



**PCC Proposal to Establish a Post-Baccalaureate Certificate in Wireless Communications (PCC ID #16055)**

**PRESENTED BY** Dylan Roby, Chair

**REVIEW DATES** SEC – August 29, 2017 | SENATE – September 6, 2017

**VOTING METHOD** In a single vote

**RELEVANT POLICY/DOCUMENT** N/A

**NECESSARY APPROVALS** Senate, President, Chancellor, Maryland Higher Education Commission (MHEC)

**ISSUE**

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The A. James Clark School of Engineering and Department of Electrical and Computer Engineering propose to establish a 12-credit Post-Baccalaureate Certificate in Wireless Communications. This certificate program will be for students who are enrolled in the Master of Science in Telecommunications program. As cellular wireless communication networks and wireless local area networks continue to evolve, there is an increasing need for engineers who can deploy, configure, maintain, and trouble-shoot wireless networks.

Each student must complete four courses from the following list (at least two must be at the 700-level):

- ENTS657 Satellite Communication Systems
- ENTS689F Special Topics: Fundamentals of Wireless LANs
- ENTS689L Special Topics: Cellular Network Infrastructure-Cell Site Design and Components
- ENTS689W Special Topics: Short-range Wireless Systems
- ENTS659X Special Topics in Communications series
- ENTS749X Advanced Topics in Communications series

This proposal was approved by the Graduate School Programs, Curricula, and Courses committee on March 17, 2017, and was approved by the Senate Programs, Curricula, and Courses committee on May 5, 2017.

**RECOMMENDATION(S)**

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The Senate Committee on Programs, Curricula, and Courses recommends that the Senate approve this new certificate program.

**COMMITTEE WORK**

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The committee first considered this proposal at its meeting on April 7, 2017. The committee recommended changes to the proposal. The revised proposal was presented to the committee on

May 5, 2017. Zoltan Safar, director of the Master of Science in Telecommunications program, presented the proposal. The revised proposal was unanimously approved by the committee.

## **ALTERNATIVES**

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The Senate could decline to approve this new certificate program. If the Senate declines to approve this certificate program, students in the Master of Science in Telecommunications program will lose an opportunity to have their focus in wireless communications formally recognized.

## **RISKS**

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There are no risks to the University.

## **FINANCIAL IMPLICATIONS**

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There are no significant financial implications with this proposal.

**THE UNIVERSITY OF MARYLAND, COLLEGE PARK  
PROGRAM/CURRICULUM/UNIT PROPOSAL**

- Please email the rest of the proposal as an MSWord attachment to [pcc-submissions@umd.edu](mailto:pcc-submissions@umd.edu).

PCC LOG NO.

16055

- Please submit the signed form to the Office of the Associate Provost for Academic Planning and Programs, 1119 Main Administration Building, Campus.

**College/School: A. James Clark School of Engineering**

Please also add College/School Unit Code-First 8 digits:

Unit Codes can be found at: [https://hypprod.umd.edu/Html\\_Reports/units.htm](https://hypprod.umd.edu/Html_Reports/units.htm)

**Department/Program: Department of Electrical and Computer Engineering/Master's in Telecommunications program**

Please also add Department/Program Unit Code-Last 7 digits:

**Type of Action (choose one):**

- |   |  |
|---|--|
| <input type="checkbox"/> Curriculum change (including informal specializations)     | <input checked="" type="checkbox"/> <i>New academic degree/award program</i> |
| <input type="checkbox"/> <i>Renaming of program or formal Area of Concentration</i> | <input type="checkbox"/> New Professional Studies award iteration            |
| <input type="checkbox"/> <i>Addition/deletion of formal Area of Concentration</i>   | <input type="checkbox"/> New Minor   |
| <input type="checkbox"/> <i>Suspend/delete program</i>                              | <input type="checkbox"/> Other   |

*Italics indicate that the proposed program action must be presented to the full University Senate for consideration.*

**Summary of Proposed Action: The Master's in Telecommunications program is proposing a new Graduate Certificate Program in Wireless Communications.**

**APPROVAL SIGNATURES - Please print name, sign, and date. Use additional lines for multi-unit programs.**

1. Department Committee Chair Dr. Zoltan Safar Zoltan Safar 02.16.17.
2. Department Chair Dr. Rama Chellappa for Rama Chellappa
3. College/School PCC Chair Jenna Bucci Jenna E. Bucci 3/7/17
4. Dean /Dr. Peter Kofinas Peter Kofinas 3/6/17
5. Dean of the Graduate School (if required) Jeffrey Franke Jeff Franke 4/17/2017
6. Chair, Senate PCC Andrew Harris Andrew Harris 4/7/17
7. University Senate Chair (if required) \_\_\_\_\_
8. Senior Vice President and Provost \_\_\_\_\_

## Proposal to Establish a Graduate Certificate in Wireless Communications

### I. OVERVIEW

#### A. Overview and Rationale

Established in 1992, the Master of Science in Telecommunications (ENTS) program provides a unique cross-disciplinary industry-oriented graduate education in telecommunications. It is run jointly by the Department of Electrical and Computer Engineering in the A. James Clark School of Engineering and the Robert H. Smith School of Business. Combining rigorous technical education with invaluable business insight and entrepreneurial skills, the ENTS program offers students a unique perspective on the telecommunications industry and profession. The ENTS program caters to both full-time students and working professionals. Most ENTS courses are offered once a week and are scheduled in the afternoon or evening to suit working professionals, while some courses additionally offer daytime sections. All ENTS courses are “traditional” (residential) courses; the program does not offer off-campus locations or online options. ENTS students are responsible for a differential tuition rate and the program is considered a self-support unit within the University of Maryland. Currently, approximately 240 students are enrolled and approximately 110-120 MS degrees are awarded each year.

To be considered for admission, applicants to the ENTS program must have earned a bachelor’s degree, typically in a technical field (engineering, computer science, etc.) and have an undergraduate GPA of 3.0. Applicants must also submit a personal statement and three letters of recommendation. To earn the MS in Telecommunications degree, students must successfully complete 30 credits of course work (10 three-credit courses) with a GPA of 3.0 or more and a scholarly paper. A typical ENTS student takes 6-8 core courses (up to 2 of the 8 core courses may be waived if justified) and 2-4 elective courses.

The ENTS program is taught by full-time and part-time instructors employed by the Electrical and Computer Engineering Department and the Robert H. Smith School of Business. They all hold PhDs in their respective fields (engineering/computer science or business), and they all have worked in the industry for several years and have considerable industrial experience.

Smart phones and other portable wireless devices have become ubiquitous, and their designs frequently experience technological advancements. As cellular wireless communication networks evolve from 4G to 5G and wireless local area networks evolve from IEEE 802.11n to 802.11ac and ad, the wireless industry needs engineers who can deploy, configure, maintain, and trouble-shoot these new wireless networks. The increased demand for higher data rates and better quality of service, especially indoors, will create demand for wireless engineers well versed in RF engineering, propagation modeling and system design, multi-antenna transmission technologies and distributed antenna systems (DASs).

We propose the creation of a Graduate Certificate Program in Wireless Communications embedded in the ENTS program. The Certificate Program will be offered to current ENTS students, and its aim is to provide official recognition for acquiring focused knowledge in a particular subfield of telecommunications. Over the past years, many of our students opted to take additional electives (i.e. electives in addition to meeting the minimum degree requirements) to improve their skill sets and their marketability to employers after graduation. This trend is beneficial to both students and the program as it results in better prepared and more marketable graduates with stronger, focused technical background, thus improving the quality of our graduates. This enhances their transcripts, resumes, and chances of finding employment or promotion in their current employment, further improving the reputation of the ENTS program and its alumni base. We would like to encourage, organize and recognize such efforts by offering the Graduate Certificate in Wireless Communications, a well-defined, focused area within telecommunications. The certificate will be comprised of existing ENTS elective courses, which include special topics and advanced topics courses in wireless communications. Within the telecommunications industry, certificates are widely accepted proof of expertise in a given technical subfield such as routing, computer security, etc. A Graduate Certificate is an appropriate recognition for the additional coursework, time and effort the student needs to invest to obtain the knowledge/expertise. The Graduate Certificate in Wireless Communications will be one of the several proposed certificates designed to strengthen the ENTS program.

The aim of the Graduate Certificate in Wireless Communications is to encourage the students to acquire specialized knowledge and skills in the technical area of wireless communications. We have positioned this Certificate to allow the students to further deepen their understanding of wireless communication technologies, and become specialists in this sub-field of telecommunications. While going through the certificate program, students will also acquire/develop additional practical problem-solving and analytical skills and become proficient in using one or more industry-standard RF and wireless network design and testing tools. Typical industry positions our students take after graduation that would benefit from this Certificate include: RF engineer, wireless test engineer, RF analyst, and specialist RAN engineer. (RF stands for radio frequency, and RAN stands for Radio Access Network.)

The Master's in Telecommunications program is unique to the University System of Maryland, and thus adding certificate programs for current ENTS students would not replicate or detract from any existing programs. Since the ENTS program specializes in Telecommunications, we offer a wide range of special-topics and advanced-topics courses in Wireless Communications that no other units offer. The ENTS electives will serve as the basis for the proposed Graduate Certificate Program.

The University of Colorado Boulder offers the "Interdisciplinary Telecom Program" (ITP). UCB has marketed ITP as "a highly-integrated and comprehensive program combining technology, policy, and business with hands-on experience." As a peer program to the ENTS, ITP offers a Master of Science in Telecom. MS students have the option to pursue "tracks" in network

engineering, wireless engineering, network security and telecom policy. These tracks enable students to tailor the technical content of their degree to prepare themselves for careers in industry. Embedded with the tracks is the opportunity for students, who complete the requirements, to earn the corresponding 12-credit Graduate Certificate. Students may be awarded the certificate while completing the MS degree. ITP also offers the Graduate Certificates to non-degree seeking students. The Graduate Certificates include: Computer and Network Security; Network Architecture; Telecom Policy and Strategy; and Wireless Networks and Technologies.

The Graduate Certificate in Wireless Communications allows ENTS students to have the option of enhancing their MS degree with specific technical knowledge and also enable them to remain competitive in the marketplace with graduates from similar degree programs at peer institutions.

Additional information:

<http://www.colorado.edu/itp/>

<http://www.colorado.edu/itp/masters-degree>

<http://www.colorado.edu/itp/prospective-students/graduate-certificates>

## **B. Student Audience**

The Certificate in Wireless Communications will only be available to current ENTS students. For a typical ENTS student, this will mean taking 1-2 extra electives in addition to the courses taken to satisfy the MS degree requirements.

Based on the results of a survey we have recently conducted among current ENTS students, there is a significant interest in obtaining Graduate Certificates. Out of 58 responses, 46.6% found a Graduate Certificate very valuable to their portfolios, and 36.2% found it somewhat valuable. Demonstrating their interest, 58.6% responded that they would most definitely obtain a Graduate Certificate if offered, and 32.8% responded that they would most likely obtain one. Finally, 37.9% of the responding students showed interest in obtaining a Graduate Certificate in wireless communications.

We also reached out to 39 ENTS alumni to poll their opinions on the value a Graduate Certificate program. Out of 24 responses, 54.2% found it very valuable, and 37.5% found it somewhat valuable to their portfolios. We also asked if they would encourage current ENTS students to obtain a Graduate Certificate if it was offered, and 45.8% responded “yes, most definitely”, and 41.7% responded “yes, most likely”. Out of the responding alumni, 62.5% responded that they found a Graduate Certificate in the area of wireless communications valuable.

## **C. Eligibility**

Enrollment in this program will be limited to ENTS students, so the admission requirements are the same as the ENTS program’s.

## II. CURRICULUM

### A. Title

The proposed title is: Graduate Certificate in Wireless Communications.

### B. Structure and Course Requirements

The ENTS program has grouped its electives into course series according to specialization areas within telecommunications. The course series relevant to wireless communications are Special Topics in Communications and Advanced Topics in Communications. These courses series will be included in the certificate program in order to maintain dynamic and up-to-date program offerings. New courses are offered almost every year to effectively respond to the dynamic changes in the telecommunications industry and to produce graduates who are well versed in the latest technology and telecommunications industry trends. At the end of this section, we will provide an example set of courses satisfying the certificate requirements based on our Spring 2015 and Fall 2015 offerings.

The Graduate Certificate in Wireless Communications is a 12-credit program, by coursework only. The courses taken to earn the Graduate Certificate may also be counted toward meeting the MS degree requirements, and the MS degree and the Graduate Certificate may be earned and awarded in the same semester. Each student must complete four 3-credit courses from the following course list; at least two must be at the 700-level.

- ENTS 657: Satellite Communication Systems (Only if it is taken as an elective, and not as a core course.)
- ENTS 689F Special Topics: Fundamentals of Wireless LANs
- ENTS 689L Special Topics: Cellular Network Infrastructure- Cell Site Design and Components
- ENTS 689W Special Topics: Short-range Wireless Systems
- 659X Series: Special Topics in Communications
- 759X Series: Advanced Topics in Communications

Course Descriptions:

#### **ENTS 657: Satellite Communication Systems**

An examination of satellite telecommunication systems with an emphasis on the mobile satellite systems (MSS). Topics will include a historical perspective, orbital mechanics and constellations, choice of orbital parameters, propagations considerations, link budgets, interference issues and other obstacles, and existing and proposed mobile satellite systems. It will also look at some of the business aspects such as the cost of deploying and maintaining these systems.

### **ENTS 689F Special Topics: Fundamentals of Wireless LANs**

Wireless LAN protocols (802.11 family) are at the foundation of this course. This course covers engineering concepts and business-practices related to Wireless LAN technologies. The first half of the course will go into engineering details of Wireless LAN protocols (802.11 b,g,a and n). Starting with the basics of radio technologies used for Wireless LANs to deployment related issues like site-survey and RF-efficient installation of antennas will be covered. MAC layer frames and communication will be taught in great details. Key features of 802.11n - MIMO, Radio Chains, Spatial Multiplexing and Transmit Beam Forming will be studied. In the second half of the course, Wireless LAN Security will be covered with an examination of current practices and standards in use (WEP/WPA, RADIUS, AES, 802.11i, 802.1x). New addition to the course is 802.11 “ac” and “ad” protocols which are the latest initiatives in WLAN industry. 802.11 protocols will be compared with DAS (Distributed Antenna Systems), Femto Cells and 802.22 (Super Wi-Fi). Throughout the semester, students will be required to practice class-room learning through hands-on projects. Industry-accepted software and hardware based tools for WLAN Site Survey, Design and Deployment, Network Optimization, Spectrum Analysis and Packet Sniffing will be provided to the students to work on group projects. Class presentations on each project by each group will ensure familiarity and learning of all the tools for every student.

### **ENTS 689L Special Topics: Cellular Network Infrastructure- Cell Site Design and Components**

This course will familiarize the students with different elements of the cellular eco-system. After going through the fundamentals of cellular communication, this course will provide in-depth understanding of various in-line RF equipments, starting from Base Station (BTS) inside the shelter of a cell-site to the antennas mounted on the tower and all other components in-between, including and not limited to, power amplifiers, tower mounted amplifiers (TMAs), filters, combiners, multiplexers, diplexers, bias tees, cable connectors and lightening protectors. Applications, limitations, and troubleshooting of various RF inline components will be studied through hands-on exercises. Students will get the opportunity to learn antenna and cable sweeping measurements through Anritsu test-gear. Towards the end of the class, a field-trip to a live cell-site will be scheduled where we will be able to see all the RF components in action and relate the RF theories to the practical applications.

### **ENTS 689W Special Topics: Short-range Wireless Systems**

Prerequisite: ENTS 622. This course will cover the physical layer characteristics and performance of wireless LAN technologies including ZigBee (IEEE 802.15.4), prominent 802.11 standards, and Bluetooth. The course focuses on the modeling and implementation of physical layer aspects of these technologies, such as channel characteristics, modulation techniques and packet and frame synchronization, carrier recovery and symbol synchronization, ranges and data rates.

## **ENTS659X Series: Special Topics in Communications**

### **ENTS 659A Special Topics in Communications: Wireless Communications System Design and Simulation**

This course is oriented towards practical detailed waveform simulation of transmitter/receivers which has been adopted by the industry as a first step in implementation of communications systems on software defined radios. During this course we use a communication standard (11 Mb/s and 54 Mb/s 802.11 for example) to cover practical implementation of communication concepts and modules. The goal of this course is to develop and test individual transceiver modules throughout the course and integrate them to build an end to end transceiver. The performance of the end to end system will be tested using channel models (AWGN, Frequency Selective and Frequency Non-Selecting Channels) developed during the course with a special attention on the concept of noise power, oversampling, and Doppler spread. The course will cover modulator/demodulator, frequency and time synchronization, channel equalization, and channel coding and decoding modules in great detail.

### **ENTS 659B Special Topics in Communications: Microwave Radio Communications Systems**

This course will study the design, deployment and coordination of point-to-point microwave communications systems. Emphasis will be placed on the use of microwave systems as backhaul for modern cellular networks to support increasing data demands. Topics will include modulation, equipment, design strategies, fade margins, interference, and coordination and implementation issues. Students will use industry-leading professional design software to perform RF-path analysis and design backhaul capacity networks. Through real-world case-studies, students will be exposed to professional coordination methods. Grades will be determined based on performance on exams and projects.

### **ENTS 659M Special Topics in Communications: Intelligent Wireless Technologies**

Communications principles for adaptive intelligent systems. This course will cover the communications components of Machine-to-Machine (M2M) technologies, Intelligent Transportation Systems (ITS), and Smart Grid Systems. Within M2M, students will learn about the Internet of Things (IoT) architectures, standards, services, peer discovery, spectrum resource allocation, interference coordination and management, internet geolocation, and location-based services. The course will then focus on ITS, automotive control area networks (CAN), road-based vehicular ad-hoc network (VANET), and inter-vehicle communication systems. The final segment of the course will turn to Smart Grid, narrowband power line communication in smart grid applications, event-driven and hybrid communication between meters, data traffic scheduling, and capacity of a wireless backhaul for the distribution level, and data aggregating. The course will emphasize lower layer communications, and students will participate in a simulation project.

## **ENTS759X Series: Advanced Topics in Communications**

### **ENTS 759A Advanced Topics in Communications: 3G/4G Wireless Networks and Systems**

Prerequisite: ENTS 622 and permission from instructor. This course presents some of the key concepts and technologies used in the design of third generation (3G/3G+/4G) wireless networks and standards. The course is divided into three main areas of study. First, the course begins with an overview of 3G4G standardization process, key concepts and technologies including CDMA and OFDM principles, link adaptation and advanced antenna system followed by detailed discussion of their implementation into 3G/3G+ standards such as cdma2000/EV\_DO and WCDMA/HSPA. The third part of this course focuses on 4G specific technology elements and design principles followed by a detailed discussion on LTE air interface, channelization, protocol layers and signaling as well as network architecture. Throughout the course the emphasis on the rationalization of wireless technology evolution and similarities and difference in design requirements and solutions.

### **ENTS 759B Advanced Topics in Communications: Wireless OFDM Systems**

Prerequisite: ENTS 622 and ENTS 653 or 656. The main objective of the course is to introduce the most important concepts and technologies used in the design of current wireless OFDM systems, focusing on the physical layer. First, the basic principles of OFDM systems are presented: OFDM modulation/demodulation, role of the cyclic prefix, pilot symbols and preambles, transmit/receive filtering, RF impairments and their impact on performance, channel estimation, timing and synchronization. Then, the 3PP Long Term Evolution (LTE) standard is described in details as an example of a state-of-the-art wireless OFDM system, emphasizing its physical-layer aspects. As a part of the course work, the students will explore the design and implementation issues of an OFDM-based transceiver in Matlab.

### **ENTS 759C Advanced Topics in Communications: Optimization, Drivetesting, and Analysis of Modern Cellular Networks**

Prerequisite: ENTS 656 or ENTS 653 or permission of the instructor. Students must have a graduate level of understanding of cellular networks prior to taking this course. This course will focus on optimizing an operational 2G/3G network by collecting drivetest data and analyzing the results in detail. Students will learn to use drivetest equipment in a real-world environment and will study the behavior of both 2G and 3G networks in varying conditions. Students will also learn details of the GSM and UMTS physical and network layers as they relate to optimization.

### **ENTS 759D Advanced Topics in Communications: Distributed Antenna Systems (DAS) and Small Cells**

Prerequisite: ENTS 656 or ENTS 653. Distributed Antenna Systems (DAS) and small cells help solve the growing problem of coverage, capacity and spectrum crunch in the cellular

industry. This course will focus on DAS (70-80%) and small cell architecture (20-30%). It plans to cover comprehensive engineering details of DAS, recent technical advances, widely used RF practices, and open issues of the DAS and in-building coverage. We will study the architecture, capacity, connectivity and scalability aspects of DAS and small cells. In-building propagation models, fading and interference aspects along with PDPs will be covered in greater detail. We will also study essential elements of DAS infrastructure (antennas, repeaters, amplifiers, outdoor vs. indoor components, and backhaul options, etc.) For small cells, we will cover key technical components of HetNets and small cell deployments both indoors and outdoors. Students will use industry-leading professional DAS design software (iBWave or similar) to design and analyze an in-building network for optimal coverage and capacity. A final project, based on real-world problem from the industry will be assigned to students. Handful of lab-based assignments will be given to become familiar with the software before assigning the final project. Grades will be determined based on the performance on exams (midterm and final), assignments and final project.

An example course sequence:

1. **ENTS 659M Special Topics in Communications: Intelligent Wireless Technologies** (3 credits)
2. **ENTS 759A Advanced Topics in Communications: 3G/4G Wireless Networks and Systems** (3 credits)
3. **ENTS 759C Advanced Topics in Communications: Optimization, Drive-testing, and Analysis of Modern Cellular Networks** (3 credits)
4. **ENTS 759D Advanced Topics in Communications: Distributed Antenna Systems (DAS) and Small Cells** (3 credits)

### III. STUDENT LEARNING OUTCOMES AND ASSESSMENT MEASURES

Since this graduate certificate program will be embedded in the standard ENTS curriculum, the learning outcomes will also be similar to those of the ENTS program. The items relevant to the Graduate Certificate Program are as follows:

1. Academic outcome goals:
  - Students acquire specialized knowledge and skills in the technical area of wireless communications.
  - Students acquire/develop practical problem-solving, programming and analytical skills necessary to succeed in industry.
2. Academic outcome assessment measures:
  - Percentage of students mastering the foundations of wireless communication systems, protocols and standards: cellular concept, RF propagation indoors and/or outdoors, link budgets, coverage and capacity optimization, GSM, WCDMA, HSPA, CDMA2000, LTE, LTE-A, WLAN/Wifi standards such as IEEE 802.11a/b/g/n/ac/ad.
  - Percentage of students who work on course-related projects requiring programming

- Percentage of students acquiring hands-on lab or field experience using state-of-the-art wireless measurement and test equipment, RF design tools (indoor and/or outdoor), wireless trouble-shooting and performance evaluation tools.
3. Non-academic outcome goals:
    - Diversity: The ENTS program promotes diversity and strives to admit and educate a diverse student population.
    - Degree completion and student retention: The ENTS program will make every effort to help its students from admission to degree completion and minimize the number of students who leave the program without a degree.
    - Quality of learning experience: The ENTS program will actively improve the student experience and increase its perceived value.
  4. Non-academic outcome assessment measures:
    - Diversity: Percentage of female students; percentage of female faculty /instructors; percentage of minority faculty /instructors
    - Degree completion and student retention: Percentage of students who obtain the graduate certificate within two years after entering the program
    - Quality of learning experience: Graduate student to faculty ratio in the classroom; number of students receiving education in state-of-the-art facilities/labs or using state-of-the-art tools; number of offered elective courses in wireless communications.

#### **IV. PROGRAM ADMINISTRATION**

Administrative oversight and program management will be provided by ENTS staff. This includes student services, academic advising, marketing and outreach, program evaluation and assessment, and degree requirement verification.

##### **A. Program Faculty**

The courses for this certificate program are all ENTS courses, so they will be taught by ENTS instructors.

##### **B. Program Offerings**

The program will be wholly residential. There will be no off-campus locations nor distance/online education components.

#### **IV. FINANCE (Budget Resources)**

The ENTS program is a self-support unit and the Graduate Certificate in Wireless Communications program will be administered through its resources.

#### **V. ADDITIONAL RESOURCES**

##### **A. Library**

No additional resources are needed. See library assessment (Appendix A.)

**B. Facilities**

No new facilities are required.

**C. Outside Academic Units**

This program will not rely upon courses provided through other academic units.

**D. Personnel**

No new personnel are required. The new program will involve a small increase in administrative work for some staff. Existing staff members have experience in handling ENTS student records.



February 13, 2017

VPAC - PCC Committees  
University of Maryland  
College Park, MD 20742

To whom it may concern:

The R. H. Smith School of Business hereby expresses its support for the new initiatives of the MS in Telecommunications Program to establish graduate certificate programs in (a) Networking Software Development, (b) Wireless Communications and (c) Computing. It is understood that the Electrical and Computer Engineering Department will be responsible for managing all aspects of the above certificate programs as they are based on technical/engineering discipline rather than business discipline.

Sincerely,



Michael Faulkender  
Associate Dean, Masters Programs  
R. H. Smith School of Business  
University of Maryland

DATE: February 7, 2017

TO: Leah Grosse  
Program Coordinator, Masters in Telecommunication Program

FROM: On behalf of the University of Maryland Libraries:  
Elizabeth Soergel, Engineering Librarian  
Maggie Saponaro, Head of Collection Development  
Daniel Mack, Associate Dean, Collection Strategies & Services

RE: Library Collection Assessment

We are providing this assessment in response to a proposal by the Department of Electrical and Computer Engineering's Masters in Telecommunications program in the A. James Clark School of Engineering to create a Graduate Certificate in Wireless Communications. The Masters in Telecommunications program asked that we at the University of Maryland Libraries assess our collection resources to determine how well the Libraries support the curriculum of this proposed program.

### **Serial Publications and Research Databases**

The University of Maryland Libraries currently subscribe to a large number of scholarly journals—almost all in online format—that focus on telecommunications, including wireless communications. Most articles in journals that we do not own electronically are available through either the Libraries' Scan and Deliver program or via Interlibrary Loan. The Libraries' "Database Finder" offers online access to databases that provide indexing and access to popular and scholarly journal articles, and other information sources. Many of these databases cover subject areas that would be relevant to this proposed graduate certificate. These databases can be accessed remotely by authenticating using UMD login credentials.

Most of the relevant research is available through the following databases to which the Libraries subscribe:

- IEEEExplore
- ACM Digital Library
- Web of Science

In addition, the general, multidisciplinary database Academic Search Complete provides information for nearly every area of academic study, including wireless communications.

Academic Search Complete includes an enormous collection of the most valuable peer-reviewed full text journals, as well as additional journals, magazines, newspapers and books.

As noted previously, in those instances in which either the Libraries do not subscribe to the journal or the journal articles are available only in print format, the Libraries can supply copies through the Libraries' Scan and Deliver program or via Interlibrary Loan.

## **Monographs**

The Libraries regularly acquire scholarly monographs in wireless communications and allied subject disciplines. The UMD Libraries' acquisition policies and budgets are expected to ensure scholarly books about wireless communications continue to be added to the collection. As the University of Maryland already has a robust tradition of acquiring materials related to telecommunications, current collection development practices in the Libraries should adequately support the new graduate certificate in wireless communication. Monographs not already part of the collection can usually be added upon request.

Monographs are typically purchased in electronic format, but the Libraries have a large collection of print materials related to wireless communications. Students will be able to take advantage of the print book collection by checking out these items or requesting specific chapters be sent to them through the Libraries' Scan and Deliver program. Faculty can also request, within fair use copyright guidelines, that sections of print books be made available digitally through course reserves.

## **Scan and Deliver and Interlibrary Loan**

The Scan and Deliver program (<http://www.lib.umd.edu/access/scan-deliver>) mentioned above allows students to request chapters of books or journal articles that the University Libraries own in print. Digital copies of these resources are sent directly to the student. For materials not owned by the University Libraries, students can request either digital or physical delivery of bibliographic materials that otherwise would not be available to the UMD community via Interlibrary Loan (<http://www.lib.umd.edu/access/ill-classic>). As a member of the Big Ten Academic Alliance, UMD students have access to physical materials from other institutions in the Big Ten. These items can be requested through the UBorrow service (<http://www.lib.umd.edu/access/uborrow>) and users typically receive the items within one week. Scan and Deliver and Interlibrary Loan are available free of charge.

## **Conclusion**

The University of Maryland Libraries' serials holdings and research databases have an established record for providing bibliographic support for researchers and professionals in subject disciplines that are relevant to telecommunications and wireless communications. These materials are supplemented by relevant monograph collections. In addition, the Libraries' Scan

and Deliver and Interlibrary Loan services make materials that otherwise would not be available online or through the UM Libraries. The Libraries also offer students a wide range of services to ensure their success. Additionally, the libraries are already supporting the Master of Science in Telecommunications, so no additional library resources should be necessary for the proposed graduate certificate, which compliments the Masters program. As a result, our assessment is that the University of Maryland Libraries are able to meet the curricular and research needs of the proposed Graduate Certificate in Wireless Communications.