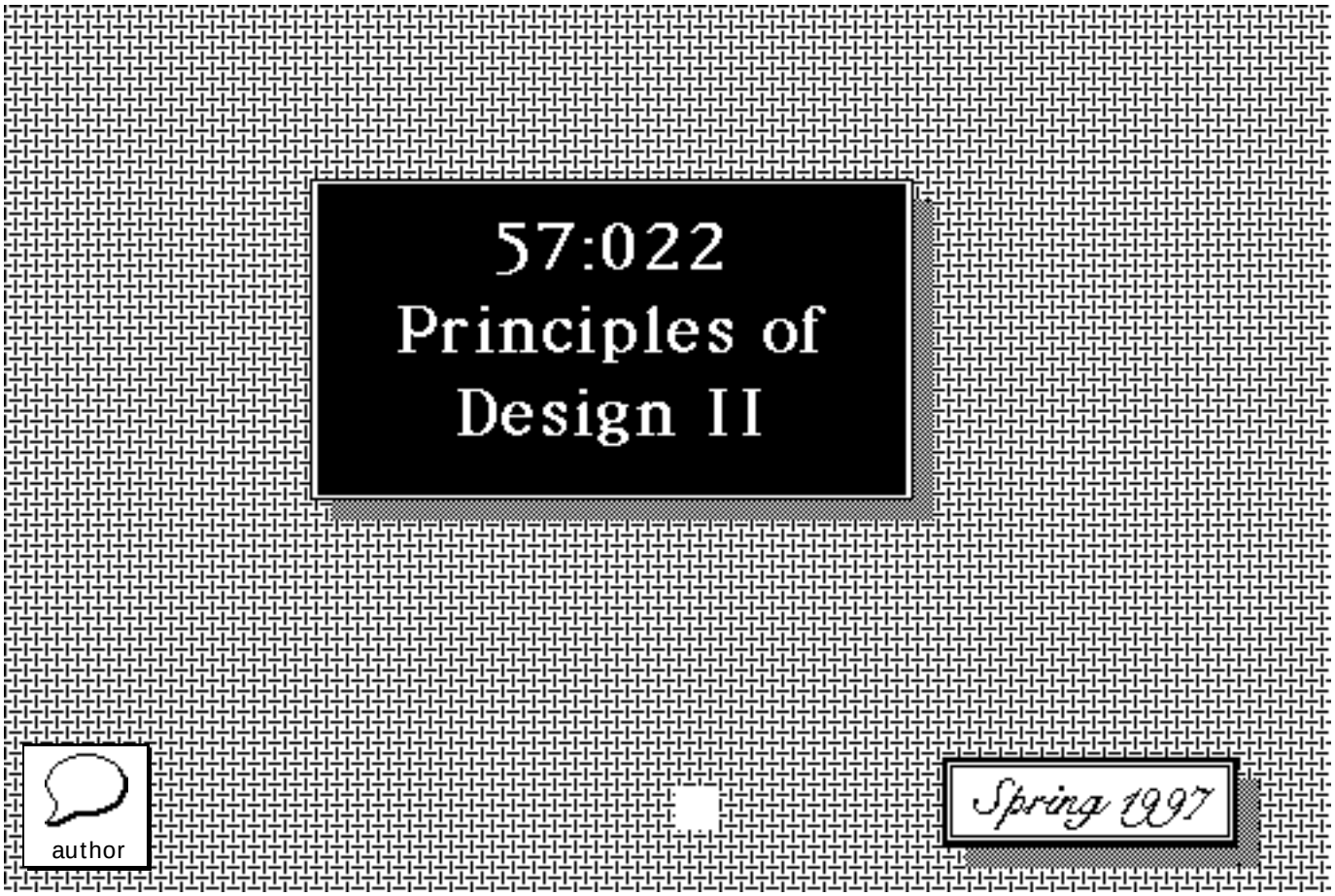

I plan to schedule a 1-hour "problem session" per week in "ALF" (4130 SC).

Instructor

Dennis Bricker, Dept. of I.E.

Office: 4120 Seamans Center

Phone: 335-5935

E-mail: dbricker@engineering.uiowa.edu

Office Hours: *to be announced*

Tentatively 11-12 Monday & Wed.
4 - 5 Wed. & Friday

Other times by appointment

Teaching Assistant

Wai Sang "Kelly" Leyu

Office:

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Office hours: *to be announced*

Course Description

Probabilistic and statistical aspects of engineering design; emphasis on model construction, systems simulation, applications in engineering design, and technical report writing.

Prerequisites

57:021 Principles of Design I

22S:039 Probability & Statistics for Engineers

Topics

- Review of common probability distributions
- Simulation of systems & statistical analysis of results
- Stochastic processes
  - Bernoulli processes
  - Poisson processes
- Discrete-time Markov chains
  - Classification of states
  - Long-run characteristics: Steady state distribution
  - Transient characteristics: First-passage times, etc.
- Continuous-time Markov chains
  - Birth-death processes
  - Some Markovian queueing models

Topics

- Regression analysis (fitting curves to data)
- Probability distribution fitting, goodness-of-fit tests
- Design of experiments
- Reliability
  - Component reliability
    - Weibull lifetime model
  - System reliability
    - simulation models
- Project scheduling with random task durations
  - PERT method
  - simulation model

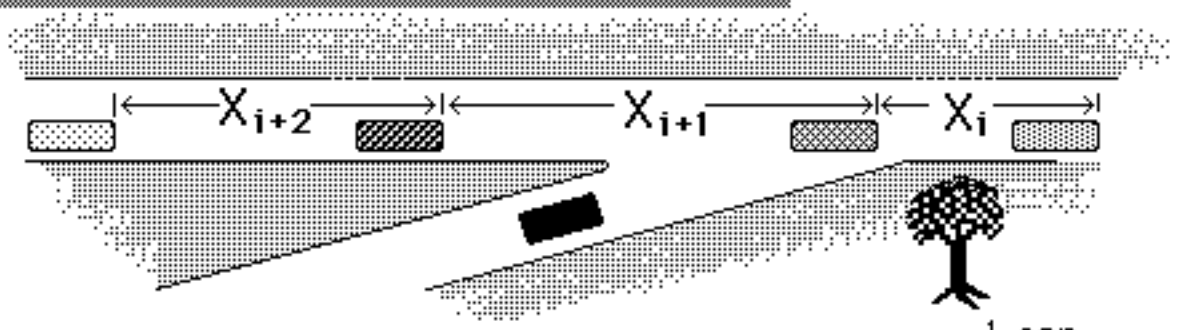
A brief glance at the types of problems we address in this course...

Example: Merging Traffic

A certain class of drivers will merge into freely flowing traffic *only if* the time X_i between oncoming cars is *at least* y seconds.

Extreme Value Distributions

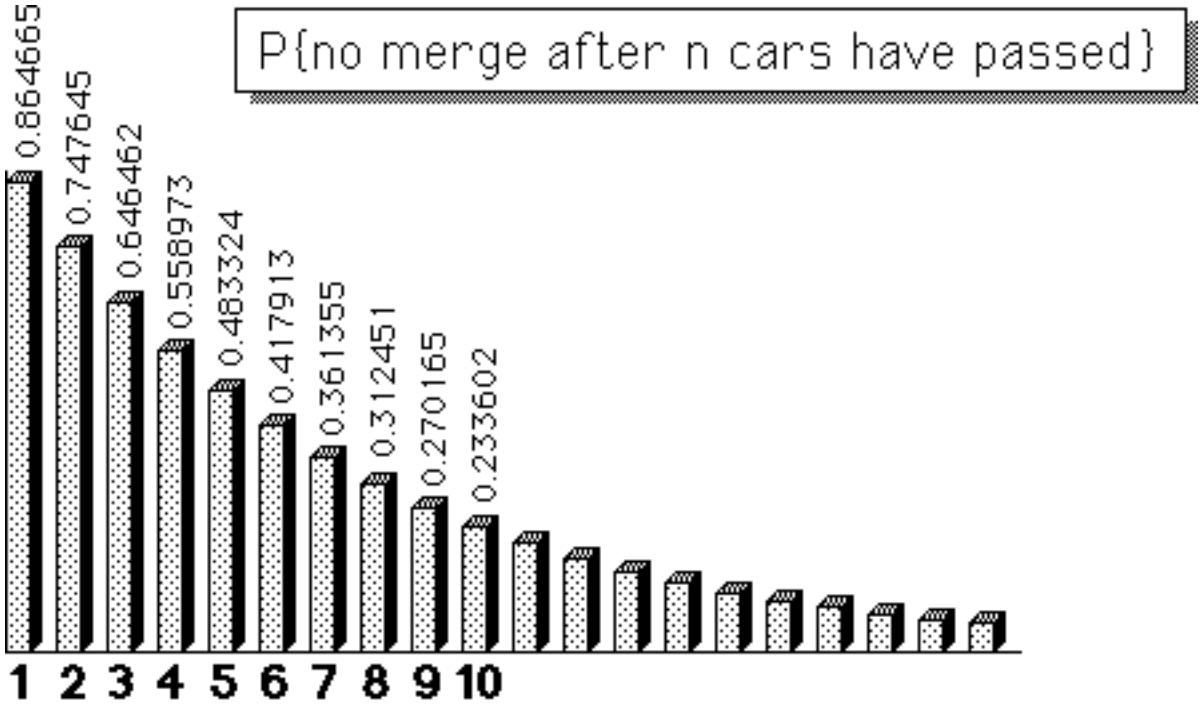
Example: Merging Traffic



Suppose that the rate of traffic is $\lambda = \frac{1 \text{ car}}{5 \text{ seconds}}$

and y=10 seconds between oncoming cars is required for merging.

What is the probability that a driver will NOT have merged after n cars have passed?

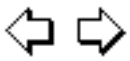


Markov Chains

Example

Allcity Insurance Co. sets auto insurance premiums based upon a customer's accident history.

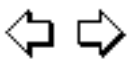
Premium	Accident History
$100	no accident during past 2 years
$400	accident during each of last 2 yrs.
$300	accident during only 1 of last 2 yrs.



A customer who has had an accident during the last year has a 10% chance of having an accident during the current year.

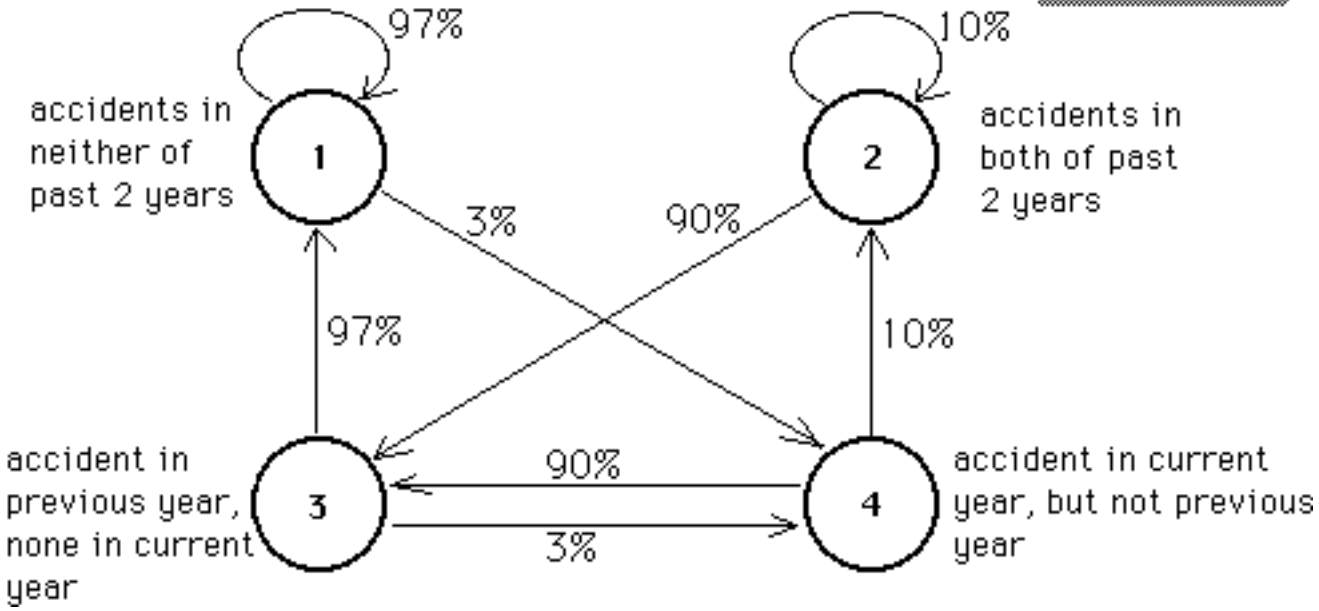
If he/she has not had an accident during the last year, there is only a 3% chance of having an accident during the current year.

During a typical year, what is the average premium paid by an Allcity customer?



Transitions between states

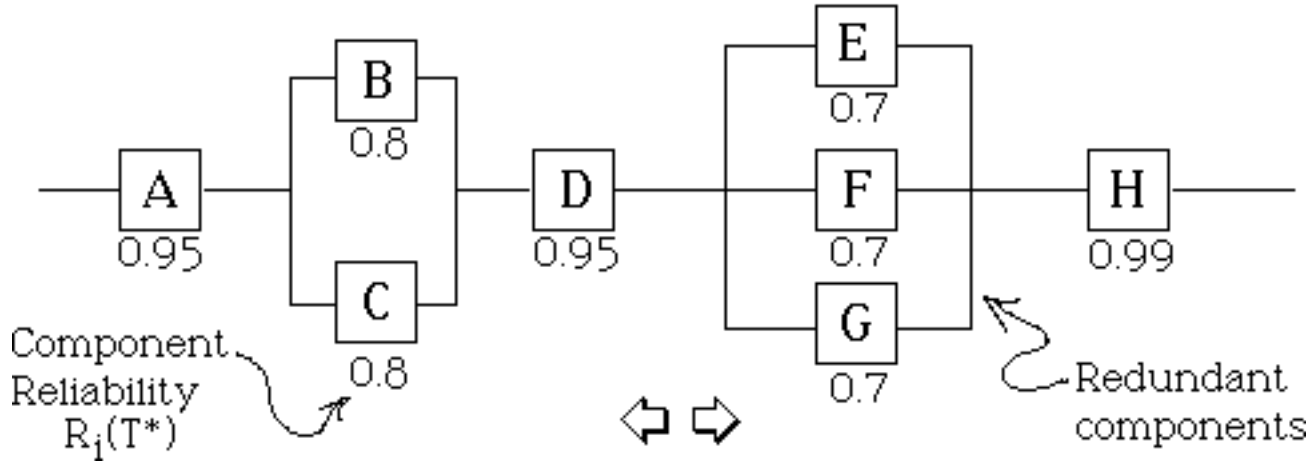
Markov Chain



System Reliability

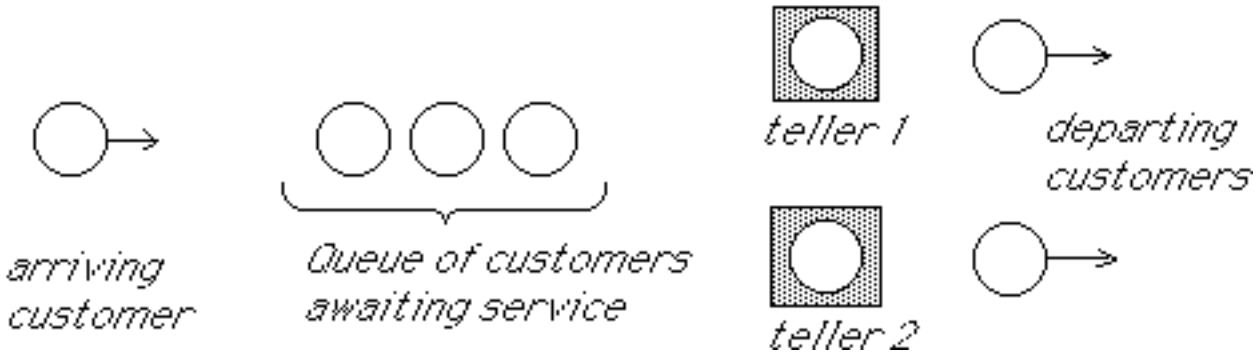
Suppose that a system is designed to fulfill its mission for a planned lifetime T.*

Find the reliability of the system, given the component reliabilities:



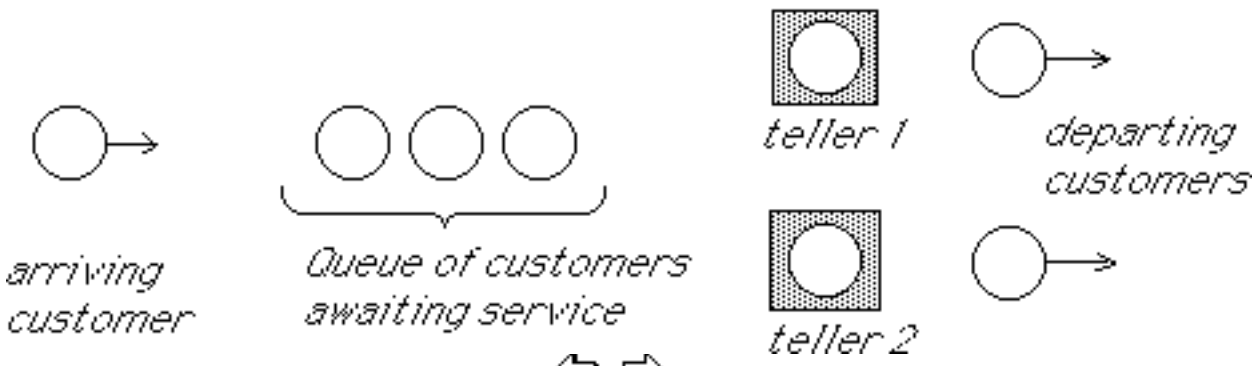
Queues

Example Bank customers are processed by one of 2 tellers with a single waiting line.

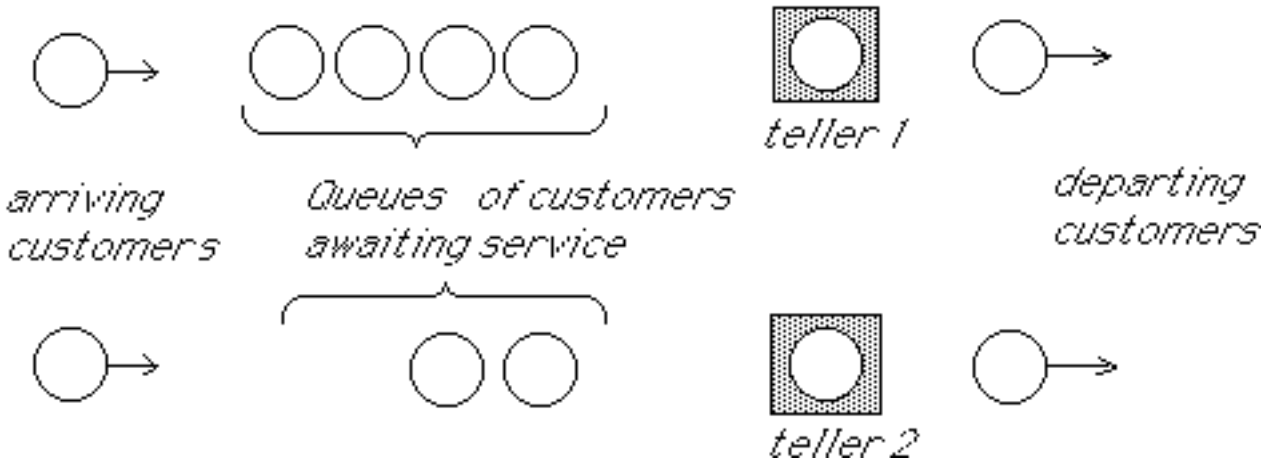


What is:

- *the average & maximum numbers of customers waiting in the queue for service?*
- *the average & maximum time which customers spend waiting in the queue for service?*



How does the performance of this system compare with that in which a separate queue forms in front of each teller (with no switching between queues)?



Two approaches:

- analysis of a mathematical model, based upon assumptions about the probability distribution of the service time & time between arrivals

  Requires strict assumptions about probability distributions

- simulation model, with multiple simulations and analysis of statistics collected during the simulations.

  Can handle a wide variety of probability dist'ns, etc.

Example

Project Scheduling

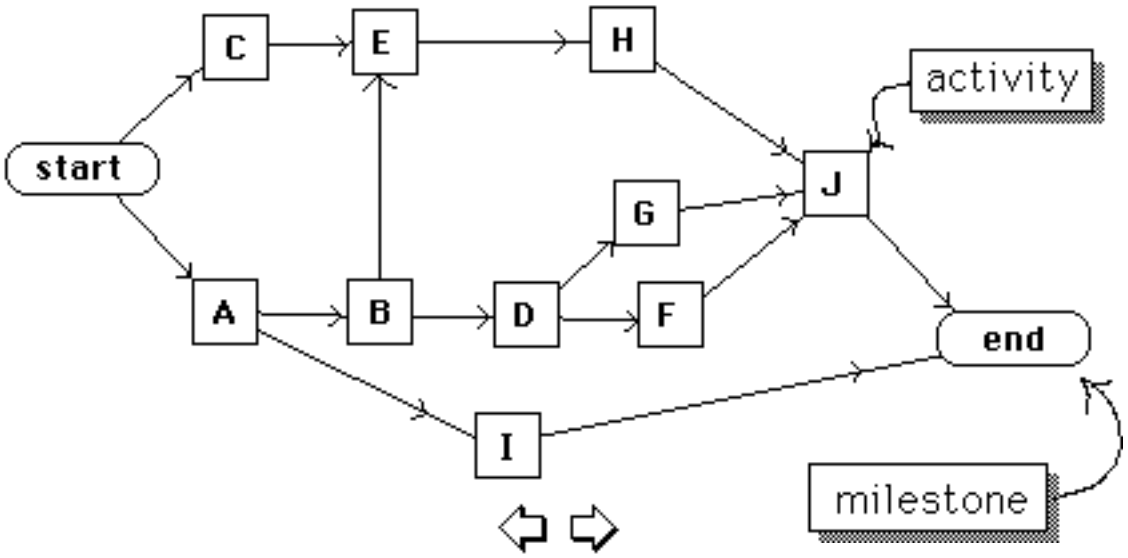
task	predecessor	duration
A	none	5
B	A	3
C	none	3
D	B	2
E	B,C	4
F	D	4
G	D	2
H	E	8
I	A	5
J	F,G,H	3

Before beginning a task, certain predecessor tasks need to have been completed.

What is

- *the earliest start time of each task?*
- *the minimum duration of the project?*

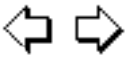
Project Network
(AON - Activity-On-Node)



Suppose that the durations are random...

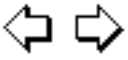
task	predecessor	estimates of duration		
		optimistic	best guess	pessimistic
A	none	3	5	8
B	A	1	3	4
C	none	2	3	4
D	B	1	2	4
E	B,C	2	4	7
F	D	2	4	7
G	D	1	2	4
H	E	4	8	11
I	A	3	5	8
J	F,G,H	1	3	4

How do you estimate the project completion time?

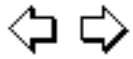


Textbook

- No req'd text.
  (*Probabilistic Engineering Design,* by James Siddall has a price tag of $130, so it will be put on reserve in Engineering Library. You may wish to copy portions of this book for your own use.)



- Several books have been placed on reserve in the Engineering Library, including:
  - *Probability, Statistics, and Decision-Making for Civil Engineers* by Benjamin & Cornell
  - *Operations Research: Applications & Algorithms* by Wayne Winston. (This has been used for several years as the text in 56:171 *Operations Research*.

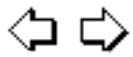


- Copies of class notes (Hypercard stacks) will be available:
  - hardcopy form, from Zephyr Copy Center
  - electronic form

    Acrobat .pdf files (either 2 or 8 screens per page) which can be downloaded from the class web pages

http://www.alf.ie.engineering.uiowa.edu/bricker/pod2_index.html

- Sample exams, quizzes, homeworks, as well as ARENA documentation, etc. are available from the web.



Computer Software

- ARENA for simulation (HP-UX workstations)
- Hypercard (Macintosh)
- MacProject for project scheduling (Macintosh)
- APL.68000 workspaces (Macintosh)

In previous semesters, SLAM II was used instead of ARENA for simulation, and some of the class materials may continue to reflect this, especially early in the semester!

Tentative Grading Scheme

Midterm Exam	20%
Final Exam	20%
Two Projects (10% each)	20%
HW (best 9 of 12)	15%
Quizzes (best 9 of 12)	25%

- Homework will generally be assigned weekly, except when projects are due. No late homework will be accepted after 5 pm on duedate.

- Credit will be given for submitting homework, but on occasion only a few exercises may be graded.

- Short quizzes will usually be given on days that homework is due, based upon the topic of the HW assignment.

- Students will be allowed one 8.5x11-inch "crib sheet" for midterm exam, and two such sheets for the final exam.

(It is intended that the exam will test for comprehension of the concepts and mastery of modeling techniques, and not memorization of formulae, etc.)

Policy on Collaboration

It is my view that discussions of problems and exchange of ideas with other students enhances the learning process. Consequently, on the homework assignments, students may collaborate with others-- however, it is strongly encouraged that students first work independently on the exercises, and then compare & discuss their answers. Do not simply copy another's work "verbatim", or allow another to copy yours-- doing so may result in your both losing credit for homework assignments!

- Homework assignments, projects, the course syllabus, etc. will generally be placed on the web as Acrobat .pdf documents for student access.
- Hypercard stacks will usually be used to present the lecture material.
- I plan to schedule a 1-hour "problem session" per week in "ALF" (4130 SC).

- APL.68000 "workspaces" of computer software for solving various classes of problems will be available over the ICAEN fileserver.
- If you have not already done so, obtain an ICAEN account for the HP-UX workstations from the ICAEN office (Rm. 3133 EB).
- If you cannot find me in my office, questions may be addressed to me via e-mail. I will try to reply to these questions the day that they are received, or suggest a time to meet in my office.

- In order that I can quickly get information to the class between class meetings (e.g., a correction to a homework assignment), please send me your e-mail address, using my address:

dbricker@engineering.uiowa.edu

or, if you are on the ICAEN network, simply

dbricker