Digital Communication Systems
ECS 452

Asst. Prof. Dr. Prapun Suksompong

(ผศ.ดร.ประพันธ์ สุขสมปอง)

prapun@siit.tu.ac.th

Introduction

Office Hours:

BKD, 6th floor of Sirindhralai building

Tuesday	**14:20-15:20**
Wednesday	**14:20-15:20**
Friday	**9:15-10:15**

Course Syllabus

Sirindhorn International Institute of Technology
Thammasat University
School of Information, Computer and Communication Technology

ECS452: Course Syllabus

Semester/Year: 2/2016

Course Title: Digital Communication Systems
Instructor: Asst. Prof. Dr.Prapun Suksompong (prapun@siit.tu.ac.th)
Course Website: http://www2.siit.tu.ac.th/prapun/ecs452/

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

Lectures

- Tuesday 10:40-12:00 BKD 3511
- Thursday 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: The subject of digital communications involves the transmission of information in digital form from a source that generates the information to one or more destinations. This course extends the knowledge gained from ECS332 (Principles of Communications) and ECS315 (Probability and Random Processes). Basic principles that underlie the analysis and design of digital communication systems are covered.

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 dropped.
  Similarly, the lowest assignment score will be dropped.
- Cheating will not be tolerated

Textbook: John Proakis and Masoud Salehi, Digital Communications, 5th Edition, McGraw-Hill, 2007.

Additional References:

1. Robert G. Gallagher, Principles of Digital Communications, Cambridge University Press, 2008.
2. Bernard Sklar, Digital communications: fundamentals and applications, Prentice Hall, 2001
3. Ha H. Nguyen and Ed Shwedyk, A first course in digital communications, Cambridge University Press, 2009

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: A handwritten A4 study sheet is allowed. One side for the midterm exam. Another side for the final exam.

Students should notify the instructor before missing any exam if at all possible and immediately 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 *participate actively* 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.

It is your responsibility to protect your work from unauthorized access. For example, do not discard copies of your codes/assignments in public places.

Course Web Site

prapun.com

Asst. Prof. Dr.Prapun Suksompong (ผศ.ดร.ประพันธ์ สุขสมปอง) is currently the Chairperson of Electronics and Communication Engineering (EC) Curriculum at Sirindhorn International Institute of Technology (SIIT), Thammasat University, Thailand. In 1997, he received the King's Scholarship to study in the School of Electrical and Computer Engineering (ECE) at Cornell university. He topped the Cornell ECE class of 2002, with the highest GPA among all engineering students. He then received the Cornell's fellowship for his graduate study. Prapun joined Prof. Toby Berger'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 communication theory, information theory, probability theory, and theoretical neuroscience. 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 ประเภทอาจารย์) 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

Current version

- For 2/2016, he teaches
  - ECS452 (Digital Communication Systems)
  - ECS455 (Mobile Communications)
- For 1/2016, he taught
  - ECS315 (Probability and Random Processes)
  - ECS332 (Principles of Communications)
- For 3/2015, he taught
  - ICT Elementary for Embedded Systems (Fourier transform and principles of communications)
- For 2/2015, he taught
  - ECS203 (Basic Electrical Engineering) (For non-major students)
  - ECS452 (Digital Communication Systems)
- For 1/2015, he taught
  - ECS315 (Probability and Random Processes)
  - ECS332 (Principles of Communications)
  - ECS204 (Basic Electrical Engineering Laboratory) (For non-major students)
- For 3/2014, he taught
  - ICT Elementary for Embedded Systems (Fourier transform and principles of communications)
- For 2/2014, he taught
  - ECS203 (Basic Electrical Engineering) (For non-major students)
  - ECS455 (Mobile Communications)
  - ECS204 (Basic Electrical Engineering Laboratory) (For non-major students)

Earlier version

Getting Info About This Course

- The **syllabus** contains tentative information.

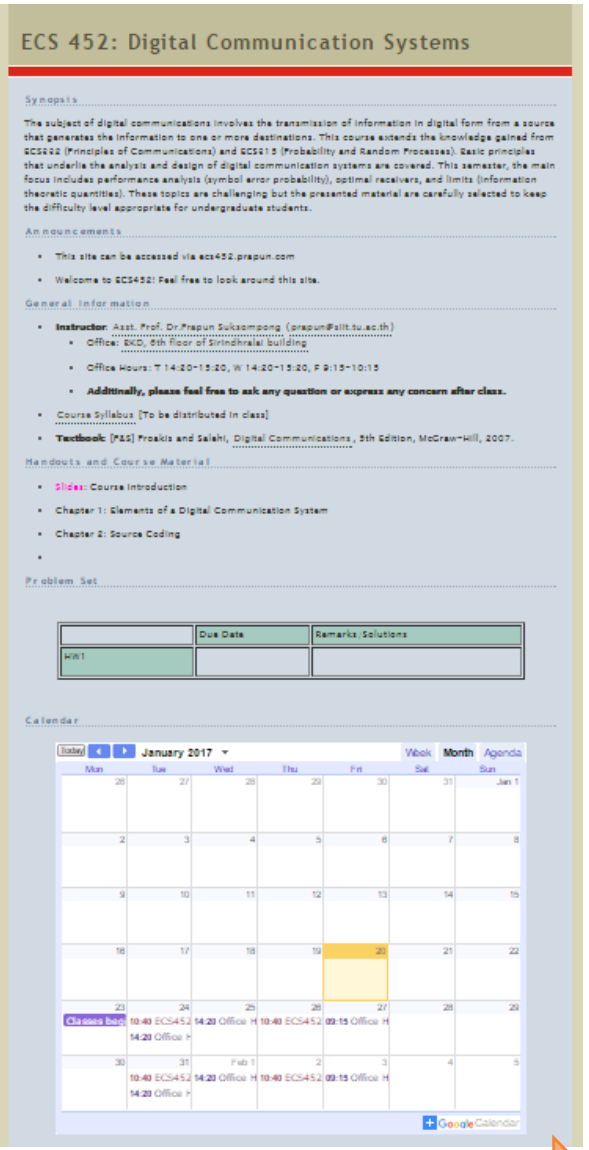
Announcements

- 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 also available on my web site (**prapun.com**).

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/ecs452/

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

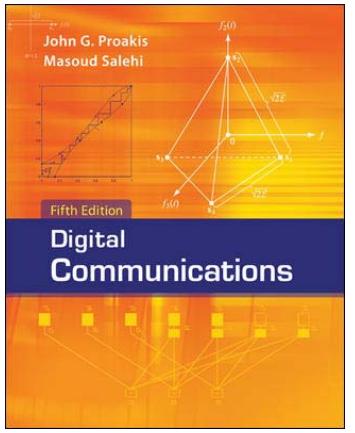
Me?

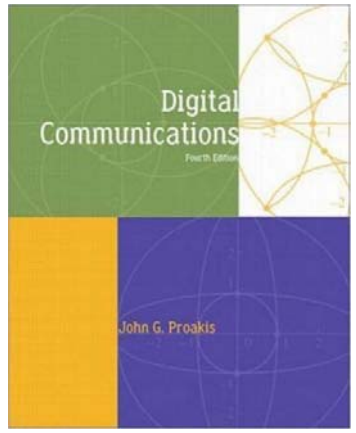
- Ph.D. from **Cornell** University, USA
- In Electrical and Computer Engineering
- Minor: Mathematics (Probability Theory)
- Ph.D. Research: Neuro-Information Theory
- Current Research:
  Wireless Communications
- 2009 and 2013 SIIT Best Teaching Awards
- 2011 SIIT Research Award
- 2013 TU Outstanding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

prapun.com

Course Organization

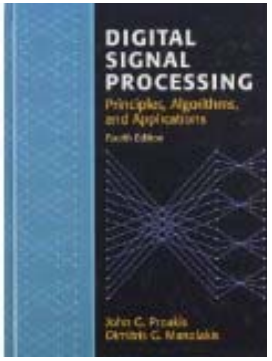
- **Course Website:**
  http://www2.siit.tu.ac.th/prapun/ecs452/
- **Lectures:**
  - **Tuesday 10:40-12:00 BKD 3511**
  - **Thursday 10:40-12:00 BKD 3511**
- **Textbook:** Digital Communications
  - By John Proakis and Masoud Salehi
    - Northeastern University
  - 5th (International) Edition
  - Call No. TK5103.7 P76 2008

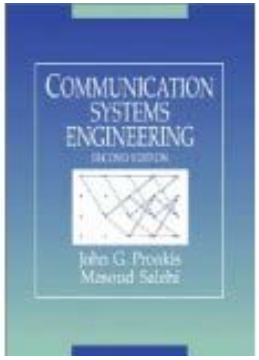


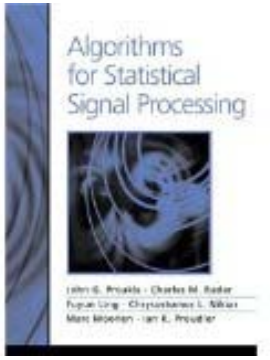


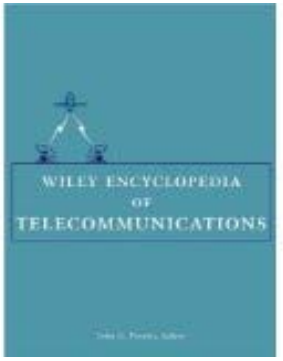
John Proakis

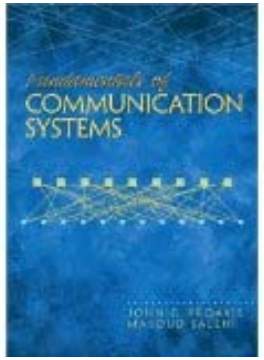
- Adjunct Professor at the University of California at San Diego (UCSD)
- Professor Emeritus at Northeastern University.

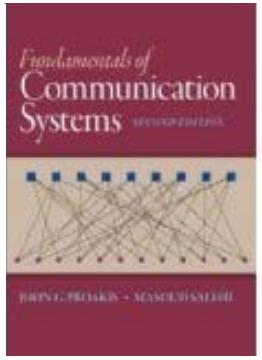


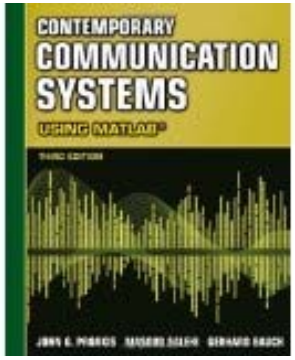


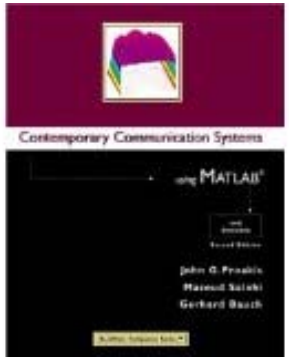




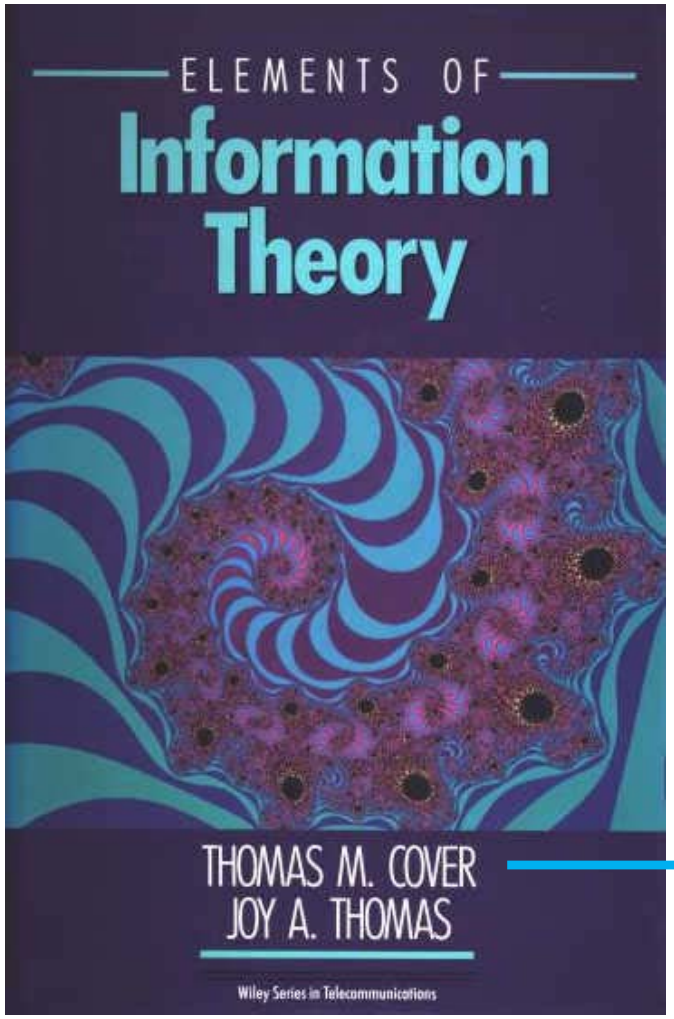




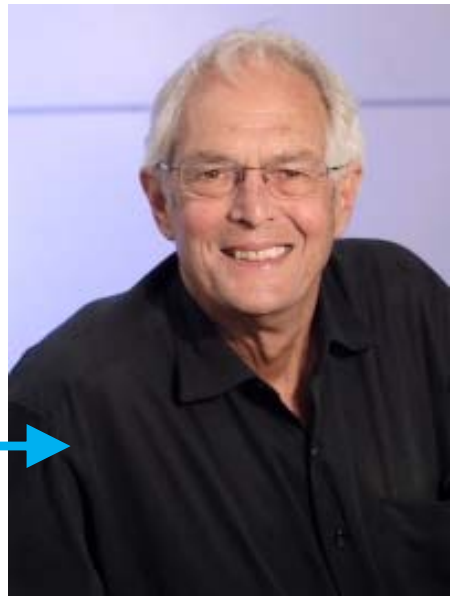




Additional Reference



- Elements of Information Theory
- 2006, 2nd Edition



'the jewel in Stanford's crown'

One of the greatest information theorists since Claude Shannon (and the one most like Shannon in approach, clarity, and taste).

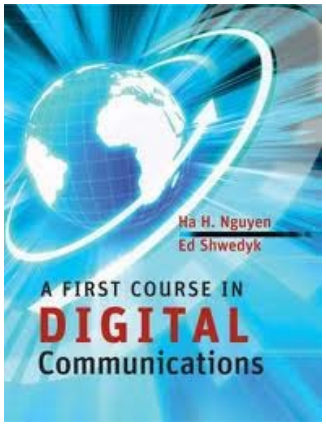
(August 7, 1938 – March 26, 2012)

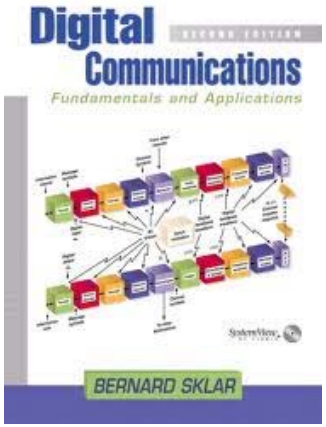
Prof. Toby Berger's Tribute to Cover

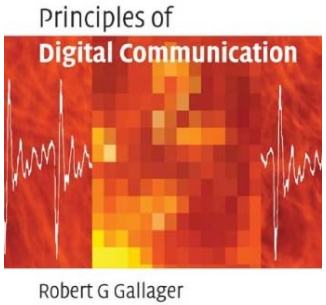
[https://www.youtube.com/watch?v=Y35twm25aFk]

Additional References

- A first course in digital communications
  - By Ha H. Nguyen and Ed Shwedyk
  - Call No: TK5103.7 N49 2009
  - Cambridge University Press
- Digital communications: fundamentals and applications
  - By Bernard Sklar.
  - Call No: TK5103.7 S55 2001
  - Prentice Hall
- Principles of Digital Communication
  - By Robert G. Gallager
  - 2008
  - Cambridge University Press







Calendar

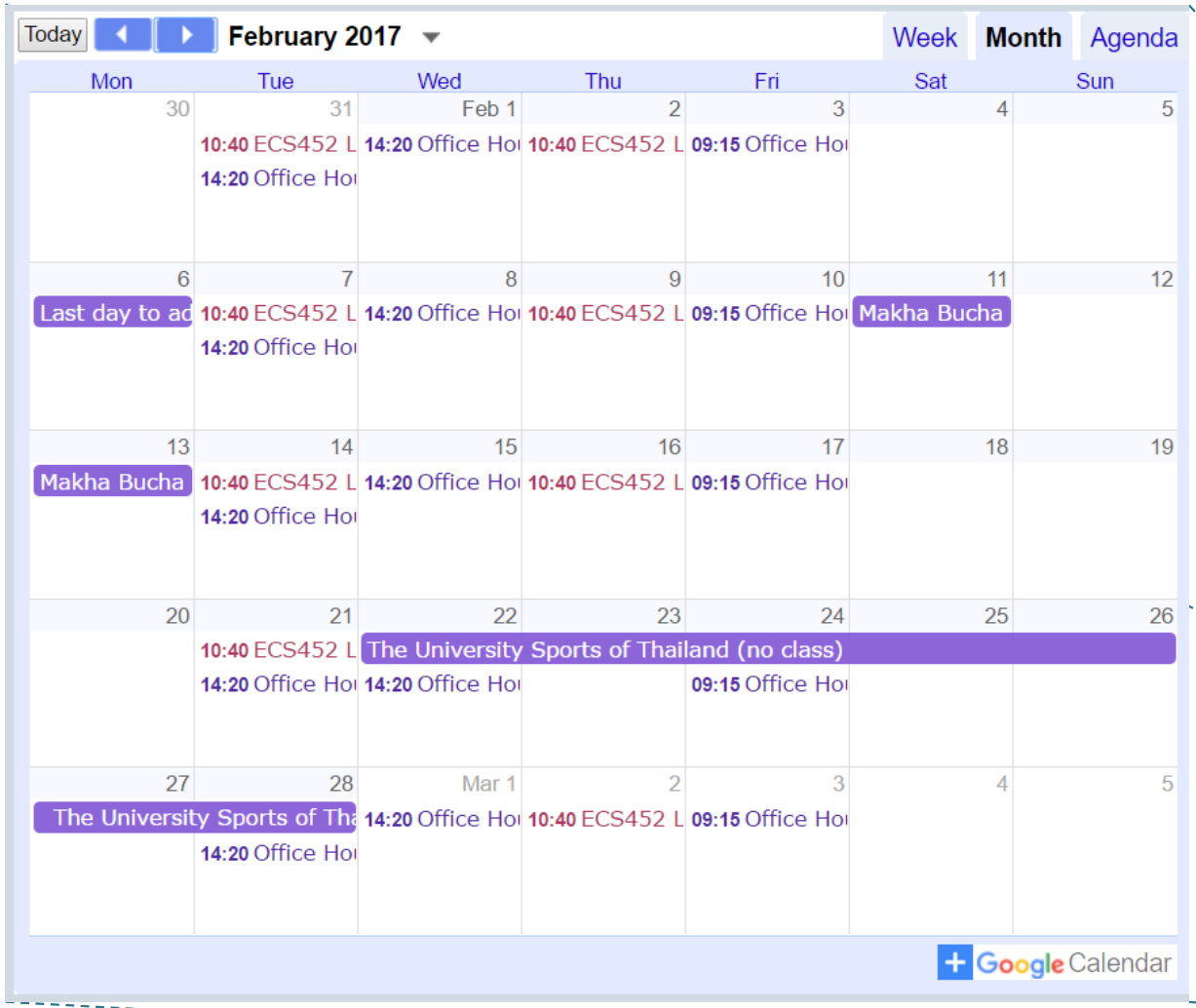
M	T	W	R	F
23-Jan-17	24-Jan-17	25-Jan-17	26-Jan-17	27-Jan-17
30-Jan-17	31-Jan-17	1-Feb-17	2-Feb-17	
6-Feb-17	7-Feb-17	8-Feb-17	9-Feb-17	10-Feb-17
13-Feb-17	14-Feb-17	15-Feb-17	16-Feb-17	17-Feb-17
20-Feb-17	21-Feb-17	22-Feb-17	23-Feb-17	24-Feb-17
27-Feb-17	28-Feb-17	1-Mar-17	2-Mar-17	3-Mar-17
6-Mar-17	7-Mar-17	8-Mar-17	9-Mar-17	10-Mar-17
13-Mar-17	14-Mar-17	15-Mar-17	16-Mar-17	17-Mar-17
20-Mar-17	21-Mar-17	22-Mar-17	23-Mar-17	24-Mar-17
27-Mar-17	28-Mar-17	29-Mar-17	30-Mar-17	31-Mar-17
3-Apr-17	4-Apr-17	5-Apr-17	6-Apr-17	7-Apr-17
10-Apr-17	11-Apr-17	12-Apr-17	13-Apr-17	14-Apr-17
17-Apr-17	18-Apr-17	19-Apr-17	20-Apr-17	21-Apr-17
24-Apr-17	25-Apr-17	26-Apr-17	27-Apr-17	28-Apr-17
1-May-17	2-May-17	3-May-17	4-May-17	5-May-17
8-May-17	9-May-17	10-May-17	11-May-17	12-May-17
15-May-17	16-May-17	17-May-17	18-May-17	19-May-17
22-May-17	23-May-17	24-May-17	25-May-17	26-May-17
29-May-17	30-May-17	31-May-17	1-Jun-17	2-Jun-17
5-Jun-17	6-Jun-17	7-Jun-17	8-Jun-17	9-Jun-17

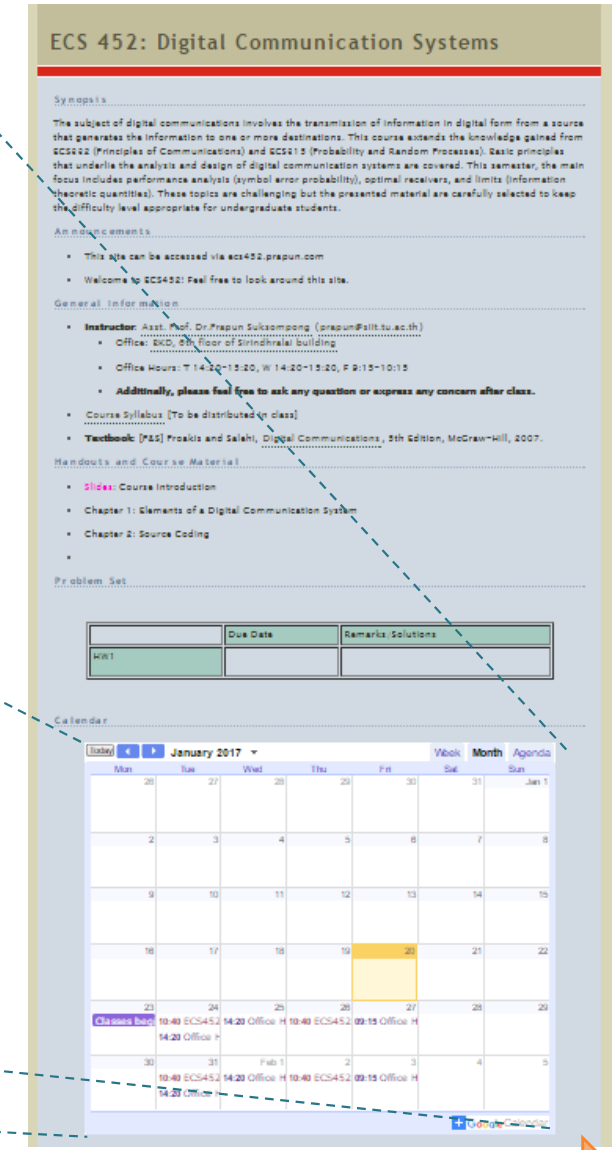
Lectures

Exams

Please Double-Check Exam Dates!

Calendar (Google)





ECS 452 Topics

1. Elements of a Digital Communication System
2. Source Coding and Entropy
3. Digital Communication Systems Over Discrete Memoryless Channel (DMC)
4. Mutual Information and Channel Capacity
5. An Introduction to Channel Coding and Decoding over BSC
6. Introduction to Digital Modulation, Signal Space Representation of Waveforms, Constellations for Digital Modulation Schemes
7. The Waveform Channel, Random Processes, White Noise
8. Optimal Detection for Additive Noise Channels, Matched filter.

General Ideas About This Course

- Extend the knowledge from Principles of Communications (ECS332) and Probability and Random Processes (ECS315)
- Focus more on
  - Performance analysis (bit error rates),
  - Optimal receivers, and
  - Limits (information theoretic quantities).

Grading System

- Coursework will be weighted as follows:

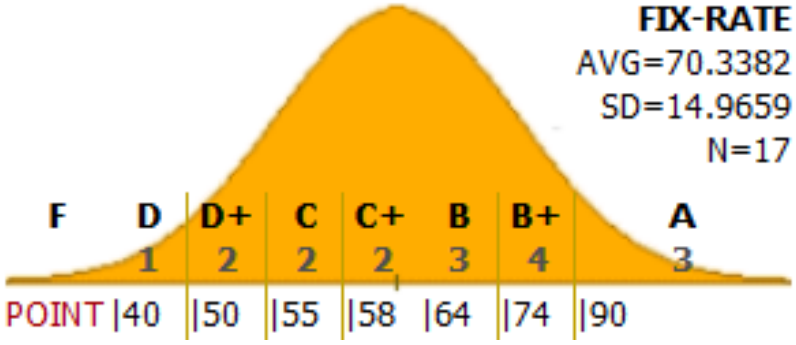
Assignments	5%
In-Class Exercises	5%
Class Discussion/Participation	10%
Midterm Examination	40%
Final Examination (comprehensive)	40%

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

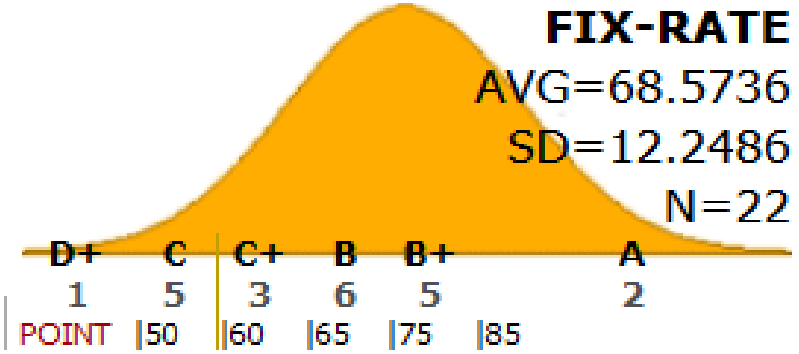
Please Double-Check Exam Dates!

Grading System

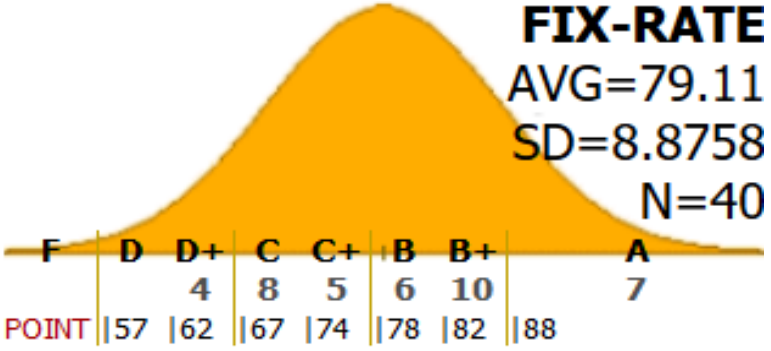
2013: CLASS GPA: 2.82



2014: CLASS GPA: 2.84



2015: CLASS GPA: 2.89



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 452: Self-Evaluation

1. 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.

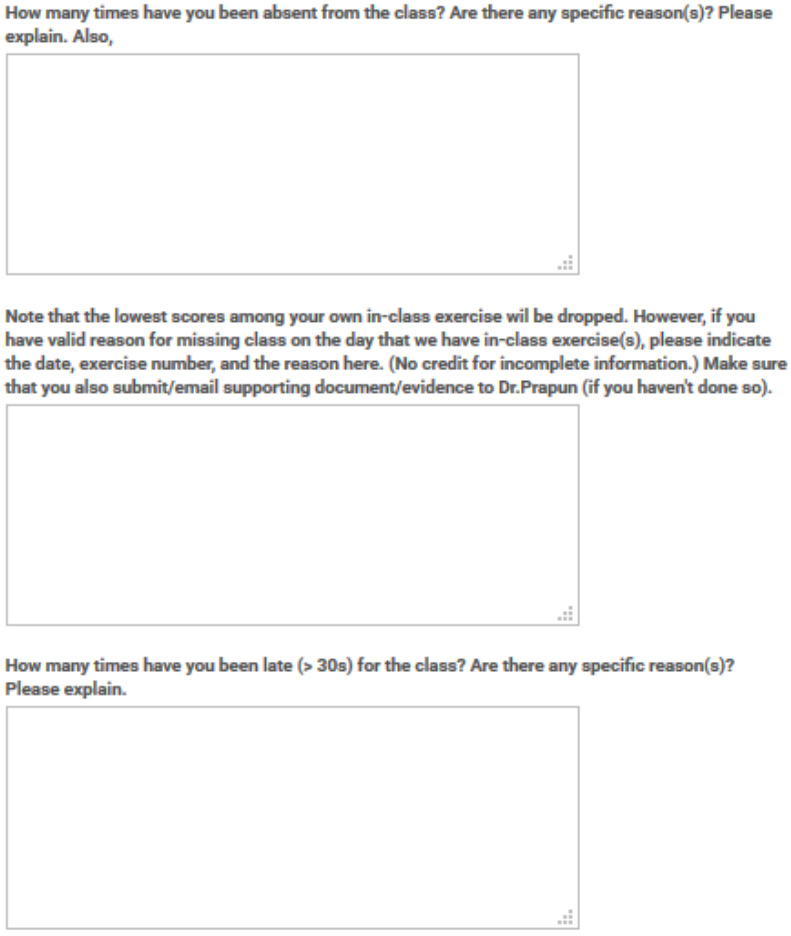
In-Class Exercises

- 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.



Policy

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.)

- 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.

- 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	Meeting Room	

Office Hours:

BKD, 6th floor of Sirindhralai building

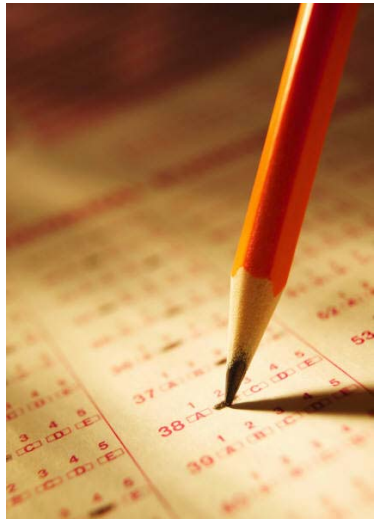
Tuesday 14:20-15:20

Wednesday 14:20-15:20

Friday 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 exercises/activities
  - Weekly assignments
  - 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.