Syllabus

CPS 221: Software Systems
CPS 521: Software Systems[1]

Fall 2019

Class: MWF 3:20 - 4:20pm, KOS 125

Lab: Tues 9:45am - 12:45pm, KOSC 244

Course web site: Blackboard sites for CPS 221 and CPS 221 Lab
(shared by CPS 521 and CPS 521 Lab)

Professor

Russ Tuck, Ph.D., russ.tuck@gordon.edu
Office: KOSC 243; Phone: 978-867-3754 (office), 408-335-0890 (mobile)
Office hours: M 9-10am, T 4:30-5:30pm, W 11:30-12:30, Thur 5-6:30pm, F 9-10am.
Also when my door is open, and by appointment at: https://russtuck.youcanbook.me/.

Catalog Description

Introduces fundamental software systems: operating systems, computer networks, and database management systems. Common concerns such as concurrency and security. Continued development of design and programming skills using Java through weekly laboratories.

Prerequisite: CPS122, CPS 520, or familiarity with Java.

Course Objectives

Operating systems, networks, and databases are fundamental software systems that support almost every user and use of computers. They are also large, complex, multi-layer systems with a wealth of abstractions, interfaces, and accumulated knowledge. These systems serve multiple users, often simultaneously, and must protect both the integrity and privacy of each user's data. The mechanisms used to meet these requirements show important similarities and differences across these systems.

Students will gain a deeper understanding of these systems, and the ability to reason about design and algorithmic choices and alternatives, and their implications for users. They will gain

[1] CPS 521 is a graduate version of CPS 221, offered as part of the Masters of Education in Digital Literacy and Computer Science (M.Ed. in DLCS).

first-hand experience with example systems and algorithms in the labs, preparing them to apply and test their knowledge and ideas.
This course teaches important parts of the 2016 Massachusetts Digital LIteracy and Computer Science (DLCS) Curriculum Framework. The section "DLCS Curriculum Map" lists those parts and describes how they are taught and assessed.

Syllabus Organization

The schedule is next, because it will be used almost daily. But but skip it the first time and read the important introductory and reference material after that first.

Course Schedule (subject to change)

Abbreviations:

H = Hailperin
O = OSTEP
C = Casad,
OS = Custom: OS*
DBS = Custom: DB/Sec**
JDBC = *JDBC API Tutorial and Reference* (on Blackboard)

#	Date	Topic(s)	Reading	Work Due
Unit 1: Operating Systems				
1	W 8/28	Course Introduction and Overview (slides)		(start HW 1)
	H 8/29	Lab 1: The Unix Command Line (slides)	"An Overview of the Unix* Operating System"	
2	F 8/30	Operating System Functions and History (slides)	Syllabus; H 1 or O 1-2	Lab 1
	M 9/2	*Labor Day, no class*		
3	W 9/4	Processes (slides)	H 2 or O 3-4	
	H 9/5	Lab 2: Unix Shell Scripting (slides)		
4	F 9/6	Processes, cont. (slides)		HW 1, Lab 2
5	M 9/9	The Critical Section Problem (slides, handout)	H 4.1-4.3	(start HW 3)
6	W 9/11	The Critical Section Problem, cont. (slides, Critical Section Summary handout)	H 4.4-4.6	

	H 9/12	Lab 3: Threads in Java (slides)		
7	F 9/13	The Critical Section Problem, cont. (slides)	H 4.8-4.10	Lab 3
8	M 9/16	Deadlock (slides)	H 4.7	
9	W 9/18	Guest speaker on Bible translation software (slides)		HW 3 (out of order, NOT 2)
	H 9/19	Lab 4: Semaphores and Message Passing *(Prof. Bjork will teach this lab, while Prof. Tuck is at the Tapia Celebration of Diversity in Computing.)*		
10	F 9/20	Scheduling (slides) *(This class will be taught by Prof. Bjork.)*	H 3.1-3.5 (optional: OSTEP 7-8)	Lab 4
11	M 9/23	~~HW3~~, Scheduling (cont); (slides)	H 3.6-3.7	
12	W 9/25	Scheduling (cont), HW3, ~~Processes~~ (slides)	H 7.1-7.2	~~HW 2~~
	H 9/26	Lab 5: Synchronization and Deadlock (slides)		
13	F 9/27	Processes; Virtual Memory; ~~Protection~~ (slides)	H 6.1-6.2, H 7.3-7.6	HW 2, Lab 5
14	M 9/30	Protection (cont.) (slides)	OS 1	HW 4
Unit 2: Networks				
15	W 10/2	OS Structure; Virtual Machines; Containers (slides)	OS 2 (beginning through 16.4.1, and 16.6 to end), Docker, "Borg, Omega, and Kubernetes" (p.70-79, or 1-10 of 24) on Blackboard	
	H 10/3	Lab 6: Virtual Machines and Containers (finished slides from previous class)		
16	F 10/4	Introduction to Net-Centric Computing (slides)	C 1, 17;	HW 5, Lab 6
17	M 10/7	Review and Catch Up (slides)		
18	W 10/9	Layered Network Architecture (slides) **~~Hour Exam 1: Unit 1~~ (postponed)**	C 2	Practice problems in last

				class's slides (ungraded)
	H 10/10	Lab 7: Network Configuration		
19	F 10/11	**Hour Exam 1: Unit 1**		Lab 7 (start HW 6)
20	M 10/14	Physical and Data Link (Network Access) Layers; (slides) ~~Discuss Exam (slides)~~	C 3, 9;	
21	W 10/16	Discuss Exam (slides) ~~Physical and Data Link (Network Access) Layers; (slides)~~	~~C 3, 9;~~	HW 6
	H 10/17	*Quad Finals, no lab*		
	F 10/18	*Quad Finals, no class*		
22	M 10/21	Network Layer; Routing (slides, Ethernet+ARP handout)	C 4, 5, 8 (just pp. 127-141)	(start HW 7)
23	W 10/23	Routing (slides) Transport Layer	C 6; C 10 (just through Dynamic DNS); skim C 12-13; Optional IPv6 rfc2460	
	H 10/24	Lab 8: Packet sniffing (slides - transport layer)		
24	F 10/25	Transport Layer Application Layer; Client-Server Model; (slides) Network Layer Packet Header handout Transport Layer Packet Header handout	C 7, skim C 18-22; H 10.1, 10.3-10.4	HW 7, Lab 8
25	M 10/28	Web Services Cloud Computing (slides)	C 22; Optional: The Compositional Architecture of the Internet	HW 8a
Unit 3: Database Management Systems				
26	W 10/30	Introduction to Database Management Systems (slides)	DBS 1	HW 8b
	H 10/31	Lab 9: Sockets		

27	F 11/1	(continued) (slides)		HW 8c, Lab 9
28	M 11/4	Review and Catch Up (slides)		
29	W 11/6	**Hour Exam 2: Unit 2**		
	H 11/7	Lab 10: Remote Method Invocation		
30	F 11/8	Exam 2 results and DB Intro/Demo (slides)	DBS 2	Lab 10 ~~(start HW 9)~~
31	M 11/11	Relational Data Model (slides)		(start HW 9)
32	W 11/13	Relational Database Querying and Updating (slides, SQL handout, worksheet, answers will be on blackboard)	DBS 3	
	H 11/14	Lab 11: Using SQL		
33	F 11/15	(continued); ~~JDBC~~ Relational Database Design and Creation (slides) *(changed order because of broken demo)*	JDBC pp.49-79 (in Blackboard, as 2 files)	HW 9, Lab 11
34	M 11/18	JDBC ~~Relational Database Design and Creation~~ (slides)	Why SQL is Beating NoSQL...	(start HW 10a)
35	W 11/20	(continued); ACID Transactions, NoSQL (slides)	H 5.1-5.4 but 5.2.2 and 5.3.1 are optional;	
	H 11/21	Lab 12: JDBC		
Unit 4: Security				
36	F 11/22	(finish NoSQL) Introduction to Security (slides)	DBS 4	HW 10a
37	M 11/25	(continued) (slides)	"Reflections on Trusting Trust" (on Blackboard)	HW 10b, Lab 12
	W 11/27	*Thanksgiving Break, no class*		
	F 11/29			
38	M 12/2	Intro to security, cont., start Encryption (slides)	DBS 5	
39	W 12/4	Encryption (slides)		HW 11a
	H 12/5	Lab 13: A Database-Driven Web Site		

40	F 12/6	Encryption, cont.; start Secure Programming (slides),	DBS 6	Lab 13
41	M 12/9	Secure Programming (slides)	Securing the Tangled Web (optional)	HW 11b
42	W 12/11	Review and Catch Up (slides)		
	H 12/12	Lab 14: Encryption		Lab 14
	W 12/18	**Final Exam, 2:30 - 4:30 pm** **Cumulative with emphasis on Units 3-4** **https://www.gordon.edu/academiccalendars**		

*** Custom:OS ebook contents:**

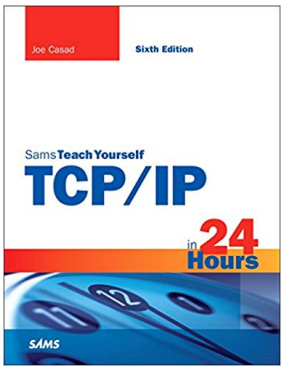
1. Operating-System Structures: *Chapter 2 from **Operating System Concepts, 9th edition**, by Silberschatz, Galvin, and Gagne, 2013.*
2. Virtual Machines: *Chapter 16 from **Operating System Concepts, 9th edition**, by Silberschatz, Galvin, and Gagne, 2013.*

**** Custom:DB/Sec ebook contents:**

1. Introduction: *Chapter 1 from **Database System Concepts, Sixth Edition** by Silberschatz, Korth, Sudarshan, 2011.*
2. Introduction to the Relational Model: *Chapter 2 from **Database System Concepts, Sixth Edition** by Silberschatz, Korth, Sudarshan, 2011.*
3. Introduction to SQL: *Chapter 3 from **Database System Concepts, Sixth Edition** by Silberschatz, Korth, Sudarshan, 2011.*
4. General Security Concepts: *Chapter 2 from **Principles of Computer Security: CompTIA Security+ and Beyond, 3rd Edition (Exam SY0-301)** by Conklin, White, Williams, Davis, Cothren, 2012.*
5. Cryptography and Network Security: *Chapter 29 from **TCP/IP Protocol Suite, Fourth Edition**, by Forouzan, 2010.*
6. Writing Secure Software: *Chapter 27 from **Information Security: The Complete Reference**, Second Edition, by Rhodes-Ousley, 2014.*

Resources

Required Texts



[Hailperin] Hailperin, Max. *Operating Systems and Middleware*. (Free pdf: https://gustavus.edu/mcs/max/os-book/osm-rev1.3.pdf)

[OSTEP] Remzi H. Arpaci-Dusseau and Andrea C. Arpaci-Dusseau, *Operating Systems: Three Easy Pieces* (Free pdf: http://pages.cs.wisc.edu/~remzi/OSTEP/#book-chapters)

[Casad] Casad, Joe. *Teach Yourself TCP/IP in 24 Hours.* (5th edition or 6th edition) (Indianapolis: Sams, 2012 or 2017)

[Custom: DB/Sec] *Software Systems.* ISBN: 9781308613116. Purchase ($18.30) from https://create.mheducation.com/shop/#/catalog/details/?isbn=9781308613116 Further instructions for this electronic book: http://create.mheducation.com/shopresources/pdfs/eBookstore_instructions.pdf

[Custom: OS] *Software Systems eText for Gordon College Wenham*. ISBN: 9781119220145. Purchase ($12.80) and download from http://store.vitalsource.com/show/9781119220145. Special software (download instructions) is required to read the text.

(See the schedule section for a list of the custom text contents.)

Readings on Blackboard

- *JDBC API Tutorial and Reference*
- "Reflections on Trusting Trust" *Communications of the ACM* 27.8 (August, 1984) pp. 761-763
- Other selections as assigned.

Course Techniques and Procedures

Readings in the text or supplementary material are assigned for every class, which you are expected to read before class. Class sessions will include a discussion and amplification of the material in the text and the presentation of further examples and supplementary material. You should not expect to grasp everything presented in the text when you first read it; however, you should note areas that are unclear to you and be prepared to raise questions about them in class. You will further develop your understanding of the material by by doing homework problems and through weekly laboratories.

Course Requirements and Evaluation

The college has adopted the following statement regarding work expectations for courses; "For each semester hour of credit, students should expect to spend a minimum of 2-3 hours per week outside of class in engaged academic time. This time includes reading, writing, studying, completing assignments, lab work, or group projects, among other activities."

So plan to spend AT LEAST 8-12 hours per week, plus class time, on this course. Plan your other commitments accordingly, and limit them if necessary.

Reading

You will be expected to complete reading assignments BEFORE the class in which the topic is discussed, as specified in the schedule. You aren't expected to master every reading before class, but rather to become familiar with it, understand as much as you can, and bring questions to class. The reading will prepare you for our classroom discussion, which may progress in a different order and include additional material.

There will sometimes be reading quizzes at the start of class (to see if you read it and gained some understanding, not if you mastered it), and comprehension quizzes at the end of class.

Note: Hailperin and OSTEP are both good free texts that cover much of the same material. You may find that you prefer the style of one or the other. In some cases, the schedule gives equivalent readings in both, and you may choose which to read. If you would like a choice in more places, tell me and I'll see where I can add more.

Homework

Homework sets will be distributed during the semester, and will be due as shown in the course schedule. Solutions to each set will be discussed in class on the due date and/or posted on Blackboard after the set is turned in. Credit for homework sets will be awarded on the basis of the completeness and correctness of your solutions, with significant credit given for a reasonably complete attempt at solving each problem, even if the final answer is not correct. In other words, you should try to do all the homework, and turn in your best attempt even if you don't think it's correct.

A passing grade on homework is required to pass the course.

The tentative emphases of the various homework sets are as follows (subject to change.)

1. Operating System Functions and History
2. Threads and Scheduling
3. Critical Sections
4. Deadlock

5. Processes and Protection; Operating System Structure; Virtual Machines
6. Network Architecture
7. Physical, Data Link, and Network Layers
8. Transport and Application Layers; Client-Server Model; Cloud Computing
9. Introduction to Database Management Systems; The Relational Data Model
10. Relational Database Design and Creation; ACID Transactions
11. Security; Encryption; Secure Programming

Labs

Weekly laboratories will focus on gaining practical experience with the material covered in the book and/or in lecture. Lab assignments will be posted on Blackboard ahead of time, and must be read carefully before coming to lab. In some cases, you will be explicitly directed to study certain material in preparation for the lab. For most laboratories, there will be a writeup to turn in. Some labs start with a quiz on your reading of the lab assignment and any assigned pre-lab preparation. Some labs have a quiz afterwards on the work done in lab. The post-lab quiz may be given in the lab, or at the start of class on the due date.

Planned emphases for the lab sessions are included in the course schedule.

Exams

There will be two hour exams given as shown in the course schedule, plus a final exam. The first hour exam will be worth 13% of the final course grade, the second will be worth 9%, and the final exam will be worth 18%. Each exam will assume familiarity with material in the text, covered in lecture, and/or used in homework problems or labs. Exams will be open book (course text only), and open notes.

Course Grade

Your final grade will be computed on the basis of a weighted sum of the items listed above. The weight of quizzes will depend partially on how many are given. This is why the weights are ranges.

Quizzes	1 - 2 %
Homework	29 - 30 %
Labs	29 - 30 %
Exams	40 %
Total	100 %

The following are minimum guaranteed grades for the scores indicated:

	93% - 100%: A	90% - 92.9%: A-
87% - 89.9%: B+	83% - 86.9%: B	80% - 82.9%: B-
77% - 79.9%: C+	73% - 76.9%: C	70% - 72.9%: C-
67% - 69.9%: D+	63% - 66.9%: D	60% - 62.9%: D-

Honesty and Integrity

If you get stuck on a lab or homework problem, first seek help from the professor or TA. If that is not possible, you may seek help from a classmate or other source in order to make progress. However, if you get help from a source other than the professor or TA, you MUST report the source, nature, and extent of the help in writing on the lab or homework problem. You might receive reduced credit, if the help is substantial, but as long as you are honest there will be no other problems.

Never lie by presenting another's work as your own - whether by copying homework answers, ideas, test answers, code, or otherwise. It is always better to give credit where it's due. The Department Project Guidelines give more detailed instructions.

Note that Gordon College's Academic Dishonesty policy (on p. 11-13 of the Student Handbook) requires that plagiarism result in an F for at least the assignment, and in some cases the entire course. Further consequences can include suspension from the College.

For completeness, the standard statement also applies: Academic dishonesty is regarded as a major violation of both the academic and spiritual principles of this community and may result in a failing grade or suspension. Academic dishonesty includes plagiarism, (see Plagiarism in Student Handbook), cheating (whether in or out of the classroom), and abuse or misuse of library materials when such abuse or misuse can be related to course requirements

Computer Use in Class

If you have a laptop, please bring it to class. However, electronic devices (computers, tablets, phones, etc.) may be used in class ONLY for class work, including note taking, consulting class materials, and in-class assignments.

Using electronic devices for non-academic activities during class (email, social networking, games, internet browsing, etc.) will cause the student to lose the privilege of using electronic devices in class.

Extensions and Incompletes

Extensions of the due dates for homework may be given in the event of extenuating circumstances (such as illness, personal emergency), IF you submit a brief email request to the professor as soon as possible after the circumstances arise. The professor will reply with

whether the request is approved. When you turn in the work for which an extension was granted, include a reminder note about the extension.

A grade of Incomplete will be given without penalty IF you are unable to complete the course work by the last day of the term due to major illness or other similar emergency. Again, an email request should be submitted. Such a request will only be granted if you are substantially up-to-date with your course work and were making good progress in the course up to the time that the difficulty arose. Of course, you must complete all work for the course by the midpoint of the next semester in accordance with College policy.

A grade of Incomplete with a penalty of one letter grade to be applied in the final grade computation MAY be given if you are unable to complete all the course work for reasons other than those noted above. You must make a written request, and your progress in the course, class attendance etc. will be taken into consideration in determining whether to grant it. Again, you must complete all work for the course by the midpoint of the next semester.

Attendance Policy

Regular class attendance is expected of all students, and class attendance will be recorded. Absences from class will be classified as “documented” or “undocumented”. A documented absence is one where written documentation is submitted supporting an absence from class due to circumstances beyond the student’s control. An undocumented absence is any other absence, including one which could qualify as documented if proper documentation were submitted.

Students who have more than three undocumented absences during the semester should expect to see their final grade reduced by 1% for each undocumented absence over 3, and students who have more than 12 undocumented absences will fail the course automatically. The allowance of 3 undocumented absences may be reduced by one for each documented absence over 3 - e.g. a student who has 2 documented absences may be allowed only 1 undocumented absence without grade penalty. (This will not be applied retroactively, though.) Note that it is not necessary to document absences unless there are more than three total absences; for most students, this will avoid the need to submit documentation. A student who anticipates the need to miss more than three classes due to athletic competitions or other student activities should review the college’s attendance policy in the catalog, and should then discuss alternatives to class attendance with the professor at the start of the semester.

A student who is habitually late will have late arrival for class counted as a half absence for that class, and a student who sleeps through most or all of a given class session will be counted as absent for that class.

You may ask the professor to waive this policy for you if you have an A average in this course after the first exam. If you wish to take advantage of this exemption, you must so inform the

professor. However, the attendance policy will be reimposed if your subsequent work deteriorates.

Accommodations for Students with Disabilities

Our academic community is committed to providing access to a Gordon education for students with disabilities. A student with a disability who intends to request academic accommodations should follow this procedure:

1. Meet with a staff person from the Academic Success Center (ASC) and provide them with current documentation of the disability.
2. Obtain a Faculty Notification Form from the Academic Success Center, listing appropriate accommodations.
3. Submit this form to professors and discuss those accommodations with them, ideally within the first two weeks of classes.

Some accommodations need more time to arrange so communicating early in the semester is important. For more information consult the Academic Support Center webpage: http://www.gordon.edu/academicaccessibility or email asc@gordon.edu.

DLCS Curriculum Mapping

Standard	Description	Teaching & Learning	Assessment
3-5.CS.a-d, 6-8.CS.a-d, 3-5.CT.a-e, 6-8.CT.a-e	Consistent with the natural progression of these standards, and the maturity of our students, some standards are so widely known that we teach them by exception. By assessing students in the class, we are able to teach them individually when formative assessments reveal a need.	Some as part of related 9-12 standards; others individually, as needed.	Assessments for related 9-12 standards; classroom interaction; progress in labs; lab writeups.
9-12.CS.a.5	Describe how computing devices manage and allocate shared resources (e.g., memory, Central Processing Unit [CPU]).	Classes 2-15	Homework 2-5 Exam 1
9-12.CS.c.1	Explain how network topologies and protocols enable users, devices, and systems to communicate with each other.	Classes 16-24	Homework 6-8 Exam 2
9-12.CS.c.2	Examine common network vulnerabilities (e.g., cyberattacks, identity theft, privacy) and their associated responses.	Classes 36-41	Homework 11 Exam 3
9-12.CS.c.3	Examine the issues (e.g., latency, bandwidth, firewalls, server capability) that impact	Classes 16-24	Homework 6-8

	network functionality.		Exam 2
9-12.CS.d.1	Compare the value of using an existing service versus building the equivalent functionality (e.g., using a reference search engine versus creating a database of references for a project).	Class 26	Homework 8 Exam 2
9-12.CS.d.2	Explain the concept of quality of service (e.g., security, availability, performance) for services providers (e.g., online storefronts that must supply secure transactions for buyer and seller).	Class 26	Homework 8 Exam 2
9-12.CT.e.1	Create models and simulations to help formulate, test, and refine hypotheses.	Creating simulations: Labs 4-5	Labs 4-5
9-12.CT.e.2	Form a model from a hypothesis generated from research and run a simulation to collect and analyze data to test that hypothesis.	Simulations in the context of testing algorithm correctness: Labs 4-5	Labs 4-5