Mobile Communications

ECS 455



Asst. Prof. Dr. Prapun Suksompong (ผศ.ดร.ประพันธ์ สุขสมปอง)

Mobile Communications ECS 455

Asst. Prof. Dr. Prapun Suksompong (ผศ.ดร.ประพันธ์ สุขสมปอง)

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Introduction



Office Hours:

BKD, 6th floor of Sirindhralai building

Tuesday Wednesday

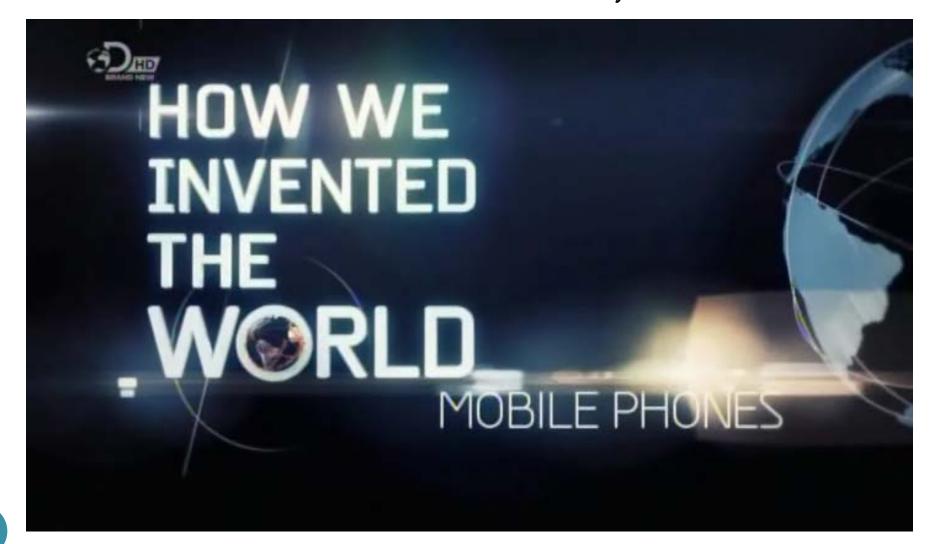
14:20-15:20 14:20-15:20

Friday

9:15-10:15

These devices need no introduction

• We all know them and use them heavily.



More than just making phone calls

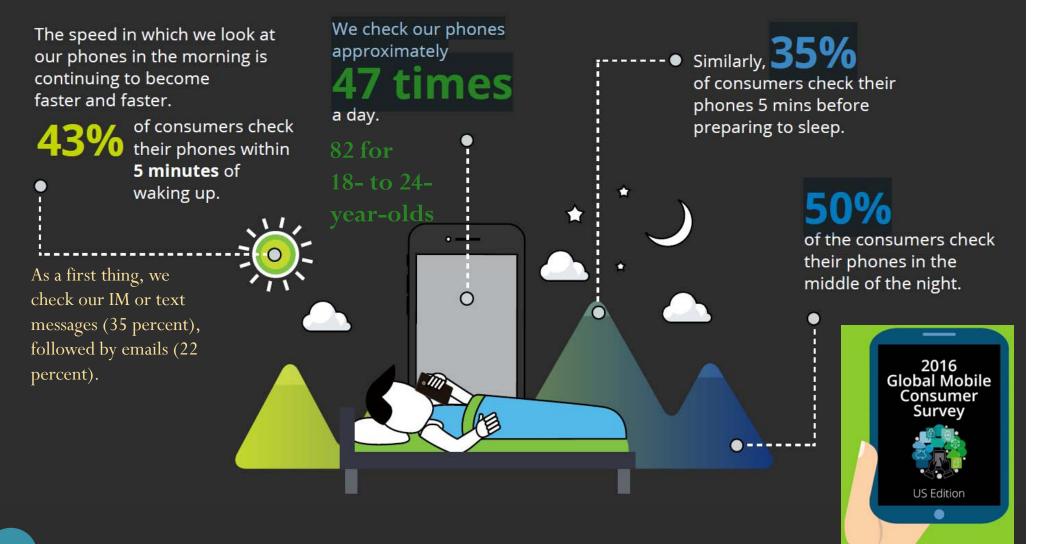


On average, how many times per day do we check our phones?



How many times per day do we check our phones?

Life's essentials: Air, water, food, and smartphones



How many times per day do we check our phones?

- The average adult checks their phone 30 times
- The average millennial checks their phone more than 150 times a day.
- Presented by Michelle Klein
 - Head of Marketing for North America at Facebook.
- May 31st, 2016



[https://socialmediaweek.org/newyork/2016/05/31/millennials-check-phones-157-times-per-day/] [https://www.facebook.com/socialmediaweek/videos/10154213889539789/]

Recent Research

• A journal article in 2015

JOURNAL OF COMPUTER-MEDIATED COMMUNICATION

- Title: "The Extended iSelf: The Impact of iPhone Separation on Cognition, Emotion, and Physiology"
- Conducted by University of Missouri
- <u>http://onlinelibrary.wiley.com</u> /doi/10.1111/jcc4.12109/full

The Extended iSelf: The Impact of iPhone Separation on Cognition, Emotion, and Physiology

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Missouri School of Journalism, University of Missouri, 120 Neff Hall, Columbia, MO 65211

Glenn Leshner

Gaylord College of Journalism and Mass Communication, University of Oklahoma, 395 W. Lindsey Room, Norman, OK 73019

Anthony Almond

The Media School, Indiana University, 1229 E. 7th St., Bloomington, IN 47405

This study uniquely examined the effects on self, cognition, anxiety, and physiology when iPhone users are unable to answer their iPhone while performing cognitive tasks. A 2 x 2 within-subjects experiment was conducted. Participants (N= 40 iPhone users) completed 2 word search puzzles. Among the key findings from this study were that when iPhone users were unable to answer their ringing iPhone during a word search puzzle, heart rate and blood pressure increased, self-reported feelings of anxiety and unpleasantness increased, and self-reported extended self and cognition decreased. These findings suggest that negative psychological and physiological outcomes are associated with iPhone separation and the inability to answer one's ringing iPhone during cognitive tasks. Implications of these findings are discussed.

Keywords: Cell Phone Separation, Extended Self, Cognition, Anxiety, Physiology.

doi:10.1111/jcc4.12109

Cell phone use has become a ubiquitous part of everyday life, and the cell phone has become one of the most popular devices for communicating with others. Consistent with the primary social functions of the household/landline telephone, mobile communication via the smart phone helps strengthen bonds among family members (Wei & Hwei-Lo, 2006) while also expanding the user's "psychological neighborhoods" and facilitating "maintenance of symbolic proximity" (Wei & Hwei-Lo, 2006). While

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JOURNAL OF COMPUTER-MEDIATED COMMUNICATION

Author Disclosure Statement: The authors have no commercial interest related to this manuscript and there are no conflicts of interest for any author of this manuscript

Editorial Record: First manuscript received on May 20, 2014. Revisions received on August 15, 2014 and October 10, 2014. Accepted by Matthew Lombard on October 25, 2014. Final manuscript received on October 27, 2014.

Excerpts from the paper

- Cell phone use has become a **ubiquitous** part of everyday life, and the cell phone has become one of the most popular devices for communicating with others.
- Mobile communication via the smart phone helps strengthen bonds among family members [Wei & Hwei-Lo, 2006] while also
 - expanding the user's "psychological neighborhoods" and
 - facilitating "maintenance of symbolic proximity".

Excerpts from the paper

- Harkin (2003) proposes that mobile technologies are important to the **modern sense of self** because they
 - "function as comfort objects, antidotes to the hostile terrain of wider society," and
 - have become entities so intimately a part of us that they are capable of representing "an extension of our physical selves – an umbilical cord, anchoring the information society's digital infrastructure to our very bodies"
- Extended-Self Theory [Belk, 1988/2013]

Excerpts from the paper

- The **physical and emotional attachments** humans have developed with cell phones have simultaneously increased [Srivastava, 2005].
- Recent research indicates that such attachments are associated with greater feelings of anxiety when users are distanced from their smart phone devices [Cheever, Rosen, Carrier, & Chavez, 2014]



http://www.totelifestyle.com/life/a-smartphone-obsession/ http://en.wikipedia.org/wiki/Nomophobia

Nomo-"phobia"

- run out of credit
- lose your phone
- in an area with no reception
- An abbreviation for *no-mobile-phone* phobia.
- A term coined in a study (of around 2000 people) in UK. "anxiety"
- The "fear" of being without your mobile phones.
- About 58% of men and 47% of women suffer from the phobia, and an additional 9% feel stressed when their mobile phones are off.
- Stress levels induced are on-par with getting married, moving into a new house, or going to the dentist.



Mobile Communications ECS 455

Dr. Prapun Suksompong

Course Organization





Course Syllabus



Sirindhorn International Institute of Technology

Thammasat University

School of Information, Computer and Communication Technology

ECS455: Course Syllabus

Semester/Year: 2/2016

 Course Title:
 Mobile Communications

 Instructor:
 Asst. Prof. Dr.Prapun Suksompong (prapun@siit.tu.ac.th)

 Course Web Site:
 http://www2.siit.tu.ac.th/prapun/ecs455/

Please check the course web site regularly for updated information about this course.

Lectures

Wednesday 10:40-12:00 BKD 3511
 Friday 10:40-12:00 BKD 3511

You are STRONGLY encouraged to attend lectures. (See the grading policy below.)

Course Information

Prerequisite: ECS 332 or consent of Head of School

Course Description: This course introduces selected topics in mobile communications to undergraduate students. Topics include wireless channel, principles of cellular communications, multiple access methods, digital mobile communication systems: TDMA, GSM, CDMA, WCDMA, multi-carrier and OFDM systems.

Grading Policy: Coursework will be weighted as follows:

	Assignments (HWs)	5%
	In-Class Exercises	5%
	Class Discussion/Participation	10%
	Midterm Examination	40%
	Final Examination (comprehensive)	40%
•	Late assignments will be heavily penalized	or rejected.
•	The lowest in-class exercise score will be dr	opped.
	Similarly, the lowest assignment score will	be dropped.
•	Cheating will not be tolerated	
	I. D. T	()), ()

Textbook: D. Tse and P. Viswanath, "Fundamentals of Wireless Communication," Cambridge University Press, 2005

- [http://www.eecs.berkeley.edu/~dtse/book.html]
- Chapters from other books will be used as well.

Additional References:

- A. Goldsmith, "Wireless Communications," Cambridge Press, 2005. [http://wsl.stanford.edu/~andrea/Wireless/]
- Theodore S. Rappaport, "Wireless Communications: Principles and Practice," 2nd Edition, Prentice Hall PTR, 2002. ISBN-13: 978-0130422323. Call No. TK5103.2 R37 2002

[http://authors.phptr.com/rappaport/]

- M. R. Karim and Mohsen Sarraf, W-CDMA and cdma2000 for 3G Mobile Networks, McGraw-Hill Professional, 2002.
- J. S. Lee and L. E. Miller, "CDMA Systems Engineering Handbook." Boston, MA: Artech House, Oct. 1998.
- R.E. Ziemer, "Fundamentals of Spread Spectrum Modulation." Colorado Springs: Morgan & Claypool Publishers, 2007
- A. Bahai, B. R. Saltzberg, and M. Ergen, Multi-Carrier Digital Communications: Theory and Applications of OFDM, 2nd ed., New York: Springer Verlag, 2004.
- 7. H.G. Myung and D.J. Goodman, Single Carrier FDMA: A New Air Interface for Long Term Evolution, Wiley, 2008.

Assignments: Homework will be assigned throughout the semester. Most assignments will be graded on completeness, not correctness: if an honest attempt was made on an assigned problem, it will be considered complete. Occasionally, part(s) of a selected problem will be graded. Of course, you do not know which problem of which assignment will be selected; so you should work on all of them. The complete solutions to all problems (not just answers) will be posted on the course web site.

In-Class Exercises: In-class exercises will focus on current or recently-discussed topics. An exercise may be given at any time during any class period. Students are expected to work in groups of at most three persons. In-class exercises will be given only to those students who are present. There will be no make-up exercise.

Exams: Exams will be closed book. Some formulas will be provided on the exams.

Students should notify the instructor <u>before</u> missing any exam if at all possible and <u>immediately</u> thereafter when not possible. The instructor (and/or the fact-finding committee) will determine if the absence from an exam is legitimate. Simply not feeling well is not a reason to miss an exam. In the case of legitimate absence, an oral and/or written make-up exam could be arranged.

Expectations: You should expect to spend extra 5-8 hours per week studying outside of class. However, I do expect you to come to class and <u>participate actively</u> in class discussions. If you must miss a class, I expect you to find out and catch up with what happened in lecture, either from me or one of your classmates. You are responsible for all materials that are discussed in class.

Academic Integrity

The work you submit in this class is expected to be the result of your individual effort. You are free to discuss course material, approaches to problems with your colleagues or the instructor but you should never misrepresent someone else's work as your own.

Course Web Site

prapun.com



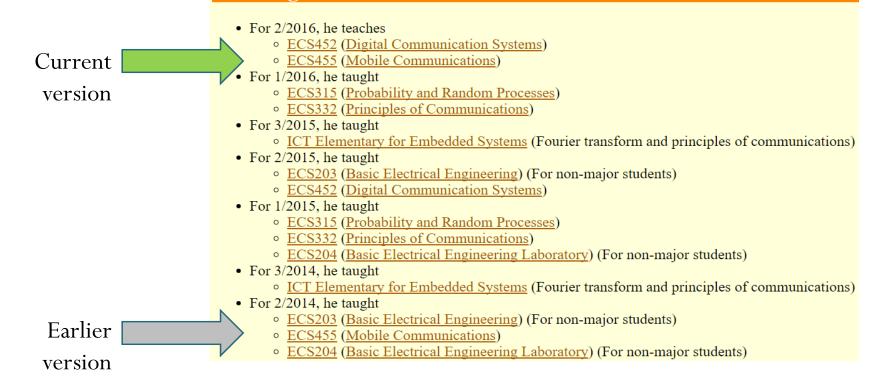
Asst. Prof. Dr.Prapun Suksompong (HA.OS.JSEWINE AUANJOS) is currently the Chairperson of <u>Electronics and Communication</u> <u>Engineering (EC)</u> Curriculum at <u>Sirindhorn International Institute of Technology (SIIT)</u>, Thammasat University, <u>Thailand</u>. In 1997, he received the <u>King's Scholarship</u> to study in the <u>School of Electrical and Computer Engineering (ECE)</u> at <u>Cornell university</u>. He topped the <u>Cornell ECE class of 2002</u>, with the highest GPA among all engineering students. He then received the Cornell's fellowship for his graduate study. Prapun joined Prof. <u>Toby Berger</u>'s group in 2003 and got his Ph.D. in 2008.

Right after his graduation, he started his teaching career at SIIT. His research interest is in the areas of <u>communication theory</u>, <u>information theory</u>, <u>probability theory</u>, and <u>theoretical neuroscience</u>. In 2012, he (along with two other faculty members in the Wireless Communication Research Group) received the 2011 SIIT Research Award. In 2014, he received the 2013 Outstanding Young Researcher Award (รางวัลนักวิจัยรุ่นใหม่ดีเด่นระดับคณะ ประเภทอารษ์) from Thammasat University.

Ajarn Prapun always highly values the teaching aspect of his career and his life. Many of his notes are available on his personal websites. In 2006, he received the Teaching Assistant of the Year Award from members of the Cornell IEEE Student Branch "for exemplary teaching in ECE". In 2010 and in 2014, he also received the Best Teaching Awards from SIIT.

For more information, here is his CV. (Download pdf version.)

Teaching



Getting Info About This Course

- The **syllabus** contains tentative information.
- I will announce **in class** and on the **web site** if there is any change.
- You are **responsible** for making sure that you obtain this information.
- Come to classes on time and listen carefully for announcement(s).
- For those who want a preview of the class materials, old slides along with the notes and HWs from earlier years are available on my web site (**prapun.com**).

Announcements

Course Web Site

- Announcements
- References
- Handouts (Posted before corresponding lectures; also available at the copy center)
- Annotated Notes/Slides (Posted after corresponding lectures)
- Calendar
 - Exams
 - HW due dates

Please check the course website regularly.

www2.siit.tu.ac.th/prapun/ecs455/

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Course Website: Notes & Slides

- Some **PDF notes/slides** will be posted *before* the corresponding lectures.
 - Hard copies can be purchased from the **copy center**.
- In lectures...
 - PDF notes/slides will be highlighted and annotated with examples / comments.
 - These annotated materials will be **posted after** the corresponding lectures.

• Put all of your energy into understanding the material.

• **Remind** me the day after the lecture if the annotated notes/slides from the day before are still not posted on the web.

Me?

- Ph.D. from **Cornell** University, USA
- In Electrical and Computer Engineering
- Minor: Mathematics (Probability Theory)
- Ph.D. Research: Neuro-Information Theory
- Current Research: Wireless Communications
- 2009 and 2013 SIIT Best Teaching Awards
- 2011 SIIT Research Award

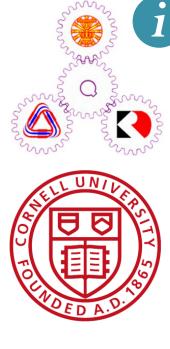
prapun.com

• 2013 TU Outstanding Young Researcher Award













Course Organization

• Course Web Site:

http://www2.siit.tu.ac.th/prapun/ecs455/

- Lectures:
 - Wednesday 10:40-12:00 BKD 3511
 Friday 10:40-12:00 BKD 3511





Fundamentals of Wireless Comm.

D. Tse and P. Viswanath, "<u>Wireless Communications</u>," Cambridge Press, 2005.



All chapters of the textbook can be downloaded.

Fundamentals of Wireless Communication David Tse Pramod Viswanath

Now with exercises

2. The wireless channel; PDF

detection, diversity and

channel uncertainty; PDF

Cellular systems: multiple access

Point-to-point communication:

included!

1. Introduction; PDF

and interference

management; PDF

 Capacity of wireless channels;<u>PDF</u>
 Multiuser capacity and

opportunistic

Fundamentals of Wireless Communication

David Tse and <u>Pramod Viswanath</u>

Cambridge University Press, 2005

Buy the book: <u>Cambridge University Press</u> <u>Amazon.com</u> <u>BookFinder.com</u>

http://www.eecs.berkeley.edu/~dtse/book.html

Book Description

The past decade has seen many advances in physical-layer wireless communication theory and their implementation in wireless systems. This textbook takes a unified view of the fundamentals of wireless communication and explains the web of concepts underpinning these advances at a level accessible to an audience with a basic background in probability and digital communication. Topics covered include MIMO (multiple input multiple output) communication, space-time coding, opportunistic communication, OFDM and CDMA. The concepts are illustrated using many examples from wireless systems such as GSM, IS-95 (CDMA), IS-856(1xEV-DO), Flash OFDM and ArrayComm SDMA systems. Particular emphasis is placed on the interplay between concepts and their implementation in systems. An abundant supply of exercises and figures reinforce the material in the text. This book is intended for use on graduate courses in electrical and computer engineering and will also be of great interest to practicing engineers.

<u>Reviews</u>

Wireless

Communications

Wireless Communications

A. Goldsmith,

"Wireless Communications,"

Cambridge Press, 2005.





Sample chapters (1, 3, 4, 6, 10, 12, 14, A, B, C, D) of the textbook can be downloaded.

Wireless Communications by Andrea Goldsmith

The book is now available from Cambridge University Press. The publisher's website for the book is http://www.cambridge.org/uk/catalogue (catalogue asp?isbn=0521837162. It is also in stock at <u>Amazon</u>. Book typos uncovered so far are posted <u>here</u> and to the publisher's website. Please send additional typos to <u>wireless@wsl stanford edu</u>. The publisher's website also contains a password-protected solutions manual (in pdf) for all homework problems along with other supporting material such as lecture slides for instructors adopting the book.

The book's Table of Contents is posted here. Sample chapters can be viewed here. These sample chapters contain many typos, errors, and omissions that were corrected during the production process of the book (all figures were awn). Therefore, while email comments on the sample chapters are welcome, please only email typos and corrections based on the published book, not ple chapters. All emails regarding the book should be sent to <u>wireless@wsl stanford edu</u>.

dsmith

Vireless Communications

Wineless technology is a transformer paradigm shift, enabling multimedia constructed sector and devices from any rocation. I homes, televised sector networks, smarthores, televised to the technology of technology of the technology of technology of the technology of technolo

A begine with an overview of windless systems and standards. The theninitios of the windless channel are then described, including their fundamental aparty limits. Vericus medulation, coding, and signal processing stremes re then discussed in detail, including state of the art adaptive medulation, mulcertier, spread spectrum, and multiple antonna techniques. The concluding hapters deal with multiple rommunications, cellular system design, and adco-nation's dealign.

Design insights and tradeoffs are emphasized throughout the book. It contains many worked examples, once 200 figures, atmost 300 homework exercises, 700 references, and is an ideal textbook for students. The book is also a valuable reference for engineers in the wireless industry.

Anders Goldandit Inscrived her Ph.D. thorn the University of California, Berkeley, and is on Associate Pholessor of Electrical Engineering at Starford University, Phicrotonic shows an Associate Pholessor the California Institute of Schorleigy. She has also held positions in industry at Maxim Technologies and AT&T Bell Labcratories. She is a Fellow of the IEEE, has received numerous other wards and homes, and is the author of over 150 technical papers in the field of weeks communications.

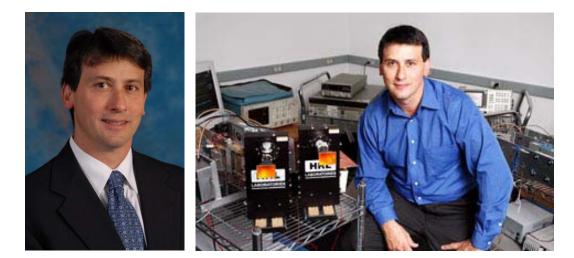
Given activor's by Selborah McEauch/an

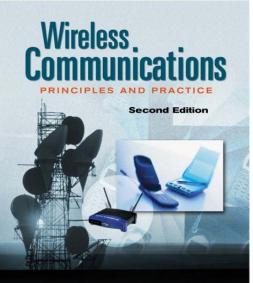
Andrea Goldsmith

http://wsl.stanford.edu/~andrea/Wireless/

Wireless Communications

Theodore (Ted) S. Rappaport, *Wireless Communications: Principles and Practice*,"
2nd Edition, Prentice Hall, 2002.

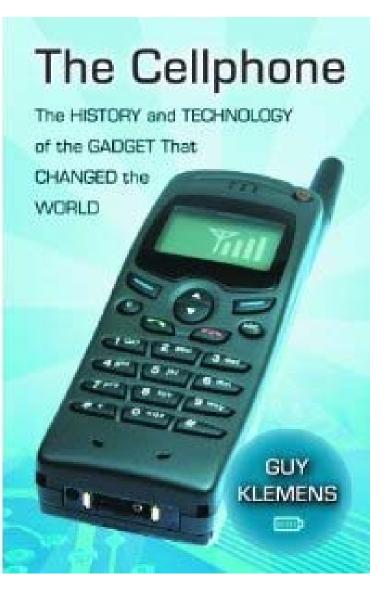




THEODORE S. RAPPAPORT

Prentice Hall Communications Engineering and Emerging Technologies Series Theodore S. Rappaport, Series Editor

The Cellphone



Guy Klemens, "<u>The Cellphone: The History and</u> <u>Technology of the Gadget That</u> <u>Changed the World,</u>" McFarland, September 2010

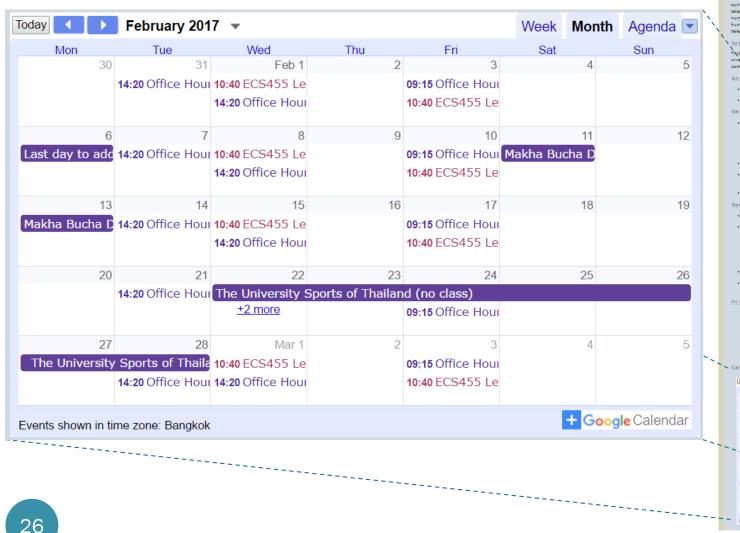
Easy-to-Read yet Related Book

Calendar

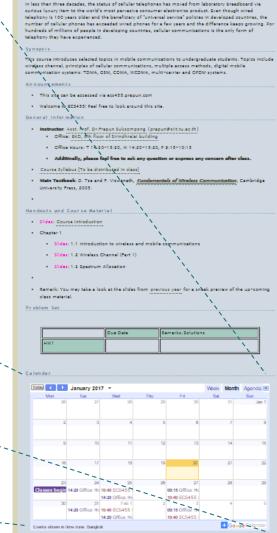
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20-Feb-17	21-Feb-17	22-Feb-17	23-Feb-17	24-Feb-17	
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5-Jun-17	6-Jun-17	7-Jun-17	8-Jun-17	9-Jun-17	Please Double-Check Ex

Please Double-Check Exam Dates!

Calendar (Google)



ECS455: Mobile Communications



ECS455: Topics

- 1. "Wireless" Communications: Problems and Solutions.
- 2. "Cellular" Communications: Motivation and Analysis.
- 3. Multiple Access Schemes: How can many users share communication resources?
- 4. Spread Spectrum Communications (CDMA)
- 5. OFDM systems
- 6. Communication techniques in GSM, GPRS, EDGE, UMTS (W-CDMA), WiMAX (OFDMA), LTE (SC-FDMA)

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ECS455: Course Outline

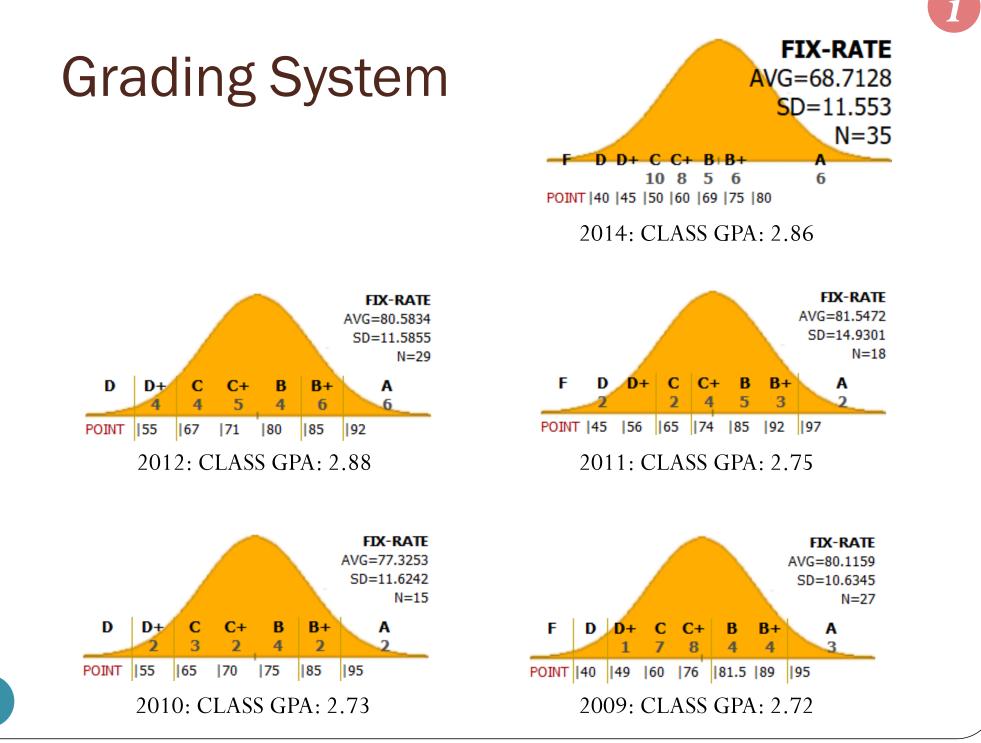
- 1. Review
- 2. Capacity of Cellular Systems
- 3. M/M/m/m Assumption and Derivation of Erlang B Formula
- 4. Duplexing: TDD vs. FDD
- 5. Multiple Access Schemes
- 6. Spread Spectrum Communications
- 7. Multi-carrier and OFDM systems
- 8. PHY for GSM, GPRS, EDGE, UMTS (W-CDMA), WiMAX (OFDMA), LTE (SC-FDMA)

Grading System

• Coursework will be weighted as follows:

Assignments	5%
In-Class Exercises	5%
Class Discussion/Participation	10%
Midterm Examination	40%
Final Examination (comprehensive)	40%

- Mark your calendars now!
- Late HW submission will be rejected.



Class Participation

- NOT the same as class attendance!
- If you come only to **receive**, you will fall **asleep**.
 - Do not simply sit quietly in the class.
- Need **interaction** between lecturer and students.
- Ask question when there is something that you don't understand.
 - Don't be shy!
 - It is very likely that your friends don't understand it as well.
- If you already understand what I'm presenting, SHOW ME!
 - Point out the errors/typos.
 - I will raise many issues/questions in class. Try to comment on them.

Self-Evaluation Form

- Record what you have done.
 - To be submitted right after the midterm and right after the final.

ECS 455: Self-Evaluation

 The class participation score for this class is judged by how much you actively participate in the class discussion both inside and outside of the classroom.

2. Please honestly answer the following questions. Please provide as much information as possible.

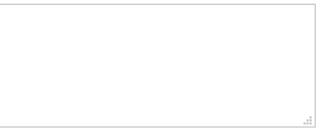
3. Do not include the activities that you have already stated in the first self-evaluation form.

Name

(±

Student ID

How many times have you participated (provided comments, asked questions, answered questions, etc) in the lectures? Be specific. Provide some short description for each event. Number alone does not count.



How many times have you correctly informed the instructors the typo or mistake on the whiteboard/slides/hw/etc? Provide short description for each of the issues.



How many times have you discussed with the instructor outside of class? (Ask questions, express concerns, etc.) Be specific. Number alone does not count.

In-Class Exercises

- Most in-class exercises will occur without prior warning or announcement.
 - Focus on the current topic under discussion.
- Done in group to reduce pressure and provide opportunity
 - for those who think they understand the course material to explain to their friends and see whether they really know the material under consideration

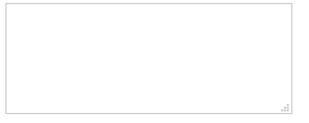
and

- for those who are falling behind to get an alternative explanation from their peers
- Note that you can't be in exactly the same group every time.
 - Have to change your group members every time.
 - If you are with a friend before, then next time, form a group with someone else.

Self-Evaluation Form (Con't)

- If you have valid reason for missing class on the day that we have exercise, please indicate the date, exercise number, and the reason in the self-evaluation form.
- Make sure that you also submit/email supporting document/evidence to Dr.Prapun.

How many times have you been absent from the class? Are there any specific reason(s)? Please explain. Also,



Note that the lowest scores among your own in-class exercise wil be dropped. However, if you have valid reason for missing class on the day that we have in-class exercise(s), please indicate the date, exercise number, and the reason here. (No credit for incomplete information.) Make sure that you also submit/email supporting document/evidence to Dr.Prapun (if you haven't done so).

How many times have you been late (> 30s) for the class? Are there any specific reason(s)? Please explain. Based on the clock on my computer. (This should be approx. the same as your phone's and computer's clocks if they are synchronized properly.)

Policy

- We will start the class on time and will finish on time.
 - I recommend arriving at least 3 minutes before the start time.
 - Raise your hand and tell me immediately if I go over the time limit.
 - Does NOT mean that I will leave the room immediately after lecture.
 - I will stay and answer questions.
- Mobile phones *must* be turned off or set in silent mode.



1

- Attendance will be taken/given irregularly and randomly.
- Cheating will not be tolerated.
- Feel free to stop me when I talk too fast or too slow.

Policy (con't)

- I will surely make some **mistakes** in lectures / HW / exams.
 - Some amount of class participation scores will be reserved to reward the **first** student who informs me about each of these mistakes.
 - Grammatical errors are best informed/corrected after class.
- Unless instructed otherwise, points on exercises and exams are based on your entire solution, not your final answer.
 - You may get full credit even when you have the wrong final answer.
 - You may get **zero** even when you write down a right answer without justification.

Policy (con't)

- Please stop me if I go over the time limit.
- Please stop me if I talk too fast.
- Please stop me if you have any question.



Help and Office Hours

- Get some help!
 - Do not wait until the final exam time or after the grade is out.
 - Right after lecture is always a good time to ask question.
- Office Hours
 - T 14:20-15:20, W 14:20-15:20, F 9:15-10:15
 - Appointment can be made.
 - Feel free to come to my office and chat!
 - Don't be shy.

	Asst.Prof.Dr.Prapun Suksompong - 2/2016						
	9.00-10.20	10.40-12.00	13.00-14.20	14.40-16.00	16:00-17:00		
MON			JAE	MEETING			
TUE		ECS452 BKD 3511		Office Hour			
WED		ECS455 BKD 3511		Office Hour			
THU		ECS452 BKD 3511					
FRI	Office Hour	ECS455 BKD 3511	Network Group ICT Meeting				

Office Hours:

BKD, 6th floor of Sirindhralai building Tuesday 14:20-15:20

Tuesday 14:2 Wednesday 14:2 Friday 9:15

14:20-15:20 9:15-10:15

Warning

- This class can be **difficult**.
 - Keep up with the lectures.
 - Make sure that you understand the concepts presented in the lecture before you go home.
- I will evaluate your understanding of the course regularly through
 - In class Q&A/activities
 - Quizzes
 - Exams



Remarks

- Get as much **legitimate** help as you can
- Participate actively in class and outside of class
 - Record what you have done.
- If you feel that the class is very easy, you might overlook something.
- If you feel that the class is very difficult, you are probably not the only one who feel that way.
 - Don't give up. Chat with me.
- My notation can be different from the textbook.
 - Every notation has some advantages and disadvantages.