ECS 50, Computer Organization and Machine Dependent Programming

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Highlights

- hard copy of (open source) textbook is required, student-printed
- discussion section is required, weekly Quizzes given there
- heavy emphasis on Group work
- no final exam; instead, have final Group Project/Homework
- it is required that you read the course Blog every day
- in-class Group Quiz, last day of lecture
- see Important Dates, Section 1
- submission of work:
  - Quizzes taken in-class, but required to submit electronic version of your answers (very short) via **handin** to the professor
  - submit HomeworK via **handin** to the TA

1 Important Dates and Deadlines

- formation of Homework Groups: by October 4
- Midterm Exam: November 29
- Group Quiz: December 6
- Group Project due: December 12

2 Required Course Materials

2.1 Textbook

The textbook is my open source book, available at `http://heather.cs.ucdavis.edu/~matloff/50/PLN/ECS50Fall2012.pdf`.

We will cover the entire book. Note, though, that it is actually an abridged version of `http://heather.cs.ucdavis.edu/~matloff/50/PLN/CompSystsBook.pdf`, shortened by removing chapters on advanced material. I continually revise the long version, and you may find that sometimes the revised material is helpful, but it is NOT required.

You can print the book anywhere, say at Copyland on G Street and Davis Copy Shop on 3rd St., but you may find it's cheaper elsewhere. Cost, including binding, should be between $20 and $30. One student said she got her book from Digital Copies on 3rd St. for just $16. (Note: When you talk to a vendor on this, be sure to distinguish between *pages* and *sheets*.) Just bring the store a copy of the correct PDF file, say on a memory stick.

PLEASE NOTE: Pagination matters! Tests (which are open book) will refer to specific pages in the book. So you need exactly the particular file stated above.

It is required that you have a hard copy of the book, as it will be used during Tests.

3 Course Content and Goals

This course is a lot different from courses you've likely had before—especially the way I teach it.

3.1 It's NOT a Programming Course

I know that you are thinking that ECS 50 is "the assembly language course," treating it as being devoted to learning just another programming language like C or C++. **THIS IS NOT TRUE.**

We definitely will do a lot of programming in this course, but AS A MEANS OF LEARNING ABOUT COMPUTER SYSTEMS, NOT AS THE MAIN GOAL. The main goal is to LEARN ABOUT COMPUTER SYSTEMS.

3.2 So, What IS This Course About, Then?

Instead of thinking of ECS 50 as "the assembly language course," you should think of it as follows:

- it's the "Does this PC have enough cache memory?" course
- it's the "What are the basics of device drivers?" course
- it's the "What can I do when my machine won't boot up?" course
- it's the "What can I do when my program fails to link with a library file?" course
- (best of all) it's the "What should I know so that I don't look like an idiot when I interview for a job?" course

This course is an introduction to computer systems:

- *computer architecture*, i.e. high-level hardware structures
- *system software*, i.e. operating systems, linkers, compilers and so on

Again: It is certainly true that you will do a large amount of assembly language programming in this course, but it is a means to the above goals, not an end in itself.

3.3 What Is Different About My Version of ECS 50

All instructors of a given course are supposed to cover the material listed in the Expanded Course Description (ECD) for the course.

However, there is still plenty of room left for individuality. My version of ECS 50 differs from those of other instructors in that:

- As mentioned earlier, I require more programming work than other instructors do in this course.
- My course uses a real machine, rather than being simulator-based. We will be working on PCs running Linux. This is hugely important.
- Though I of course cover both computer architecture and systems software as required in the ECD, I go into extra depth on systems software (e.g. how programs are loaded into memory).
- I put a lot of emphasis on how the hardware and software interact with each other.

3.4 Why Linux?

There are several important reasons why the main computing platform in our course will be Linux:

- I feel strongly that it is not enough to teach this course on a simulator. Students learn much better on a real machine, i.e. real hardware and a real operating system (OS).
- Linux is open source, which means that all of its "innards" are visible to anyone who wants to look at them. This is perfect for us, as **ECS 50 is an "innards" course**. We will for example look at excerpts from the actual Linux source code, which we would not be able to do with Microsoft Windows.
- **LINUX IS IMPORTANT FOR YOUR CAREER.** See Section 6.

You are very strongly urged to install Linux on your home PC, if you don't already have it there.

4 Workload

There will be approximately five assignments, consisting mainly of programming work.

IN ORDER TO ACHIEVE A DECENT GRADE, PLAN TO SPEND SIGNIFICANT TIME ON CAREFUL READING OF THE TEXT, AT LEAST FIVE HOURS PER WEEK.

All in all, the number of hours per week you'll put in should be similar to something like ECS 60.[1] Note, though, that much of this will be Group work.

[1] I'm not assuming you've had that course, but you may have heard about it.

5 Prerequisites

The required background is:

- The prerequisite for this course is ECS 40 or equivalent. This means you must have had a two-course programming sequence, with the second course having you write more sophisticated programs than the first, and that you know C and C++. **Please note that prerequisites are strictly enforced.**
- You must have reasonable programming and debugging skills.

6 Machines

When you submit Homework code, it is not considered valid unless it works on the Linux PCs in CSIF.

HERE IS A SHOCK FOR SOME OF YOU: Most jobs obtained by UC graduates in the computer area are at firms that are either fully or partially based on Linux or some other kind of Unix. Google is such a strong Linux shop that it once developed its own version of Ubuntu Linux, Goobuntu. You probably also know that Android, the popular OS for smartphones and tablets, is a variant of Linux. Apple's OSs, ranging from Macs to iPads to iPhones, are also Unix-based.

Intel has complained that UCD grads don't know Linux well. Of course, students from UC Berkeley know Linux thoroughly; why be at a disadvantage to them?

In other words: If you've been using Windows to do your CS Homework, you've been limiting your future career opportunities! Not a smart strategy, right?

So, if you don't know Linux well, you should remedy that problem now, to enhance your future career prospects. And the ONLY way to learn it is to USE IT IN YOUR DAILY LIFE—not just for coursework, but also for e-mail, writing term papers, developing Web pages, video editing, and so on.

I have a Linux installation and usage tutorial at `http://heather.cs.ucdavis.edu/~matloff/linux.html`. If you are going to use Linux in your daily life, as again I urge you to do, then I recommend installing on a dual-boot basis. Otherwise, install on USB key or an external hard drive. Instructions are given in my tutorial.

7 Each Student Must Have His/Her Own Course Materials

Note that Tests are open-book, and there is no sharing of books or other materials during Tests, nor are electronic devices allowed.[2] Thus every student must have his/her own hard copy of the textbook and any other course materials.

8 Bring the Course Materials with You to Class

Bring the entire textbook and other course materiels to lectures, discussion sections and Tests.

[2] An exception is the Group Quiz, given the last day of class.

9 Terminology

- the term *Midterm Exam* refers to the midterm examination given in lecture
- the term *Quizzes* refers to tests given in discussion section; see Section 10.2
- the term *Tests* refers to the Exam and Quizzes
- the term *Homework* includes both math and programming work (most courses, other than ECS 132/256, won't have math work)
- the term *Final Project* refers to the take-home Group project that serves as the final Homework assignment and is in lieu of a final exam

10 Tests

10.1 Exam Schedule

There will be one midterm Exam, exactly one week before the last day of lecture.

There are no early or late Tests. Provisions for oral makeup Midterm Exams will be made if you have a medical excuse. Note: Oral Exams are very difficult for the student, and are difficult for me to grade. Try to avoid this situation if possible. There are no makeup Quizzes; if you miss a Quiz, it simply will become one of the two Quizzes you exclude from your grade.

10.2 Quizzes

A Quiz will be given almost every week in discussion section. Quizzes will not be announced; assume that there will be one each week.

Quizzes will consist of fill-in, multiple choice and very short-answer questions, and thus will not probe quite as deeply as the Exam will.

10.2.1 Group Quiz, Last Day of Lecture

The last Quiz, given in lecture on the last day of class, will consist of an in-class Group effort, i.e. you will work on the Quiz with your Group.

This will be done on computers. Each Group must have at least one laptop among them. Let me know if no one in your Group has one.

10.2.2 Partial Credit on Quiz Problems

Quiz problems will be short answer, but you still may be able to get partial credit, in the case of arithmetic or algebra errors, or in the case of code, spelling or syntax errors. In fact, you will probably get full credit in those situations. But it is your responsibility to bring it to my attention after the grades are out.

10.2.3 Electronic Submission Is Required

Here is the procedure for the Quizzes (except for the final one). You take the Quiz in class and turn it in on paper, but then also turn it in electronically. It is then graded semi-automatically, using a grading program but with some human intervention (mine).

Below are the rules. Please note that your submission will be gradely mostly by a PROGRAM; if you don't use the format expected by the program, the program goes crazy and bad things happen.

- Before you turn in your Quiz paper during the discussion section, copy your answers to another sheet; the Quiz problems will have only short answers, so this will be quick and easy.
- Later that day, type your answers into a file, and submit it to me using the CSIF **handin** program. Log on to CSIF, and run (say for ECS 132, Quiz 6)

  ```
  handin matloff 132quiz6 jsmith.txt
  ```

- As an added bonus, your grade on the Quiz, both letter and broken down by problems, will be automatically e-mailed to you as soon as the Quiz is graded.

Here is a sample. Say your Problem 1 has the answer $3 \cdot (2/17)$, Problem 2(a) and 2(b) have the answers 8 and 88, and Problem 3 consists of filling in two blanks in code, with answers **x*y** and **if**. You did not answer 2(c). Your answers file would then be

```
#1
3 * (2/17)
#2a
8
#2b
88
#2c
00
#3a
x*y
#3b
if
```

Here are the details:

- Your file name will consist of your official UCD e-mail address plus **.txt**, e.g. **jsmith.txt**. You must not deviate from this.
- The file structure will consist of one line containing the problem number, followed by one line for the answer.
- If you do not answer a problem or subpart, make sure to answer anyway, writing 00 (two 0s). (If you don't answer an entire problem, then put 00 for each part.)
- In the case of questions with numerical answers, write them in program style, using R syntax, e.g. using * for multiplication, $\hat{}$for exponentiation, %% for the mod operator, etc. Call **exp()** for evaluating powers of e = 2.71...

Please note that the grading program is itself is written in R, and it will automatically parse your R syntax. So it must be real R; for instance, if asked how many rows a matrix has and the answer is 5, then answer 5, not "five" or "5 rows".

I recommend that you do NOT simplify your answers, so as to maximize your chance of getting partial credit.

Please do not use **integrate()**, as you will likely get the syntax wrong.

- Your file must follow the above format exactly, alternating problem number lines with answer lines. AN ANSWER MUST BE LIMITED TO ONE LINE. If a problem asks you to write code and you believe more than one statement is needed, put all the statements on one line, separated by semicolons.
- Your electronic answers must be identical, LETTER FOR LETTER, to what you wrote on paper. The only exception is that you may correct R syntax errors.
- If a problem asks you to fill in a blank in some program code but you believe nothing should go there, answer Nothing.

For the in-lecture, Group Quiz on the last day of lecture, submission will be electronic too, but in a different form.

10.3 Coverage

Tests always cover all material through the most recent lecture, including all reading through the latest page covered in lecture. (Note: I will not cover every word in every line on every page of the text. If at Test time I have covered through page n, that means you are responsible for pages 1-n, unless I state otherwise.)

10.4 Open-Materials Policy

TESTS ARE TAKEN ON AN OPEN-MATERIALS BASIS. Bring the textbook and other course materials with you to each Test. You are also welcome to bring whatever other materials you wish, e.g. technical books, dictionaries, whatever you want. Whatever you bring, **make absolutely sure that you remember to bring all your course materials, as many of the Test questions will refer to specific pages in them.**

Please note that in program code on the Tests you are only allowed to use language, functions, etc. constructs presented in our course.

10.5 Electronic Devices

You are not allowed to use any electronic devices, INCLUDING CALCULATORS, during Tests.[3]

11 Regarding Academic Dishonesty

An embarrassing subject which nevertheless must be mentioned is academic dishonesty, i.e. cheating.

If a student is found to be cheating, it will be treated as a VERY SERIOUS matter, not a harmless prank. It will harm his/her standing at the university, and also possibly make it difficult for him/her to get a job when seeking employment after graduation.

[3]The last Quiz will involve work on your own laptops, in your Groups.

11.1 UC Davis Honor Code

You can find the UC Davis Honor Code at `http://sja.ucdavis.edu/files/CAC.PDF`. Our course will be conducted according to that code, as of course all classes are.

There is nothing surprising in the code; it's just common sense.

11.2 Tests

Official university policy[4] forbids

> "Wandering eyes," talking during exams...or leaving the exam room without permission.

Please work as follows during Tests:

- Try to sit in alternate seats if possible.
- **ABSOLUTELY NO TALKING** to classmates at any time during the Test, **ESPECIALLY INCLUDING** during the time the TA or I are collecting the Tests.
- Keep your Test paper covered when you are not actually writing, so that it will not be so exposed to view.
- It would be greatly appreciated if you **USE THE RESTROOM BEFORE THE EXAM STARTS, RATHER THAN DURING THE EXAM.** And never leave the exam room without permission.

Thanks very much for your help.

11.3 Homework

Outright copying of homework, whether in the form of code or algorithm or math, is of course a serious violation of university policy and personal ethics. Similarly, asking for advice on the Internet, or paying people for advice, is again a serious violation of university policy and personal ethics.

However, you are welcome, and indeed encouraged, to trade tips with people in other Homework Groups. You may also on rare occasions ask people whom you know outside the class for hints, say friends or relatives who have some knowledge of the field.

You are also welcome to make reasonable use of the Web. For example, I'm a big fan of Wikipedia and there is a ton of material on there.

12 Lecture Format

12.1 Bring the Materials to Lecture

Make sure you bring the textbook to every lecture. It will play a very active role in the lectures.

[4] See the *Class Schedule and Registration Guide*.

I very seldom write on the blackboard. Instead, I talk about what's in the textbook. I typically will ask you to open to a certain page, and then will call your attention to various sentences, examples and pictures on that page. **The lectures will consist mainly of discussion and amplification of the examples in the textbook, with additional examples and comments.**

Since the textbook already contains my lecture, you don't take notes (other than miscellaneous comments in the margin). This frees your attention to ask questions and to engage in class discussion.

You are very much encouraged to bring up any questions you might have. Please don't be shy about asking questions; there is no such thing as a "dumb" question. Similarly, listen carefully to the questions the other students ask; this can be a very valuable source of insight, to which you should pay special attention.

12.2 Use of Laptops During Lecture

Really, this is rude. And though it has become commonplace, I (and many other professors) do not like it, and surveys have shown that many of your fellow students are annoyed by it too. It is very distracting. If you wish to use a laptop in class, PLEASE SIT IN THE BACK OF THE ROOM.

Use of tablets is OK (during lectures, not Tests), as long as you do so quietly, with the device lying flat on the desk.

13 The Discussion Section

The discussion section is required. It will be used for the purpose of giving Quizzes, and occasionally for presenting material not covered in lecture. (That material will appear on Tests.)

14 Groups

The following will be done in Groups:

- Homework
- the last Quiz of the quarter, in class
- the take-home Final Project

So, get to be very good friends with your Group, as you will be working with them constantly!

14.1 Forming Groups

Group size must be at least three (two if the class enrollment is under 25), and no more than four.

You must submit to the TA your Group membership lists by 11:59 p.m. of the day of the first discussion section, whichever comes first (unless there is no first discussion section). Often, the TA will use the first discussion section to organize Groups. In any case, the TA will arrange Groups for anyone who has not found a Group to join on his/her own.

In working with your partners, you should work TOGETHER, instead of simply dividing up the work among the partners. I've seen many cases in which the partners do the latter, with the sad result that they, for instance, miss an easy 30-point problem on a Test.

14.2 Group Participation: Your Responsibilities

YOUR HOMEWORK PARTNERS DEPEND ON YOU. **Repeated failure to work cooperatively with your Group may result in a substantial penalty being applied to your course grade, which could drop to an F.**

You must show up at agreed-upon meetings of your Group, or arrange virtual meetings either through e-mail, Skype, Google+ Hangouts etc.

It is not acceptable to say something like "You do this assignment and I'll do the next." Each student in a group is expected to participate in every assignment.

15 Our Class Web Page and Blog

Our class Web page is at `http://heather.cs.ucdavis.edu/~matloff/xxx.html`, where xxx is our course number, e.g. 132 for ECS 132. It contains information on office hours and the like.

Our class Blog is linked to from our class Web page. **IT IS REQUIRED THAT YOU READ THE BLOG EVERY DAY**; it's used to announce Homework assignments (including clarifications), Exams and so on.

16 Homework

We will have approximately four to six Homework assignments through the quarter.

16.1 Homework Due Dates

The term *due date* means 11:59 p.m. of the stated date.

16.2 Announcements

Homework assignments will be announced in the class Blog. (Note: An assignment is not official until it is announced on the Blog.) The Homework specs themselves will be on the course Web site, so look there when an assignment is announced on the Blog.

Occasionally there will be news about a current Homework assignment, such as clarifications, hints and so on. These will be announced in the Blog.

16.3 Submitting Homework

It is REQUIRED that you use the Linux **tar** command to package all of your files. For a programming course, this will be just your source code files, except in the Final Project, where you will include your **.tex** and associated **.pdf** files. For ECS 132, there is another file needed, described below.

The file name will be **email1.email2....tar** where the "email" fields are the official UCD e-mail addresses of the members of your Group, e.g. **jsmith.agutierrez.streddy.tjwong.tar**.

You then submit your **.tar** file to the TA (not to me), using **handin** on CSIF.

16.3.1 Special Instructions for ECS 132

Your **.tar** package must include a file **Answers.txt**. The TA's automatic grading program will check these in order to get a preliminary grade on your submission, prior to the interactive grading.

16.4 Grading

We will use interactive grading. The TA will announce Homework grading times, and each Homework Group will sign up for a time slot. **All members of the Group must be present during the grading time.**

During a Group's time slot, the TA will ask each member of the Group questions about their Homework submission, such as "What if the problem had asked...", "Explain in detail why you did it this way...", "What if you were to do it this way instead... The purpose of these questions is to ensure that all partners are actively involved in all the work.

The TA will assign separate grades for each Group member. In many cases, these grades will be identical, but if there is a substantial disparity in the levels of understanding the different Group members have regarding the assignment, the TA will assign different grades to each member.

It's not expected that all members of a Group are equally proficient in programming or math, and thus it's not expected that everyone contributed equally to their submitted work. However, it IS expected that everyone was very actively involved.

The TA will e-mail me a report after grading an assignment, with tentative grades for my approval. Below are samples of what the TA might say.

Example 1:

> Group 3, John, Jim and Mary: All three students seemed to have actively contributed to this assignment, and all three answered my questions well. The program worked fine. Tentative grades—John A, Jim A, Mary A.

Example 2:

> Group 3, John, Jim and Mary: The program worked fine, but Mary seems to have done most of the work. John had some trouble answering my questions, and Jim could answer almost nothing. Tentative grades—John C, Jim F, Mary A.

Example 3:

> Group 3, John, Jim and Mary: The program worked mostly OK, but failed when I tried the input combination 8, 88 and 168. All three Grop members did answer my questions well. Tentative grades—John A-, Jim A-, Mary A-.

In the case of ECS 132, replace references to the program in the above examples to math problems.

16.5 If You Need Help, Hints, Etc.

Please note that Homework assignments here will NOT lay out a detailed recipe, with tons of hints, telling you how to do the problems.

The work is designed to be challenging and thought-provoking. This thought-provoking nature of the assignments is the vehicle by which you get to really understand the concepts. You are not necessarily expected to see right away how to do an assignment. Instead, you are expected to spend a considerable amount of time pondering the assignment, gradually seeing more and more, until you finally see how to do the whole thing. It is through that thought process that will develop insight into the course material.

The TA and I will be quite happy to help you, definitely including giving you hints—but only if, after giving a matter considerable thought, you still don't see what to do. Once you have reached the point where you cannot go any further, we very much encourage you to seek help from us. We want you to do well on the Homework!

16.6 Late Work

An assignment is late if it is submitted to the TA after the due date. If you are late, you will be assessed a 5% penalty the first late day, and 10%-per-day penalty after that in your grade for that assignment. (Since **handin** is available every day, each of the seven days of the week counts as one day.) The maximum total penalty is 50%.

Each Group will be allowed a total of 2 late days over the quarter, time which is not penalized. You can use this as being late 2 days with no penalty on one assignment, or as being late 1 day with no penalty in each of two assignments.

Don't squander your grace period days in the first assignment! The subsequent ones will almost certainly be more difficult, so save your grace time for then.

The TA will keep the appropriate records as to how many days of grace period you have used.

17 Final Project

In lieu of a Final Exam, we have a Final Project, which also serves as the last Homework assignment. It will be take-home and collaborative with your Homework Group, just as with your earlier assignments. It will be very different from regular assignments, though:

- it will be of a different nature, notably in its requirement that you submit a written report.
- it will involve less work than a regular assignment
- you submit your Final Project to me, not to the TA, and I am the one who will grade it (submit it via **handin**)
- no late Final Projects will be accepted
- an especially good Final Project may substantially your course grade, much more than a regular assignment would

Details will be given later. If you are curious now, though, you can find model examples in the **Hwk/** directory within our class Web site.

18 Grading

Grading is noncompetitive (there is no "curve"), so it is possible for everyone to do well.

18.1 Weighting

The formula used is

course grade = 0.45 x *Quizzes grade* + 0.30 x *Exam grade* + 0.25 x *Homework grade*

where the Exam, Homework and Quizzes grades are each on the 4-point scale (4 for an A, 3 for a B, etc.).

Remember, the Final Project is also considered part of the Homework. If this is missing, it will not merely be treated as an F. Instead, you will be imposed a heavy penalty on your course grade.

18.2 + and - Grades

The threshhold for a grade of n is (n-1).85; the threshhold for an 'n-' grade is (n-1).6; the threshhold for a '+' grade is n.2. So, for example, if your weighted average from the above formula is between 2.6 and 2.84, your course grade is B-; if the average is between 2.85 and 3.19, your course grade is B; if the average is between 3.2 and 3.59, your grade is B+.

18.3 Quizzes Grade

You will get a letter grade on each Quiz.

In recognition of the fact that on (rare) occasions you will not be able to attend discussion section, or you simply will have an "off day," your lowest two (letter) Quiz grades will be thrown out. Your other Quiz letter grades will be averaged to produce your overall Quizzes grade.

If you receive an F grade on many quizzes, your course grade will be reduced, possibly to an F, regardless of overall grades on the Quizzes, Midterm Exam and Homework.

18.4 You Should Get an A or A- on the Homework

I aim for the vast majority of the class to get an A or A- on the Homework. Lots of help is available, so this aim should be achievable. (And it is; I use this policy in every course I teach, and it always works out that most people get A or A- Homework grades.)

The most important part of getting a good Homework grade is to **start an assignment as soon as it is assigned.** Don't wait until a few days before the due date to start. **And make sure you have read the textbook thoroughly before starting.**

18.5 Getting Feedback from the TA

My agreement with the TA is that he/she must grade Homework within one week. TAs are students themselves, so this shouldn't be a completely firm rule, but if you find that the TA is consistently slow in grading, please remind him/her, and let me know as well.

18.6 Intangibles in Your Course Grade

This is not "CHEM 1A-style grading," calculated purely by formula, in which falling 0.5% below the cutoff point for an A results in a grade of B. The grade as determined above is just a lower bound. I can and often

do use intangibles to increase your grade above that that the formula in Section 18 would give. I would estimate this occurs in 20-25% of all the course grades I assign.

Extra Credit counts, of course (Section 19). Also, I have an "all's well that ends well" view; that a record of marked improvement near the end of the course will be given very positive consideration, as it indicates insight into how all the course concepts integrate with each other.

Negatives can be an obstacle. Those who miss Quizzes (except for medical or similar reasons) will probably not receive the benefit of such intangibles. Again, though, no one will be given a grade below what the rules of the course provide.

Exceptionally good work on the Final Project may be rewarded in terms of increasing its weight in your course grade.

19 Extra Credit

I give Extra Credit (EC) for all kinds of things. If during lecture a student makes an insightful remark, or answers a tough question I throw out to the class, I record EC for the student. If a student gets a Test problem right that no other student gets, or only a couple of other students gets, then I give EC.

So, how do I use EC? There are two main ways: (a) EC can and often does raise the student's course grade at the end of the quarter. (b) I make use of EC when recommending the student, for a job or grad school.

20 I Do Care!

I wish to emphasize that I care very much that you succeed in this course, and I look forward to getting to know all of you.