2012-2013 LONG SIGNATURE SHEET

Proposal Number: _ECE-09-22⦁2014_

Proposal Title: _ECGR 6181/8181 Embedded Operating Systems_

Originating Department: _Electrical and Computer Engineering_

UNC CHARLOTTE

TYPE OF PROPOSAL: UNDERGRADUATE_____   GRADUATE ✓_____   UNDERGRADUATE & GRADUATE_____
(Separate proposals sent to UCCC and Grad. Council)

DATE RECEIVED	DATE CONSIDERED	DATE FORWARDED	ACTION	SIGNATURES
			Approved	**DEPARTMENT CHAIR** _[signature]_ [print name here:] ASIS NASIPURI
			Approved	**COLLEGE CURRICULUM COMMITTEE CHAIR** TAO HONG [print name here:] _[signature]_
			Approved	**COLLEGE FACULTY CHAIR (if applicable)** [print name here:]
	2/24/16	·	Approved	**COLLEGE DEAN** _[signature]_ [print name here:]
			Approved	**GENERAL EDUCATION** (if applicable; for General Education courses) [print name here:]
			Approved	**UNDERGRADUATE COURSE & CURRICULUM COMMITTEE CHAIR** (for undergraduate courses only)
3/9/16	4/5/16		Approved	**GRADUATE COUNCIL CHAIR** (for graduate courses only) _Rob Roy McGregor_ Rob Roy McGregor
				FACULTY GOVERNANCE ASSISTANT (Faculty Council approval on Consent Calendar)
				FACULTY EXECUTIVE COMMITTEE (if decision is appealed)

Revised 07/31/13
OAA/mjw

UNC CHARLOTTE

LONG FORM
COURSE AND CURRICULUM PROPOSAL

*To: Graduate Council

From: Arun Ravindran

Date: 10/08/2013

Re: Proposal for new graduate course

The Long Form is used for major curriculum changes. Examples of major changes can include: creation of a new major, creation of a new minor, creation of a new area of concentration, or significant changes (more than 50%) to an existing program (Note: changing the name of an academic department does not automatically change the name(s) of the degree(s). The requests must be approved separately by the Board of Governors.)

Submission of this Long Form indicates review and assessment of the proposed curriculum changes at the department and collegiate level either separately or as part of ongoing assessment efforts.

*Proposals for undergraduate courses should be sent to the Undergraduate Course and Curriculum Committee Chair. Proposals related to both undergraduate and graduate courses, (e.g., courses co-listed at both levels) must be sent to both the Undergraduate Course and Curriculum Committee and the Graduate Council.

University of North Carolina at Charlotte
Department of Electrical and Computer Engineering
Proposal for New Graduate Course
Proposal Number:

1.   Course number and title:
ECGR 6181/8181 Embedded Operating Systems

2.   Catalog Copy:
ECGR 6181/8181: Embedded Operating Systems (3). Prerequisite/Co-requisite: ECGR 4101/5101 (Embedded Systems), graduate standing, or permission of instructor.
The course introduces graduate students to fundamentals of embedded operating systems with an emphasis on real time performance. A series of labs provides students practical experience on bare metal programming, embedded Linux kernel configuration and initialization, boot loaders, kernel modules, device drivers, and interrupt handlers,
Two day lecture. *(Fall)*

3.   Pre- or Co-requisites:
Prerequisites: ECGR 4101/5101 (Embedded Systems), graduate standing, or permission of instructor.

4.   Objectives of the course:
Introduce computer engineers to topics in the design and implementation of embedded operating systems. The objective is to prepare students for design position in the industry and/or graduate research. The topics are consistent with the needs of industry and UNC Charlotte research focus areas. The following competencies should be imparted to the students
   1. Understanding of the fundamentals of operating systems
   2. Understanding of real time scheduling and synchronization algorithms
   3. Practical experience with customizing the Linux kernel

5.   Instructional method: Lecture
The instructional method is predominately professor lectures. This will be complemented by labs, and independent design projects.

6.   Means of student evaluation:
Assessment is by laboratory assignments, examinations and an independent design project. Students taking the course at the 8000 level will be assigned additional material on the literature review and the design project consistent with expectations for a doctoral student.

7.   Policies that apply to this course:
   University integrity guidelines must be followed.

Attendance is required.

Grading: Exams (50%), Labs (30%), and Project (20%). Grades will be assigned based on the total score at the end of the semester as follows - A (>= 90%), B (<90% and >= 80%), C (<80% and >= 70%), U (<70%)

The 8181 listing of the course is for doctoral students. For 8181, the project component of the course will include review of recently published research papers.

8.   Probable textbooks or resources:

"Operating Systems: Three Easy Pieces" by Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, Arpaci-Dusseau Books, ISBN 9781105979125, 2014.
(This book is available free in PDF form at http://pages.cs.wisc.edu/~remzi/OSTEP/)

"Computer Systems: A Programmer's Perspective" by Randal E. Bryant and David R. O'Hallaron, 3rd Edition, Prentice Hall, ISBN 978-0-13-409266-9, 2016.

References
"Linux Kernel Development", Robert Love. 3rd Edition, Addison-Wesley, ISBN-13: 978-0672329463, 2010.

9.   Topical outline of course content

Lecture 1: Data Representation
Lecture 2: Machine Level Programming
Lecture 3: Linking
Lecture 4: Processes & Scheduling
Lecture 5: Synchronization
Lecture 6: Virtual Memory
Lecture 7: File Systems & System-Level I/O
Lecture 8: Real Time Scheduling and Synchronization
Lecture 9: Network Programming

10.   Attachments

An operating system (OS) is responsible for managing the hardware resources and applications that run on a computer. A Real Time OS (RTOS) performs these tasks, but is also specially designed to run applications with strict timing requirements and a high degree of reliability. RTOSes are used in embedded applications such as consumer electronics, wired and wireless networking, industrial control, measurement, robotics, and medical devices. Linux dominates market share in embedded systems and is increasingly and the RTOS of choice for soft real time applications. This course introduces graduate students to fundamentals of embedded operating systems with an emphasis on real time systems.

The global market for embedded systems is expected to increase from $92.0 billion in 2008 to an estimated $112.5 billion by the end of 2013, at a compound annual growth rate of 4.1%. As a result, there is a national shortage of well-trained embedded system designers. This course introduces computer engineers to topics in the design and implementation of embedded operating systems with the goal of preparing students for design position in the industry and/or graduate research

Resources required to support proposal:

1. Personnel: Dr. Arun A. Ravindran (ECE) will perform all teaching responsibilities.
2. Physical Facilities: No new facilities required.
3. Equipment & Supplies: None.
4. Computers: Existing computer facilities will be sufficient.
5. Audio-Visual: None required, other than existing overhead and LCD projectors.
6. Other resources: None required.
7. Sources of funding: ECE to arrange for purchase of Dr. Arun A. Ravindran's instructional time.

Consultation with Library and Other Departments:

1. Library holdings are adequate
2. Other consulting units: None.

Initiation & Consideration of the Proposal:

Originating Unit: This proposal was submitted to the Department of Electrical and Computer Engineering (ECE).

Syllabus Cover

Embedded Operating Systems
ECGR 6181/8181

Instructor: Dr. Arun Ravindran   arun.ravindran@uncc.edu
Lecture hours:
Office hours:

Course Description
An operating system (OS) is responsible for managing the hardware resources and applications that run on a computer. A Real Time OS (RTOS) performs these tasks, but is also specially designed to run applications with strict timing requirements and a high degree of reliability. RTOSes are used in embedded applications such as consumer electronics, wired and wireless networking, industrial control, measurement, robotics, and medical devices. Linux dominates market share in embedded systems and is increasingly and the RTOS of choice for soft real time applications. This course introduces graduate students to fundamentals of operating systems with an emphasis on real time scheduling. A series of labs provides students practical experience on embedded Linux kernel configuration and initialization, boot loaders, kernel modules, device drivers, interrupt handlers, and file systems.

Lecture schedule (subject to change)

Lecture 1: Data Representation
Lecture 2: Machine Level Programming
Lecture 3: Linking
Lecture 4: Processes & Scheduling
Lecture 5: Synchronization
Lecture 6: Virtual Memory
Lecture 7: File Systems & System-Level I/O
Lecture 8: Real Time Scheduling and Synchronization
Lecture 9: Network Programming

Prerequisites
Embedded Systems – I (ECGR 4101/5101) or permission of instructor

Textbooks

"Operating Systems: Three Easy Pieces" by Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, Arpaci-Dusseau Books, ISBN 9781105979125, 2014.
(This book is available free in PDF form at http://pages.cs.wisc.edu/~remzi/OSTEP/)

"Computer Systems: A Programmer's Perspective" by Randal E. Bryant and David R. O'Hallaron, 3rd Edition, Prentice Hall, ISBN 978-0-13-409266-9, 2016.

References
"Linux Kernel Development", Robert Love. 3rd Edition, Addison-Wesley, ISBN-13: 978-0672329463, 2010.

Grading (subject to change)
Exams (50%), Labs (30%), and Project (20%). Grades will be assigned based on the total score at the end of the semester as follows - A ($>= 90\%$), B ($<90\%$ and $>= 80\%$), C ($<80\%$ and $>= 70\%$), U ($<70\%$)

The 8191 listing of the course is for doctoral students. For 8191, the project component of the course will include review of recently published research papers.

Academic Integrity Statement

All UNC Charlotte students have the responsibility to be familiar with and to observe the requirements of The UNC Charlotte Code of Student Academic Integrity (see the Catalog). This Code forbids cheating, fabrication or falsification of information, multiple submission of academic work, plagiarism, abuse of academic materials (such as Library books on reserve), and complicity in academic dishonesty (helping others to violate the Code). Any further specific requirements or permission regarding academic integrity in this course will be stated by the instructor, and are also binding on the students in this course. Students who violate the Code can be punished to the extent of being permanently expelled from UNC Charlotte and having this fact recorded on their official transcripts. The normal penalty is zero credit on the work involving dishonesty and further substantial reduction of the course grade. In almost all cases, the course grade is reduced to "F." If you do not have a copy of the Code, you can obtain one from the Dean of Students Office or access it online at www.legal.uncc.edu/policies/ps-105.html . Standards of academic integrity will be enforced in this course. Students are expected to report cases of academic dishonesty they become aware of to the course instructor who is responsible for dealing with them.

Diversity Statement

UNC Charlotte strives to create an academic climate in which the dignity of all individuals is respected and maintained. Therefore, we celebrate diversity that includes, but is not limited to ability/disability, age, culture, ethnicity, gender, language, race, religion, sexual orientation, and socio-economic status.

UNCCHARLOTTE

J. Murrey Atkins Library

Consultation on Library Holdings

To: **Arun Ravindran**

From: **Alison Bradley**

Date: **8/24/12**

Subject: **ECGR 6181/8181 Embedded Operating Systems**

Summary of Librarian's Evaluation of Holdings:

Evaluator: Alison Bradley   **Date: 8/24/12**

Check One:
1. Holdings are superior   _____
2. Holdings are adequate   __x__
3. Holdings are adequate only if Dept. purchases additional items.   _____
4. Holdings are inadequate   _____

Comments:
Library holdings should be adequate to support student research for this course (see list of items held by subject heading below). Students will have access to relevant databases including ACM Digital Library, IEEE Xplore, INSPEC, and Electronics & Communications Abstracts.

LC Subject Heading	Total items held
Embedded computer systems	97
Real-time data processing	157
Operating systems	361

Alison Bradley

Evaluator's Signature

8/24/12

Date

*Proposals for undergraduate courses and programs should be sent to the Undergraduate Course and Curriculum Committee Chair. Proposals related to both undergraduate and graduate courses, (e.g., courses co-listed at both levels) must be sent to both the Undergraduate Course and Curriculum Committee and the Graduate Council.

I. HEADING AND PROPOSAL NUMBER

A. HEADING.

University of North Carolina at Charlotte

New Graduate Course;

Course and Curriculum Proposal from: ECE

B. PROPOSAL NUMBER. ECE-09-22-2014

C. TITLE. Establishment of a new graduate course on embedded operating systems.

II. CONTENT OF PROPOSALS

A. PROPOSAL SUMMARY.

1. **SUMMARY**. The ECE Department proposes to add two cross-listed courses to the graduate curriculum: ECGR 6181 and ECGR 8181.

B. JUSTIFICATION.

1. The proposed course fulfills the lack of an embedded operating systems course in the ECE graduate curriculum.

2. Prerequisite: ECGR 4101/5101 or Permission of the Instructor

3. The course is offered at the 6xxx and 8xxx level for M.S. and Ph.D. students respectively.

4. The objective of the course is to prepare students for design position in the industry and/or graduate research. The topics are consistent with the needs of industry and UNC Charlotte research focus areas.

5. The course was taught 4 times previously as a special topics course with an average enrollment of 30.

C. IMPACT. Changes to courses and curricula often have impacts both within the proposing department as well as campus-wide. What effect will this proposal

have on existing courses and curricula, students, and other departments/units? Submit an Impact Statement that fully addresses how you have assessed potential impacts and what the impacts of this proposal might be. Consider the following:

1. What group(s) of students will be served by this proposal?
   Graduate students in ECE with an interest in embedded systems. The previous offerings of the course as a special topic generated considerable interest from the graduate students

2. What effect will this proposal have on existing courses and curricula?
   a. Once a year, typically in spring.
   b. The proposed course will not affect any existing courses
   c. Between 30 – 40 students.
   d. The course has been offered as a special topics in the last 4 years without any effect on the enrollment of other courses. The proposed course is important in serving the interests of the growing graduate program in ECE.
   e. No anticipated effect on other departments.

III. RESOURCES REQUIRED TO SUPPORT PROPOSAL.

When added resources are not required, indicate "none". For items which require "none" explain how this determination was made.

A. **PERSONNEL.** No new faculty is needed. The proposed course has been taught by existing faculty as special topics for the last four years. Dr. Arun A. Ravindran from ECE will be primarily responsible for teaching the proposed course.

B. **PHYSICAL FACILITY.** Yes.

C. **EQUIPMENT AND SUPPLIES:** No special equipment is required

D. **COMPUTER.** All software required in the proposed course are open source and are to be run on student owned computers.

E. **AUDIO-VISUAL.** None. (From past experience in teaching the proposed course as special topics)

F. **OTHER RESOURCES.** None. (From past experience in teaching the proposed course as special topics)

G. **SOURCE OF FUNDING.** ECE to arrange for purchase of Dr. Arun A. Ravindran's instructional time.

IV. CONSULTATION WITH THE LIBRARY AND OTHER DEPARTMENTS OR UNITS

A. **LIBRARY CONSULTATION.** See attached

B. **CONSULTATION WITH OTHER DEPARTMENTS OR UNITS**. NOT APPLICABLE

C. **HONORS COUNCIL CONSULTATION** NOT APPLICABLE

V. INITIATION, ATTACHMENTS AND CONSIDERATION OF THE PROPOSAL

A. **ORIGINATING UNIT**. Unanimously approved by the ECE departmental graduate committee

B. **CREDIT HOUR. (Mandatory if new and/or revised course in proposal)**
Review statement and check box once completed:
☒ The ECE departmental committee has reviewed the course outline/syllabus and has determined that the assignments are sufficient to meet the University definition of a credit hour.

C. **ATTACHMENTS**.
1. CONSULTATION: Attach relevant documentation of consultations with other units.

2. COURSE OUTLINE/SYLLABUS: For undergraduate courses attach course outline(s) including basic topics to be covered and suggested textbooks and reference materials with dates of publication. For Graduate Courses attach a course syllabus. Please see Boiler Plate for Syllabi for New/Revised Graduate Courses.

3. PROPOSED CATALOG COPY: Copy should be provided for all courses in the proposal. Include current subject prefixes and course numbers, full titles, credit hours, prerequisites and/or corequisites, concise descriptions, and an indication of when the courses are to be offered as to semesters and day/evening/weekend. Copy and paste the current catalog copy and use the Microsoft Word "track changes" feature (or use red text with "~~strikethrough~~" formatting for text to be deleted, and adding blue text with "underline" formatting for text to be added).

   a. For a new course or revisions to an existing course, check all the statements that apply:
   __X__ This course will be cross listed with another course.
   __X__ There are prerequisites for this course.
   _____ There are corequisites for this course.
   _____ This course is repeatable for credit.
   _____ This course will increase/decrease the number of credits hours currently offered by its program.
   _____ This proposal results in the deletion of an existing course(s) from the degree program and/or catalog.

For all items checked above, applicable statements and content must be reflected in the proposed catalog copy.

    b. If overall proposal is for a new degree program that requires approval from General Administration, please contact the facultygovernance@uncc.edu for consultation on catalog copy.

4. ACADEMIC PLAN OF STUDY (**UNDERGRADUATE ONLY**): Does the proposed change impact an existing Academic Plan of Study?
   ☐ Yes. If yes, please provide updated Academic Plan of Study in template format.
   ☐ No.

5. STUDENT LEARNING OUTCOMES (UNDERGRADUATE & GRADUATE): Does this course or curricular change require a change in Student Learning Outcomes (SLOs) or assessment for the degree program?
   ☐ Yes. If yes, please provide updated SLOs in template format.
   ☒ No.

6. TEXTBOOK COSTS: It is the policy of the Board of Governors to reduce textbook costs for students whenever possible. Have electronic textbooks, textbook rentals, or the buyback program been considered and adopted?
   ☒ Yes. Briefly explain below.
   One of the textbooks required for the course is available for free download.
   ☐ No. Briefly explain below.

IMPORTANT NOTE: A Microsoft Word version of the final course and curriculum proposal should be sent to facultygovernance@uncc.edu upon approval by the Undergraduate Course and Curriculum Committee and/or Graduate Council chair.