620-370
STATISTICS
FOR MECHANICAL ENGINEERS

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Office hours: Tuesday & Thursday 1–2
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Lectures:

Tuesday 9	Latham Theatre
Wednesday 11	Lowe Theatre
Friday 11	Lowe Theatre

Tutorials:

One hour per week.
Tutorials will be mainly concerned with the discussion of set problems.
The tutorials start in the second week of semester.

Assessment:

Homework	20%
3 hour end-of-semester examination	80%

Each week (at the Friday lecture) a Homework sheet will be handed out (and it will appear on the subject web-site on Friday afternoon).

This will contain problems to be submitted for assessment and a number of problems from the Problem Set for discussion in the tutorial.

The end-of-semester examination will contain questions like these.

Subject Notes

These notes (which include copies of most of the lecture overheads) should be sufficient.

However, any text with *Statistics* and *Engineering* in the title should be useful to give an alternative view.

Here are some examples:

Devore JL. *Probability and Statistics for Engineering and Sciences*.

Walpole RE, Myers RH, Myers SL & Ye K. *Probability & Statistics for Engineers & Scientists*.

Montgomery DC, Runger GC & Hubele NF. *Engineering Statistics*.

Vining GG. *Statistical Methods for Engineers*.

Johnson RA. *Probability & Statistics for Engineers*.

Metcalfe AV. *Statistics in Engineering*.

Devore JL & Farnum NR. *Applied Statistics for Engineers and Scientists*.

Summary notes

are given in Appendix T.
They are also available from the subject web-site.

These summary notes will be available for use in the exam.

Note: if there are any additional formulae that you want included, just ask. It can be arranged—within reason.

Statistical tables *"Statistical Tables for Students"*

are given in Appendix T.
They are also available from the subject web-site.
This set of tables will be available for use in the exam.

Problems and answers
are given in Appendix P and Appendix A.

Most of the tutorial problems come from this set of problems. Generally, there are brief answers only for the odd-numbered problems, and some indication of method for even-numbered problems. These problems resemble the homework problems — and the sort of questions in the exam.

Computer packages:

A statistical package will be useful in doing some of the homework problems, and necessary for others.

- MATLAB

  Many of you will be familiar with MATLAB and will prefer to use it. It's not a statistical package but it can do most of the things you need in this subject, provided you have the Statistics Toolbox. Students who have purchased the Student Version can purchase the Statistics toolbox, for about $50.

  MATLAB, including the Statistics toolbox, is available in the Engineering labs, and the Maths&Stats computer labs.

- EXCEL is readily available and will get a lot of the Statistics done, even if it is a bit DIY; there is a Statistics add-on, which is clunky and minimally useful.
- MINITAB is a standard statistical package used in other Statistics service courses; it's easy to use and will do all the statistical things you'll ever need.

  MINITAB is available in the Maths&Stats computer labs. It is also available for private use by enrolled students taking a Statistics course at the University of Melbourne.
- others

  There are of course many other statistical packages. If you have ready access to any of them (SAS, S-plus, R, SYSTAT, SPSS, ...) then, depending on your familiarity with them, they can be useful.

Calculators in exam?
non-programmable calculators only will be permitted

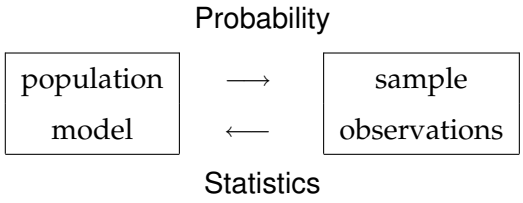
Subject website

Lecture Notes	Homework	Answers
Introduction	Problems	Answers to Problems
Week 1	Homework 1	Homework Answers 1
Week 2	Homework 2	Homework Answers 2
Week 3	Homework 3	Homework Answers 3
Week 4	Homework 4	Homework Answers 4
Week 5	Homework 5	Homework Answers 5
Week 6	Homework 6	Homework Answers 6
Week 7	Homework 7	Homework Answers 7
Week 8	Homework 8	Homework Answers 8
Week 9	Homework 9	Homework Answers 9
Week 10	Homework 10	Homework Answers 10
Week 11	Homework 11	Homework Answers 11
Week 12	Homework 12	Homework Answers 12
Summary Notes	Revision Exs	Answers to Revision Exs
Statistical Tables	Last Year's exam	Answers to Last Year's exam

Applications of Statistics in Engineering

There are three areas dealt with in this subject:

- Probability (modelling)
- Quality (management)
- Statistics (communication & decision making)



Content: [hrs]

1. Probability and Probability Models:
   Sampling (including acceptance sampling);
   probability models (trials, chains and processes) [6]
2. Random variables, distributions and applications:
   (including hazard functions and failure models);
   Normal distribution and applications [4]
3. Descriptive statistics and exploratory data analysis [2]
4. Estimation and confidence intervals;
   (including Likelihood methods). [5]
5. Hypothesis testing and Control charts [4]
6. Analysis of variance:
   one-way and two-way analysis of variance. [5]
7. Design and analysis of experiments:
   factorial experiments; experiments for improvement. [4]
8. Linear regression and prediction:
   straight line regression and correlation;
   multiple regression; response surfaces. [5]

example (Communication)

Data in Four Areas and Eight Three-Month Periods

	13-15	16-18	19-21	22-24	25-27	28-30	31-33	34-36
A	97.63	92.24	98.90	90.39	95.69	94.44	91.13	97.81
B	48.29	42.31	49.98	39.09	46.38	49.74	41.74	37.39
C	75.23	75.16	77.04	74.23	74.23	76.97	71.66	76.47
D	49.69	57.21	75.19	51.09	52.88	49.41	59.32	52.56

Quality

Any definition of quality has to be customer driven.

Quality has to be capable of transformation into objective measurements which can be made during production. (This is seldom a simple matter.)

To improve quality, we must be able to measure it, and monitor it, and find out what makes it better, and then act.

A statement of the obvious:
Measurement of quality of itself is not enough to ensure a quality output.

Many times measurement schemes are introduced, measurements taken and then filed and forgotten — as if the act of measurement will guarantee control of quality.

Measure only if you are going to record;
Record only if you are going to analyse;
Analyse only if you are going to act.

Methods of quality management:

1. **Acceptance sampling** [past]
   weeding out past problems
2. **Process control** [present]
   checking on current problems so they can be fixed quickly
3. **Design of experiments** [future]
   investing in future improvement so as to reduce future problems

A key component of quality improvement is the control of variability.

examples
- breakfast cereal & tiles
- students
- meat

For a lot of things you do in this subject, modelling or estimating the mean is "obvious", but assessment of the variance (and hence the accuracy or precision) of your model or estimate is not so obvious.

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32.4  61.0  45.1  60.9  44.2  60.8  67.9  43.1  61.4  57.5
59.1  58.0  57.4  47.9  37.3  50.5  57.0  61.5  42.2  37.2
53.6  71.4  44.2  39.6  49.1  51.3  43.2  28.2  65.6  66.0
89.9  63.0  75.9  73.9  39.4  48.9  61.3  54.6  72.9  55.9
30.0  54.4  56.6  67.9  29.6  45.4  32.7  37.9  56.1  61.7
58.4  63.5  42.9  72.1  61.7  32.1  44.1  56.1  51.6  63.2
50.6  67.8  46.6  55.7  73.2  40.7  52.4  60.3  46.2  60.6
51.7  63.3  66.1  78.5  53.5  75.8  42.1  60.4  48.9  28.9
58.9  36.9  41.1  40.6  99.9  27.9  54.7  63.5  41.1  39.1
87.3  52.2  41.2  61.3  47.1  34.1  42.1  52.1  45.6  41.3
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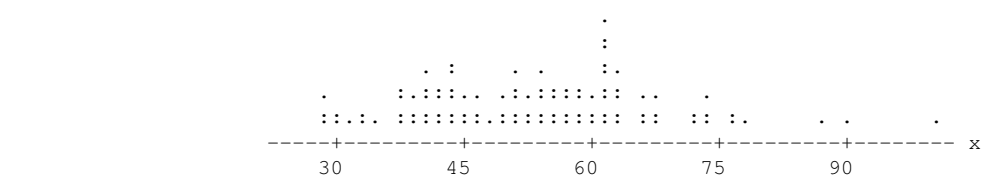

	N	Mean	StDev	Min	Q1	Med	Q3	Max
x	100	53.4	14.0	27.90	42.38	53.55	61.48	99.90

What is the underlying mean?
It is not enough to say that the estimate is 53.4.

Is it 53.4 ± 2.8? or 53.4 ± 6.8? or 53.4 ± 14.0?

Statistics provides a handle on variability.