King Fahd University of Petroleum and Minerals
College of Computer Sciences and Engineering
Department of Computer Engineering

COE 499 Wireless Sensor Networks (3-0-3)

Instructor: Dr. Marwan Abu-Amara
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Term: 072 (2nd term 2007–2008)
Day & Time: UT 10:00 AM – 11:15 AM
Location: 24-125
Prerequisite: COE 344 (Computer Networks)
Textbook: *Networking Wireless Sensors*, B. Krishnamachari, Cambridge University Press, 1st Edition, 2005.
Office Hours: UMT 12:15 PM – 01:15 PM (or by appointment)
Web Site: http://www.ccse.kfupm.edu.sa/~marwan

Course Description:
The course will cover the new field of sensor networking. There will be 2 major exams, a final exam, written assignments, quizzes, and a team project. The topics covered include applications of sensor networks, MAC design, energy efficiency issues, routing and transport protocols for these networks, k-coverage issues, and security issues.

Objectives:
The course objective is to present in a unified and organized manner the most important recent advances in wireless ad hoc and sensors networks and research. The focus will not be on the particular technologies, but rather on the most fruitful research methodologies, the underlying fundamental limitations of these networks. The course is an excellent opportunity for students to be exposed to an area of research which is currently very active, and in which important advances are continuously being made.

Student Background:
Students are expected to have an excellent understanding of the network OSI model and very good mathematical and programming skills. Also, basic knowledge of probability theory is required.

Student Outcomes:
Upon the successful completion of this course students will be able to:
1. Identify the appropriate deployment approaches that ensure coverage and connectivity.
2. Identify the appropriate localization protocols (coarse/fine-grained).
3. Identify time synchronization protocols (coarse/fine-grained).
4. Identify the appropriate medium access and sleep scheduling protocols.
5. Identify sleep-based topology control and cross layer issues.
6. Identify appropriate energy-efficient and robust routing.
7. Identify data-centric methods and ways to optimize data and energy.
8. Describe and design applications of sensor networks.

Computer Usage:
All assignments will require computer usage. This may involve the use of word processing as well as graphic software. Some assignments may require the use of electronic databases and/or the internet. Moreover, oral presentations should be conducted via computers. In different projects, students might use special packages that are available in the department to carry out their project simulations or to process their experimental data. Some simulation programs available in the COE department such as OPNET, Matlab and others or programming language such as Java and C++ can be used in the project work.

Tentative Grading Policy:
- Homeworks **10%**
- Quizzes **10%**
- Major Exam I ..... **15%** (Sunday March 23, 2008 during class period)
- Major Exam II ..... **15%** (Tuesday May 06, 2008 during class period)
- Team Project **20%**
- Final Exam ..... **30%** (*Comprehensive* – Wednesday June 11, 2008 at 7:30 AM)

Relationship to Program Outcomes:
This course supports the following five program outcomes out of the outcomes required by ABET Criterion 3 for accrediting computer engineering programs:

Outcome 1: Ability to apply knowledge of mathematics, probability, and statistics to model and analyze some networking protocols. **[ABET Criterion 3a]**
Outcome 2: Ability to function as an effective team member **[ABET Criterion 3d]**
Outcome 3: Ability to identify, formulate, and solve network engineering problems. **[ABET Criterion 3e]**
Outcome 4: Knowledge of contemporary issues in computer networks. **[ABET Criterion 3j]**
Outcome 5: The ability to design a system that involves the integration of hardware and software components **[ABET Criterion 3n]**

IMPORTANT NOTES:

- All KFUPM regulations and standards will be enforced. Attendance will be checked each class. The KFUPM rule pertaining to a DN grade will be strictly enforced (i.e. **> 6 absences** will result in a DN grade). *Check your university e-mail, both KFUPM and CCSE, regularly for warnings regarding your absences.*
- If you are late to the class for more than 5 minutes (i.e. arrive after 10:05 AM), you will **NOT be allowed to enter** the classroom and you will be considered absent for that class.
- Only university approved/certified excuses will be accepted.
- Homeworks are to be submitted **in class** on the due date during the class period. Late homeworks will **NOT be accepted**.
- You have 48 hours to object to the grade of a homework, a quiz, or a major exam from the end of the class time in which the graded papers have been distributed back. If for some reason you cannot contact me within this period, send me an email requesting an appointment. The email should be sent within the 48-hour time period.
- **NO make up exams**. ALL homeworks and quizzes will be counted towards your grade.
- Final exam is **comprehensive**.
- General guidelines for grades:

Range	**≥ 90 and ≤ 100**	**≥ 80 and < 90**	**≥ 70 and < 80**	**≥ 60 and < 70**	**< 60**
Minimum Grade	**A**	**B**	**C**	**D**	**F**

Tentative schedule

Week*	Topic	Chapter

1	• Introduction to Wireless Sensor Networks
	• Network Deployment
	  • Overview
	  • Structured versus randomized deployment
	  • Network topology
		• Ch. 1
		• Ch. 2

2	• Network Deployment
	  • Connectivity in geometric random graphs
	  • Connectivity using power control
	  • Coverage metrics
	  • Mobile deployment
	  • Discussion of chapter 2 exercises
		• Ch. 2 (contd.)

3	• Localization Protocols
	  • Overview
	  • Key issues
	  • Localization approaches
	  • Coarse-grained node localization using minimal information
		• Ch. 3

4	• Localization Protocols
	  • Fine-grained node localization using detailed information
	  • Network-wide localization
	  • Theoretical analysis of localization techniques
	  • Discussion of chapter 3 exercises
		• Ch. 3 (contd.)

5	• Time synchronization Protocols
	  • Overview
	  • Key issues
	  • Traditional approaches
	  • Fine-grained clock synchronization
		• Ch. 4

6	• Time synchronization Protocols
	  • Fine-grained clock synchronization
	  • Coarse-grained data synchronization
	  • Discussion of chapter 4 exercises
	
	First Major Exam
		• Ch. 4 (contd.)

7	• Medium-access and sleep scheduling
	  • Overview
	  • Traditional MAC protocols
	  • Energy efficiency in MAC protocols
	  • Asynchronous sleep techniques
		• Ch. 6

8	• Medium-access and sleep scheduling
	  • Medium-access and sleep scheduling
	  • Sleep-scheduled techniques
	  • Contention-free protocols
	  • Discussion of chapter 6 exercises
		• Ch. 6 (contd.)

Mid-term Break (12 April – 16 April)		

9	• Sleep-based topology control
	  • Overview
	  • Constructing topologies for connectivity
	  • Constructing topologies for coverage
		• Ch. 7

10	• Sleep-based topology control • Set K-cover algorithms	• Ch. 7 (contd.)

	• Cross-layer issues • Discussion of chapter 7 exercises	
11	• Energy-efficient and robust routing • Overview • Metric-based approaches • Routing with diversity • Multi-path routing ***Second Major Exam***	• Ch. 8
12	• Energy-efficient and robust routing • Lifetime-maximizing energy-aware routing techniques • Geographic routing • Routing to mobile sinks	• Ch. 8 (contd.)
13	• Energy-efficient and robust routing • Discussions of chapter 8 exercises • Data-centric networking • Overview • Data-centric routing • Data-gathering with compression • Querying	• Ch. 8 (contd.) • Ch. 9
14	• Data-centric networking • Querying • Discussion of chapter 9 exercises • General review of all covered material	• Ch. 9 (contd.)
15	• Oral presentations	

* Week 1 begins on ***February 16, 2008***