS REQUIRED - BY SOURCE

	Reallocation of Present Institutional Resources	Projected Differential Tuition	Enrollment Increase Funds	Other New Allocations (Identify)	Total
EPA/SPA Regular Salaries					
Professional Advisor (Position #1924)	\$ 18,750.00	\$ -	\$ -	\$ -	\$ 18,750.00
EPA Academic Salaries					
2 New faculty			\$ 196,000.00		\$ 196,000.00
Gradaute Director stipend	\$ -	\$ -	\$ 10,000.00	\$ -	\$ 10,000.00
Social Security	\$ 1,492.00	\$ -	\$ 15,594.00	\$ -	\$ 17,086.00
State Retirement	\$ 2,585.00	\$ -	\$ 27,008.00	\$ -	\$ 29,593.00
Medical Insurance	\$ 2,223.00	\$ -	\$ 12,696.00	\$ -	\$ 14,919.00
Graduate Stipends					
Graduate Teaching Assistantships (6 at \$18.5K)	\$ -	\$ 11,250.00	\$ 99,750.00	\$ -	\$ 111,000.00
Supplies and Materials					
(Identify)	\$ -	\$ -	\$ -	\$ -	\$ -
Current Services					
(Identify)	\$ -	\$ -	\$ -	\$ -	\$ -
Travel	\$ -	\$ -	\$ 5,000.00	\$ -	\$ 5,000.00
Communications	\$ -	\$ -	\$ -	\$ -	\$ -
Printing and Binding	\$ -	\$ -	\$ 2,000.00	\$ -	\$ 2,000.00
Advertising	\$ -	\$ -	\$ 1,000.00	\$ -	\$ 1,000.00
Fixed Charges					
(Identify)	\$ -	\$ -	\$ -	\$ -	\$ -
Capital Outlay (Equipment)					
(Identify)	\$ -	\$ 33,750.00	\$ 77,800.00	\$ -	\$ 111,550.00
Libraries	\$ -	\$ -	\$ -	\$ -	\$ -
TOTAL ADDITIONAL COSTS	\$ 25,050.00	\$ 45,000.00	\$ 446,848.00	\$ -	\$ 516,898.00

Narrative:

The projected enrollment increase up to Year-3 is estimated to be 25, which includes an increase of 8 students in Year-3.

Increase of 25 students amounts to an increase of approximately 450 SCH in Year-3, which is equal to Enrollment increase funds of 5 new instructional positions. Assuming \$95K salary per faculty member, the total Enrollment Increase Funds of \$474K was consider

SUMMARY OF ESTIMATED ADDITIONAL COSTS FOR PROPOSED PROGRAM

INSTITUTION	University of North Carolina at Charlotte	DATE	9-May-19
Program (CIP, Name, Level)	14.0901, Computer Engineering, General		
Degree(s) to be Granted	M.S. in Computer Engineering	Program Year	Year 4 (2023-2024)
Differential tuition requested per student per academic yr	\$1,800		
Projected annual FTE students	38		
Projected annual differential tuition	\$68,400		
Percent differential tuition for financial aid	25%		
Differential tuition remainder	51300		

ADDITIONAL FUNDS REQUIRED - BY SOURCE

	Reallocation of Present Institutional Resources	Projected Differential Tuition	Enrollment Increase Funds	Other New Allocations (Identify)	Total
EPA/SPA Regular Salaries					
Professional Advisor (Position #1924)	\$ 18,750.00	\$ -	\$ -	\$ -	\$ 18,750.00
EPA Academic Salaries					
3 New faculty			\$ 300,000.00		\$ 300,000.00
Gradaute Director stipend	\$ -	\$ -	\$ 10,000.00	\$ -	\$ 10,000.00
Social Security	\$ 1,522.00	\$ -	\$ 24,327.00	\$ -	\$ 25,849.00
State Retirement	\$ 2,667.00	\$ -	\$ 42,135.00	\$ -	\$ 44,802.00
Medical Insurance	\$ 2,267.00	\$ -	\$ 19,410.00	\$ -	\$ 21,677.00
Graduate Stipends					
Graduate Teaching Assistantships (8 at \$18.5K)	\$ -	\$ 17,100.00	\$ 130,900.00	\$ -	\$ 148,000.00
Supplies and Materials					
(Identify)	\$ -	\$ -	\$ -	\$ -	\$ -
Current Services					
(Identify)	\$ -	\$ -	\$ -	\$ -	\$ -
Travel	\$ -	\$ -	\$ 5,000.00	\$ -	\$ 5,000.00
Communications	\$ -	\$ -	\$ -	\$ -	\$ -
Printing and Binding	\$ -	\$ -	\$ 2,000.00	\$ -	\$ 2,000.00
Advertising	\$ -	\$ -	\$ 1,000.00	\$ -	\$ 1,000.00
Fixed Charges	(Identify)	\$ -	\$ -	\$ -	\$ -
Capital Outlay (Equipment)					
(Identify)	\$ -	\$ 51,300.00	\$ 76,000.00	\$ -	\$ 127,300.00
Libraries	\$ -	\$ -	\$ -	\$ -	\$ -
TOTAL ADDITIONAL COSTS	\$ 25,206.00	\$ 68,400.00	\$ 610,772.00	\$ -	\$ 704,378.00

Narrative:

The projected number of additional students enrolled in the MSCPE program is 38, which includes a projected increase of 13 in Year-4. Increase of 38 students amounts to an increase of approximately 684 SCH in Year-4, which is equal to Enrollment increase funds of 7.58 new instructional positions. Assuming \$95K salary per faculty member, the total Enrollment Increase Funds of \$720K was consi

April 16, 2019

Dr. Asis Nasipuri
Chair, Electrical and Computer Engineering Department
University of North Carolina at Charlotte

Dear Dr. Nasipuri,

The UNC Charlotte Electrical and Computer Engineering (ECE) Department Advisory Board enthusiastically supports ECE's proposal to establish a Masters in Computer Engineering (MSCpE) program. The proposal addresses long-standing needs in industry for computer engineers with advanced training. These engineers promise to fulfill existing demands that exist across all sectors of industry due to the proliferation of computing technology.

Throughout the Charlotte region and beyond companies struggle to hire the highly skilled computer engineers they need to develop their products and achieve their design goals. The proposed MSCpE program promises to provide a new type of engineer. These engineers have the highly desirable skill set needed to synthesize next-generation computing systems. These systems will emphasize unprecedented synergy between hardware and software designs to innovate in emerging markets such as "internet of things" smart devices and low-power embedded systems.

The advisory board strongly supports the ECE Department in their efforts to establish a MSCpE program at UNC Charlotte. Success in this endeavor promises to enhance not only our company, our customers and its local success but the success of many other companies in the region.

Sincerely,



Carl Fisher
UNCC ECE Department Advisory
Board Chairman
and
VP – Customer Accounts &
Government Affairs
Framatome, Inc.



UNC CHARLOTTE

College of Computing and Informatics

Department of Computer Science

9201 University City Blvd, Charlotte, NC 28223-0001

t/704.687.8560 www.cs.uncc.edu

June 21, 2019

Re: Letter of Support for the new MS degree in Computer Engineering (MSCPE)

To whom it may concern:

On behalf of the Department of Computer Science, I would like to express my support for the proposed MS degree program in Computer Engineering. Generally speaking, the scientific boundary between Computer Science and Computer Engineering disciplines is not well defined. In many universities, the exact content of Computer Engineering programs depends on the organizational structure surrounding broader engineering, computing and information sciences. At UNCC, given that the disciplines reside in two different colleges, close collaboration between faculty research and academic programs is inevitable, necessary and welcome.

Based on the preview of the Request to Establish document, I understand that it is the intent of the new MSCPE program to include several Computer Science courses as electives. The preliminary list includes Data Analytics, Algorithms, Robotics and Cyber Security areas. While additional demand from MSCPE students will create pressure on some courses that already face capacity crunch, we enthusiastically support program creation and will accept new responsibilities. More importantly, we anticipate a broader discussion which may open some of the courses taught by the Department of Electrical and Computer Engineering to MS Computer Science students. MS CS is already the largest graduate program on campus. Ideally, the cross-departmental course demand should even out and benefit all the graduate students enrolled in our programs, thus increasing the competitiveness and academic appeal of MS programs at UNC Charlotte.

The UNIVERSITY of NORTH CAROLINA at CHARLOTTE

An Equal Opportunity/Affirmative Action Employer

In case you have any questions, please feel free to contact me.

Sincerely,

A handwritten signature in black ink, appearing to read "B. Cukic", with a long, sweeping horizontal stroke extending to the right.

Bojan Cukic, Ph.D.
Professor and Chair

NC STATE UNIVERSITY

Box 7914
Raleigh, NC 27695-7911

919.515.7351
919.515.2285 (fax)
paulf@ncsu.edu

June 12, 2019

Dear Dr. Nasipuri,

I am the Director of Graduate Programs for the Electrical and Computer Engineering Department at North Carolina State University (NCSU). I have been asked to comment on the proposal for an MS Degree in Computer Engineering from the University of North Carolina at Charlotte (UNCC Charlotte).

Computer Engineering is important to our state and nation. We can validate this based on our alumni survey results. We have found that 80% of our MS in Computer Engineering graduates have job offers before they graduate, and 95% are working at a company or pursuing a PhD degree within six months of graduating. Graduates work in North Carolina (25%, mostly in RTP), California (25%, mostly in Silicon Valley), and the rest of the US and world.

I have discussed the proposal with UNC Charlotte Electrical and Computer Engineering faculty, and I find no conflicts between their proposed MS in Computer Engineering program and ours. Currently very few students from Charlotte pursue a MS in Computer Engineering degree from NCSU. In fact, their new program will provide opportunities to collaborate with respect to coursework and research. We have already discussed the ability of UNC Charlotte students taking NCSU Engineering On Line courses and transferring these course credits to their UNC Charlotte MS in Computer Engineering Degree. I can envision that some MS in Computer Engineering graduates could even pursue a PhD in Computer Engineering from NCSU.

Please contact me at 919-515-7351 or paulf@ncsu.edu if you have further questions.

Sincerely,

Sincerely yours,



Dr. Paul D. Franzon
Cirrus Logic Distinguished Professor
Director of Graduate Programs
Department of Electrical and Computer Engineering



Student Learning Outcomes Assessment Plan

College: The William States Lee College of Engineering

Department: Electrical and Computer Engineering

Degree Program: Master of Science in Electrical Engineering

Reflection on the Continuous Improvement of Student Learning

1. List the changes and improvements your program planned to implement as a result of last year's student learning outcomes assessment data.
2. Were all of the changes implemented? If not, please explain.
3. What impact did the changes have on student learning?

Student Learning Outcome 1 (knowledge, skill or ability to be assessed)

Students analyze and evaluate advanced topics in engineering.

Changes to the Student Learning Outcomes Assessment Plan: If any changes were made to the assessment plan (which includes the Student Learning Outcome, Effectiveness Measure, Methodology and Performance Outcome) for this student learning outcome since your last report was submitted, briefly summarize the changes made and the rationale for the changes.

Effectiveness Measure: Identify the data collection instrument, e.g., exam, project, paper, etc. that will be used to gauge acquisition of this student learning outcome and explain how it assesses the desired knowledge, skill or ability. A copy of the data collection instrument and any scoring rubrics associated with this student learning outcome are to be submitted electronically to the designated folder on the designated shared drive.

Measures of the acquisition of this learning outcome were obtained through analysis of the thesis or project report, the oral presentation of the thesis or project, or the review of written comprehensive examinations.

Separate criteria were defined for each of these data collection instruments, and are labeled: MSEE Dissertation Written Report (WR) and/or Oral Presentation (OP), and/or Exam (EX)

A scoring rubric was developed for each of these criteria, and performance measures were set for the combined score pertaining to this outcome.

Mapping learning outcomes and effectiveness measures: Appendix-1 (Mapping)

Scoring rubrics used: Appendix-2 (GLO_Rubric_WR)
 Appendix-3 (GLO_Rubric_OP)
 Appendix-3 (GLO_Rubric_Exams)

The ECE comprehensive exam evaluates the student's breadth of knowledge in electrical and computer engineering. This exam is taken by the students who opt for non-thesis course-only option. Students have to answer 4 problems including one problem on engineering mathematics and three problems from the five technical thrust areas identified by the department.

The student submits written thesis report to the advisory committee two weeks before the oral presentation. The committee members carefully review the thesis and evaluates the student based on the rubric. Furthermore, the committee evaluates the student during oral presentation. Student is expected to conduct detailed literature review, and identify the importance and contribution of the dissertation. Similar procedure is followed for the project option. A student submits a written project report to the committee prior to the oral presentation.

Methodology: Describe when, where and how the assessment of this student learning outcome will be administered and evaluated. Describe the process the department will use to collect, analyze and disseminate the assessment data to program faculty and to decide the changes/improvements to make on the basis of the assessment data.

The thesis or project written report and the oral presentation are evaluated by each member of the student's advisory committee and submitted to the graduate program director. The written comprehensive examinations are evaluated by graduate faculty members who prepare the problems. These data are compiled by the graduate program director and presented to the faculty each year.

The student typically submits the written report to the advisory committee two weeks before the oral presentation. Oral presentations are open to public and anyone in the audience can ask questions. The written examinations are given by the department in spring and fall semesters.

Performance Outcome: Identify the percentage of students assessed that should be able to demonstrate proficiency in this student learning outcome and the level of proficiency expected. *Example: 80% of the students assessed will achieve a score of “acceptable” or higher on the Oral Presentation Scoring Rubric.* (Note: a copy of the scoring rubric, complete with cell descriptors for each level of performance, is to be submitted electronically to the designated folder on the designated shared drive.)

For the rubrics used to evaluate student learning outcome 1, the following targets have been set for 2017:

Written Reports: 90% of the students will score at or above 20/30 according to the rubric for criteria WR1a-WR1j.

Exams: 90% of the students will score at or above 9/12 according to the rubric for criteria EX1a-EX1d **and** score at or above 80% on the examination.

Oral Presentations: 90% of the students will score at or above 20/30 according to the rubric for criteria OP1a-OP1j.

Student Learning Outcome 2
(knowledge, skill or ability to be assessed)

Students effectively communicate technical information.

Changes to the Student Learning Outcomes Assessment Plan: If any changes were made to the assessment plan (which includes the Student Learning Outcome, Effectiveness Measure, Methodology and Performance Outcome) for this student learning outcome since your last report was submitted, briefly summarize the changes made and the rationale for the changes.

Effectiveness Measure: Identify the data collection instrument, e.g., exam, project, paper, etc. that will be used to gauge acquisition of this student learning outcome and explain how it assesses the desired knowledge, skill or ability. A copy of the data collection instrument and any scoring rubrics associated with this student learning outcome are to be submitted electronically to the designated folder on the designated shared drive.

Measures of the acquisition of this learning outcome were obtained through analysis of the thesis or project report, the oral presentation of the thesis or project, or the review of written comprehensive examinations.

Separate criteria were defined for each of these data collection instruments, and are labeled: MSEE Dissertation Written Report (WR) and/or Oral Presentation (OP), and/or Exam (EX)

A scoring rubric was developed for each of these criteria, and performance measures were set for the combined score pertaining to this outcome.

Mapping learning outcomes and effectiveness measures: Appendix-1 (Mapping)

Scoring rubrics used: Appendix-2 (GLO_Rubric_WR)
 Appendix-3 (GLO_Rubric_OP)
 Appendix-3 (GLO_Rubric_Exams)

The ECE comprehensive exam evaluates the student's breadth of knowledge in electrical and computer engineering. This exam is taken by the students who opt for non-thesis course-only option. Students have to answer 4 problems including one problem on engineering mathematics and three problems from the five technical thrust areas identified by the department.

The student submits written thesis report to the advisory committee two weeks before the oral presentation. The committee members carefully review the thesis and evaluates the student based on the rubric. Furthermore, the committee evaluates the student during oral presentation. Student is expected to conduct detailed literature review, and identify the importance and contribution of the dissertation. Similar procedure is followed for the non-thesis project option. A student submits a written project report to the committee prior to the oral presentation.

Methodology: Describe when, where and how the assessment of this student learning outcome will be administered and evaluated. Describe the process the department will use to collect, analyze and disseminate the assessment data to program faculty and to decide the changes/improvements to make on the basis of the assessment data.

The thesis and project written reports and the oral presentation are evaluated by each member of the student's advisory committee and submitted to the graduate program director. The written examinations are evaluated by graduate faculty members who prepare the problems. These data are compiled by the graduate program director and presented to the faculty each year.

The student typically submits the written report to the advisory committee two weeks before the oral presentation. Oral presentations are open to public and anyone in the audience can ask questions. The written examinations are given by the department in spring and fall semesters.

Performance Outcome: Identify the percentage of students assessed that should be able to demonstrate proficiency in this student learning outcome and the level of proficiency expected. *Example: 80% of the students assessed will achieve a score of "acceptable" or higher on the Oral Presentation Scoring Rubric.* (Note: a copy of the scoring rubric, complete with cell descriptors for each level of performance, is to be submitted electronically to the designated folder on the designated shared drive.)

For the rubrics used to evaluate student learning outcome 2, the following targets have been set for 2017:

Written Reports: 100% of the students will score at or above 6/6 according to the rubric for criteria WR2a-WR2c.

Exams: 90% of the students will score at or above 8/9 according to the rubric for criteria EX2a-EX2c **and** score at or above 80% on the exam.

Oral Presentations: 100% of the students will score at or above 6/6 according to the rubric for criteria OP1a-OP1c.

THE WILLIAM STATES LEE COLLEGE OF ENGINEERING
Mapping MS and PhD Graduate Student Learning Outcomes and Effectiveness Measures
Rev. 10/24/11

SLO #1: Students analyze and evaluate advanced topics in engineering.

Effectiveness Measures:

MS: Project or Thesis Written Report (WR), Project or Thesis Oral Presentation (OP), and/or Exam (EX)

PhD: Doctoral Dissertation Written Report (WR) and/or Oral Presentation (OP), and/or Exam (EX)

Performance Targets:

Reports and Presentations: 90% of the students meet or exceed requirements ($\geq 26/36$ or 72%)

Exams: 90% of students pass the exam with a grade of 80 or higher (17/21 or 81%)

For MS and PhD candidates:

- WR1a/OP1a: Describes the scope and context of the defined problem
- WR1b/OP1b: Demonstrates existing knowledge and emerging research on the topic
- WR1c/OP1c: Compares and contrasts relevant aspects of the topic
- WR1d/OP1d: Evaluates scope of analytical methods/tools and selects the most appropriate one(s)
- WR1e/OP1e: Identifies assumptions and constraints relevant to the analytical method/tool selected
- WR1f/OP1f: Develops an appropriate model for analysis
- WR1g/OP1g: Analyzes topic beyond the previous level of coursework
- WR1h/OP1h: Evaluates topic beyond the previous level of coursework
- WR1i/OP1i: Interprets results within the scope and context of the defined problem
- WR1j/OP1j: Makes appropriate recommendations and/or identifies next steps

For MS comprehensive examinations and Ph.D. qualifying examinations:

- EX1a: Represents the problem schematically, graphically, or figuratively
- EX1b: Identifies appropriate assumptions and constraints
- EX1c: Identifies appropriate governing equation(s)
- EX1d: Develops an appropriate model for analysis

SLO #2: Students effectively communicate technical information.

Effectiveness Measures:

MS: Project or Thesis Written Report (WR) and/or Oral Presentation (OP), and/or Exam (EX)

PhD: Doctoral Dissertation Written Report (WR) and/or Oral Presentation (OP), and/or Exam (EX)

Performance Target:

Reports and Presentations: 100% of students meet or exceed requirements (= 6/6 or 100%)

Exams: 90% of students pass the exam with a grade of 80 or higher

For MS and PhD candidates:

- WR2a: Document conforms to format specified by the Graduate School (style, font size and type, margins, spacing, pagination, numbering, and organization)
- WR2b: Referencing format confirms to discipline standards
- WR2c: Quality of content, organization, and coherence of writing is at a level expected of professional publications

- OP2a: Delivery follows a logical sequence
- OP2b: Delivery is appropriately paced
- OP2c: Delivery presents a convincing argument

For MS comprehensive examinations and Ph.D. qualifying examinations:

- EX2a: Evaluates scope of analytical methods/tools and selects the most appropriate one(s)
- EX2b: Analyzes the topic beyond the BS level
- EX2c: Correctly solves the problem

SLO #3 (for Ph.D. Students Only): Students discover and create new knowledge

Effectiveness Measure: # of accepted publications upon graduation

Performance Target: 90% of students have at least one accepted publication upon graduation

The William States Lee College of Engineering
Graduate Student Learning Outcomes: *Written Reports*
 (Rev. 10/4/11)

GLO #1: Students analyze and evaluate advanced topics in engineering.				
Score	Criteria	1 Does Not Meet Expectations	2 Meets Expectations	3 Exceeds Expectations
	<i>Describes the scope and context of the defined problem</i>	Does not adequately describe the scope and context of the problem; important details are missing	Adequately describes the scope and context of the problem; sufficient level of detail is provided	Comprehensively describes the scope and context of the problem; level of detail offers additional breadth, depth, and/or new insights
	<i>Demonstrates existing knowledge and emerging research on the topic</i>	Does not adequately demonstrate knowledge of existing and emerging research on the topic; important details are missing	Adequately demonstrates knowledge of existing and emerging research on the topic; sufficient level of detail is provided	Comprehensively describes existing and emerging research on the topic; level of detail offers additional breadth, depth, and/or new insights
	<i>Compares and contrasts relevant aspects of the topic</i>	Does not adequately compare/contrast relevant aspects of the topic; important similarities or distinctions are missing	Adequately compares/contrasts relevant aspects of the topic; sufficient level of similarities and distinctions are provided	Comprehensively compares/ contrasts relevant aspects of the topic; level of detail in similarities and distinctions offers additional breadth, depth, and/or new insights

Score	Criteria	1 Does Not Meet Expectations	2 Meets Expectations	3 Exceeds Expectations
	<i>Evaluates scope of analytical methods/tools and selects the most appropriate one(s)</i>	Does not adequately evaluate the scope of analytical methods/tools and/or did not select the most appropriate one; some viable options were not considered or the best was not chosen	Adequately evaluates the scope of analytical methods/tools and selected the most appropriate one; all obvious options were considered and the best was chosen	Comprehensively evaluates the scope of analytical methods/tools and selected the most appropriate one; new or optional analytical tools were also considered and the best was chosen
	<i>Identifies assumptions and constraints relevant to the analytical methods/tools selected</i>	Does not adequately identify assumptions and constraints relevant to the analytical method selected; important assumptions or constraints are missing	Adequately identifies assumptions and constraints relevant to the analytical method selected; all obvious assumptions and constraints are identified	Comprehensively identifies assumptions and constraints relevant to the analytical method selected; assumptions and constraints beyond the obvious offer additional breadth, depth, and/or new insights
	<i>Develops an appropriate model for analysis</i>	Does not adequately develop an appropriate model for analysis; important aspects of the model are missing or extraneous aspects are included	Adequately develops an appropriate model for analysis; all obvious aspects of the model are included and justified	Comprehensively develops an appropriate model for analysis; new and relevant aspects of the model offer additional breadth, depth, and/or new insights
	<i>Analyzes topic beyond the previous level of coursework (BS or MS)</i>	Does not adequately analyze topic at the MS/PhD level; important aspects of analysis/evaluation is missing	Adequately analyzes topic at the MS/PhD level; sufficient level of analysis/evaluation is provided	Comprehensively analyzes topic at the MS/PhD level; level of analysis/evaluation offers additional breadth, depth, and/or new insights

Score	Criteria	1 Does Not Meet Expectations	2 Meets Expectations	3 Exceeds Expectations
	<i>Evaluates topic beyond the previous level of coursework (BS or MS)</i>	Does not adequately evaluate topic at the MS/PhD level; important aspects of analysis/evaluation is missing	Adequately evaluates topic at the MS/PhD level; sufficient level of analysis/evaluation is provided	Comprehensively evaluates topic at the MS/PhD level; level of analysis/evaluation offers additional breadth, depth, and/or new insights
	<i>Interprets results within the scope and context of the defined problem</i>	Does not adequately interpret results within the scope and context of the defined problem; interpretation is incomplete or lacks rationale	Adequately interprets results within the scope and context of the defined problem; interpretation is complete and rational	Comprehensively interprets results within the scope and context of the defined problem; interpretation is complete, rational, and offers additional breadth, depth, and/or new insights
	<i>Makes appropriate recommendations and/or identifies next steps</i>	Does not make recommendations or identify next steps <i>or</i> recommendations and next steps are not justified based on results	Makes recommendations and identifies next steps that are commensurate with results	Makes recommendations and identifies next steps beyond the scope of the project but which have other relevance

GLO #1 SCORE: _____/30

PERFORMANCE TARGET: 20/30

GLO #2: Students communicate technical information.

Score	Criteria	1 Does Not Meet Expectations	2 Meets Expectations	3 Exceeds Expectations
	Document conforms to format specified by the Graduate School (style, font size and type, margins, spacing, pagination, numbering, and organization)	Does not conform to format specified by the Graduate School	Conforms to format specified by the Graduate School	N/A
	Referencing format conforms to discipline standards	Does not conform to referencing format of the discipline	Conforms to referencing format of the discipline	N/A
	Quality of content, organization, and coherence of writing is at a level expected of professional publications	Is not at a level expected of professional publications; needs extensive revision	Is at a level expected of professional publications with minor or no revision	N/A

GLO #2 SCORE: _____/6

PERFORMANCE TARGET: 6/6

TOTAL SCORE: _____/36

PERFORMANCE TARGET: 26/36 (72%)

COMMENTS (required for total score < 26/36 or for any criterion with a score of 1):

The William States Lee College of Engineering
Graduate Student Learning Outcomes: *Oral Presentations*
 (Rev. 10/4/11)

GLO #1: Students analyze and evaluate advanced topics in engineering.				
Score	Criteria	1 Does Not Meet Expectations	2 Meets Expectations	3 Exceeds Expectations
	<i>Describes the scope and context of the defined problem</i>	Does not adequately describe the scope and context of the problem; important details are missing	Adequately describes the scope and context of the problem; sufficient level of detail is provided	Comprehensively describes the scope and context of the problem; level of detail offers additional breadth, depth, and/or new insights
	<i>Demonstrates existing knowledge and emerging research on the topic</i>	Does not adequately demonstrate knowledge of existing and emerging research on the topic; important details are missing	Adequately demonstrates knowledge of existing and emerging research on the topic; sufficient level of detail is provided	Comprehensively describes existing and emerging research on the topic; level of detail offers additional breadth, depth, and/or new insights
	<i>Compares and contrasts relevant aspects of the topic</i>	Does not adequately compare/contrast relevant aspects of the topic; important similarities or distinctions are missing	Adequately compares/contrasts relevant aspects of the topic; sufficient level of similarities and distinctions are provided	Comprehensively compares/ contrasts relevant aspects of the topic; level of detail in similarities and distinctions offers additional breadth, depth, and/or new insights

Score	Criteria	1 Does Not Meet Expectations	2 Meets Expectations	3 Exceeds Expectations
	<i>Evaluates scope of analytical methods/tools and selects the most appropriate one(s)</i>	Does not adequately evaluate the scope of analytical methods/tools and/or did not select the most appropriate one; some viable options were not considered or the best was not chosen	Adequately evaluates the scope of analytical methods/tools and selected the most appropriate one; all obvious options were considered and the best was chosen	Comprehensively evaluates the scope of analytical methods/tools and selected the most appropriate one; new or optional analytical tools were also considered and the best was chosen
	<i>Identifies assumptions and constraints relevant to the analytical methods/tools selected</i>	Does not adequately identify assumptions and constraints relevant to the analytical method selected; important assumptions or constraints are missing	Adequately identifies assumptions and constraints relevant to the analytical method selected; all obvious assumptions and constraints are identified	Comprehensively identifies assumptions and constraints relevant to the analytical method selected; assumptions and constraints beyond the obvious offer additional breadth, depth, and/or new insights
	<i>Develops an appropriate model for analysis</i>	Does not adequately develop an appropriate model for analysis; important aspects of the model are missing or extraneous aspects are included	Adequately develops an appropriate model for analysis; all obvious aspects of the model are included and justified	Comprehensively develops an appropriate model for analysis; new and relevant aspects of the model offer additional breadth, depth, and/or new insights
	<i>Analyzes topic beyond the previous level of coursework (BS or MS)</i>	Does not adequately analyze topic at the MS/PhD level; important aspects of analysis/evaluation is missing	Adequately analyzes topic at the MS/PhD level; sufficient level of analysis/evaluation is provided	Comprehensively analyzes topic at the MS/PhD level; level of analysis/evaluation offers additional breadth, depth, and/or new insights

Score	Criteria	1 Does Not Meet Expectations	2 Meets Expectations	3 Exceeds Expectations
	<i>Evaluates topic beyond the previous level of coursework (BS or MS)</i>	Does not adequately evaluate topic at the MS/PhD level; important aspects of analysis/evaluation is missing	Adequately evaluates topic at the MS/PhD level; sufficient level of analysis/evaluation is provided	Comprehensively evaluates topic at the MS/PhD level; level of analysis/evaluation offers additional breadth, depth, and/or new insights
	<i>Interprets results within the scope and context of the defined problem</i>	Does not adequately interpret results within the scope and context of the defined problem; interpretation is incomplete or lacks rationale	Adequately interprets results within the scope and context of the defined problem; interpretation is complete and rational	Comprehensively interprets results within the scope and context of the defined problem; interpretation is complete, rational, and offers additional breadth, depth, and/or new insights
	<i>Makes appropriate recommendations and/or identifies next steps</i>	Does not make recommendations or identify next steps <i>or</i> recommendations and next steps are not justified based on results	Makes recommendations and identifies next steps that are commensurate with results	Makes recommendations and identifies next steps beyond the scope of the project but which have other relevance

GLO #1 SCORE: _____/30

PERFORMANCE TARGET: 20/30

The William States Lee College of Engineering
Graduate Student Learning Outcomes: Exams*
 (Rev. 10/4/11)

GLO #1: Students analyze and evaluate advanced topics in engineering.				
Score	Criteria	1 Does Not Meet Expectations	2 Somewhat Meets Expectations	3 Meets Expectations
	<i>Represents the problem schematically, graphically, or figuratively</i>	Does not include a schematic, graph, or figure	Includes a schematic, graph, or figure but it is incomplete and/or contains some incorrect information	Includes a schematic, graph, or figure that is complete and correct
	<i>Identifies appropriate assumptions and constraints</i>	Does not include assumptions and constraints or they are incorrect	Includes assumptions and constraints but they are incomplete or contain some incorrect information	Includes assumptions and constraints that are complete and correct
	<i>Identifies appropriate governing equation(s)</i>	Identifies governing equations that are incorrect or incomplete	Identifies governing equations that are partially correct or complete	Identifies governing equations that are entirely correct and complete
	<i>Develops an appropriate model for analysis</i>	Does not adequately develop an appropriate model for analysis; important aspects of the model are missing or extraneous aspects are included	N/A	Adequately develops an appropriate model for analysis; all obvious aspects of the model are included and justified
GLO #2 SCORE: _____/12			PERFORMANCE TARGET: 9/12	

* Master's comprehensive and Ph.D. qualifying

GLO #2: Students communicate technical information.				
Score	Criteria	1 Does Not Meet Expectations	2 Meets Expectations	3 Exceeds Expectations
	<i>Evaluates scope of analytical methods/tools and selects the most appropriate one(s)</i>	Does not adequately evaluate the scope of analytical methods/tools and/or did not select the most appropriate one; some viable options were not considered or the best was not chosen	N/A	Adequately evaluates the scope of analytical methods/tools and selected the most appropriate one; all obvious options were considered and the best was chosen
	<i>Analyzes topic beyond the BS level</i>	Does not adequately analyze topic at the MS level; important aspects of analysis/evaluation is missing	N/A	Adequately analyzes topic at the MS level; sufficient level of analysis/evaluation is provided
	<i>Correctly solves the problem</i>	Provides a solution that is incomplete or incorrect	Provides a solution that is partially correct or complete	Provides a solution that is entirely correct and complete
GLO #2 SCORE: _____/9		PERFORMANCE TARGET: 8/9		
TOTAL SCORE: _____/21		PERFORMANCE TARGET: 17/21 (81%)		
COMMENTS (required for total score < 17/21 or for any criterion with a score of 1):				

* Master's comprehensive and Ph.D. qualifying