www.maths.uwa.edu.au/~nazim/3S5

Lecture slides can be downloaded from here.
Unit Prerequisites

Either

- STAT 2226 Statistical Models for Data 226 or
- MATH1020 or
- MATH2218 Mathematics E2B or
- STAT1106 Economic and Business Statistics or
- STAT1160 Statistics A or
- STAT1520 Economic and Business Statistics or
- STAT1510 Statistics A
See handout on unit information and Lecture Schedule.

Note the assessment schedule. There are four short in class tests worth 4% each and a project worth 20%. Part of the project will require you to make a presentation in the class. The final examination is worth 60%.

Timetable: five lectures per fortnight and one tutorial/workshop. The tutorial will used for problem solving and re-enforcing the lecture material, and will not be on the same day each fortnight.
Chapter One

1 Introduction
1.1 Aims

1. To understand the relevance and application of statistics in “industry”.

2. To learn the techniques used in industrial statistics.

3. To learn how to report findings from statistical analyses.

4. To gain practice and experience in oral communication and presenting a talk.

Here “industrial” is used in a broad context, and applies to any area that where quality monitoring and management is required.
Machine filled boxes of cereal are labelled with a weight of 1 kg. Ten consecutive measurements are taken giving the data below. Comment on the filling process.

1. 0.98, 0.99, 1.00, 1.00, 1.01, 1.01, 1.01, 1.01, 1.01, 1.02

\[ \bar{x} = 1.00, \ s = 0.0101 \]

2. 1.00, 1.00, 0.98, 1.01, 1.01, 0.99, 1.011.010.98, 1.02

\[ \bar{x} = 1.00, \ s = 0.012 \]

Both processes have a sample mean of 1.00 kg and a small sample standard deviation. From these summary statistics there seems to be no problems with the process. But look at the time plots of the data.
Time plots of data

\[ x(t) \]

\[ y(t) \]

- Time plots of data over time.
In

1. the weights are increasing over time;
2. every third weight is below 1 kg.

The time plots indicate systematic variation, and this is a sign of a process *out of control*. 
1.2 Understanding Variation

“Everything varies”. In “industrial” situations it is important to identify the cause and source of variation. Industry here is used in a very broad sense:

□ manufacturing, production lines

□ service industries - banks, hotels, service stations, . . .

□ economy - growth, unemployment, consumer confidence

□ finance and accounting - number of transaction errors, errors in financial records

□ medicine - blood sugar level, blood pressure, heart rate
OBJECTIVE

To Improve Quality
Quality

Quality is related to variation.

1. Quality means “fitness for purpose” or meeting the requirements of the customer.

   Example 1.2 A customer wants iron ore to contain 56% iron. Providing him with ore containing 60% ore is **not** providing him with higher quality. It turns out that iron smelters fail if the iron percentage is too high.

2. Quality means satisfying specifications.

3. Quality is inversely proportional to variation.

4. Quality improvement is the reduction of variability in process and products.
Definition Common causes of variation are the (random) irregular (often small) deviations from a process or a set of observations from a target value. Common causes of variation are often called noise.
Example 1.3

1. Deviations from a car’s specified/designed fuel consumption can be due to:
   - traffic - high, medium, low
   - driver behaviour
   - load
   - braking
   - weather
2. Deviations in production targets in a manufacturing industry:

- differences in raw materials
- differences in workers
- differences in machine operating conditions:
  - environmental - temperature, humidity, dust
  - wear and tear
  - machine condition - due for service
Definition

Special causes of variation are the “one-off” large changes in deviations of the process from a target, or drifts/trends in deviation over time.
Example 1.3 (ctd)

1. 
   - □ traffic accident
   - □ tuning of engine
   - □ large extra load (holiday)
   - □ large jump in fuel price

2. 
   - □ changes in production method
   - □ recession
   - □ labour strike
The usual mathematical model for *common cause* variations is to assume that the deviations are independent and identically distributes random variables (iidrvs) $\epsilon_1, \epsilon_2, \ldots$. Often we take these random variables to be normally distributes, so

$$\epsilon_i \overset{iid}{\sim} N \left(0, \sigma^2\right), \ i = 1, 2, 3, \ldots$$