Contents

1 Building Mathematical Models

1.1 a

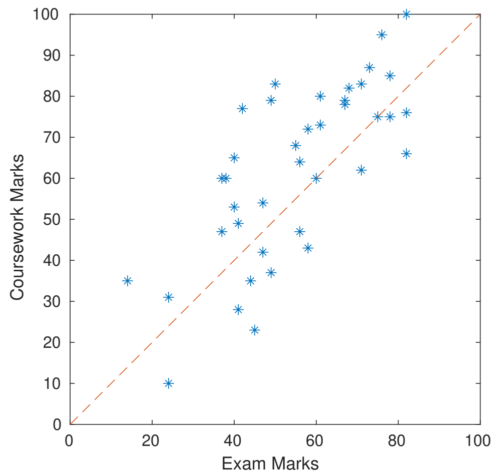

Figure 1: Coursework marks plotted against exam marks. Note the orange dashed line of symmetry

In Figure 1 the line of symmetry, $x = y$, was plotted. Because the data are reasonably spread around the line of symmetry, there is evidence for some proportionality between the two data sets.

Listing 1: Code for Topic 1. Question a.

```
data = readmatrix('MMA I CW I Dataset.xlsx');
courseworkMarks = data(:,1);
examMarks = data(:,2);
figure,plot(examMarks,courseworkMarks, '*');
xlabel('Exam Marks'); ylabel('Coursework Marks')
axis square; axis ([0 100 0 100])
hold on; plot(0:100,0:100, '--');
```

b

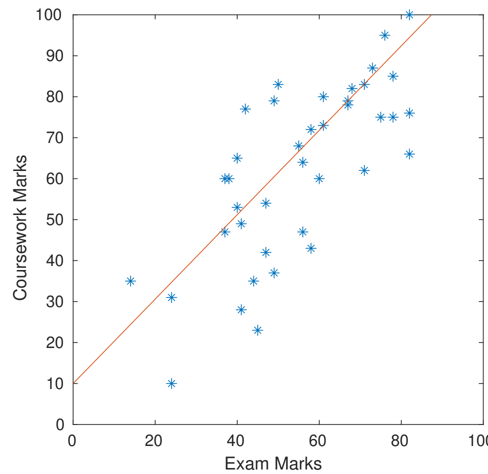

Figure 2: Coursework marks plotted against exam marks. Line of best fit estimated by eye

Given a line $y = ax + b$, the parameters were estimated as per below. This is represented in Figure 2.

$$
\begin{aligned}
a &= \frac{90 - 10}{78 - 0} = 1.03 \\
b &= 10
\end{aligned} \tag{1}
$$

c

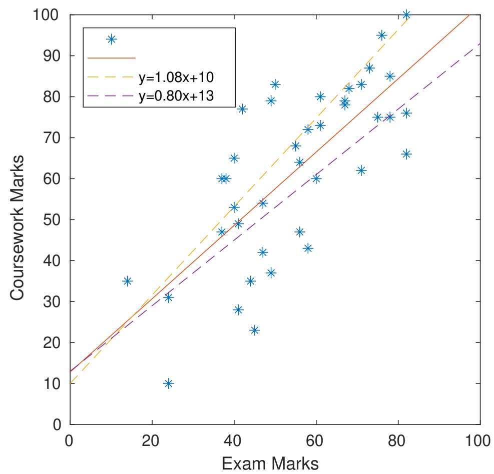

Figure 3: Coursework marks plotted against exam marks.

Therefore the uncertainty in the parameters is

$$\textit{content...} \tag{2}$$

Listing 2: Code for Topic 1. Question c.

```
figure,plot(examMarks,courseworkMarks, '*');
xlabel('Exam Marks'); ylabel('Coursework Marks')
hold on;
axis square; axis ([0 100 0 100]);

p=polyfit(examMarks, courseworkMarks, 1); %Generate polynomial of best fit
xfit=0:100; yfit=polyval(p,xfit); %Line of best fit
plot(xfit,yfit)
plot(i,10+i.*1.08, '--'); %max slope
plot(i,13+i.*0.80, '--'); %min slope
legend('', '', 'y=1.08x+10', 'y=0.80x+13', 'Location', 'northwest')
hold off;
```

d

2 Employ assumptions to simplify systems

2.1 a

Length = L, Mass = M, Time = T

- $[x] = L$
- $[m] = M$
- $[\frac{d^2x}{dt^2}] = \frac{L}{T^2}$
- $[k] = \frac{M}{T^2}$

2.2 b

$$\begin{aligned} A \approx 10^{-3}; k \approx 10^{3}; m = 1; t = 10^{-3} \\ x(10^{-3}) \approx 10^{-3} \cdot \cos\left(\cancelto{1}{10^{-3} \cdot \sqrt{10^{3}}}\right) \approx 10^{-3} \end{aligned} \tag{3}$$

3 Matrices and vectors

3.1 a

Listing 3: Code for Topic 3. Question a.

```
t=0:0.4:40
p=[20*sin(t); 20*cos(t); 10-(t./4).^2]
```

3.2 b

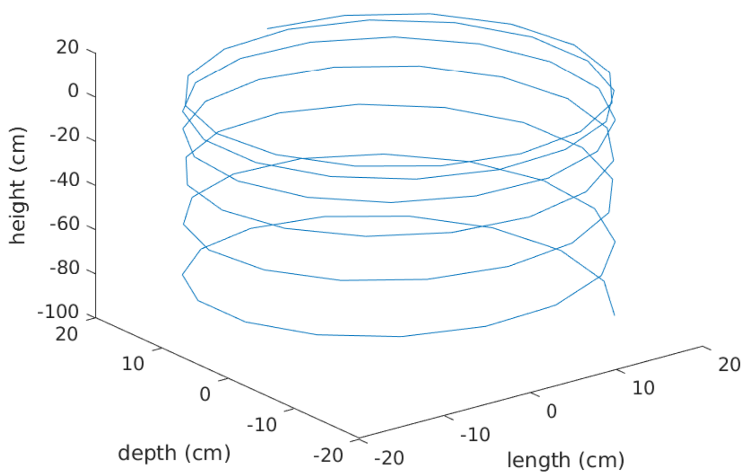

Figure 4:

Listing 4: Code for Topic 3. Question b.

```
plot3(p(1,:),p(2,:),p(3,:))
xlabel('length (cm)'),ylabel('depth (cm)'), zlabel('height (cm)')
```

3.3 c

Given that the speed is the modulus of velocity,

$$|\overrightarrow{v}(15)| = \left|\begin{bmatrix} 20\cos(15) \\ -20\sin(15) \\ -\frac{2}{16}15 \end{bmatrix}\right| = \left|\begin{bmatrix} -15.1938 \\ -13.0058 \\ -1.8750 \end{bmatrix}\right| = 20.0877 \tag{4}$$

3.4 d

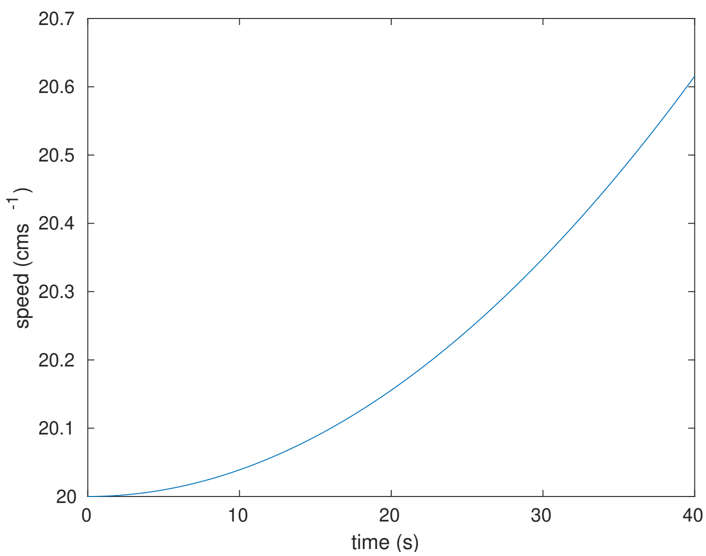

Figure 5:

Listing 5: Code for Topic 3. Question d.

```
v=[20*cos(t); -20*sin(t); -2.*t./16]
speed=sqrt(sum(v.^2))
plot(t,speed)
xlabel('time (s)'),ylabel('speed (cms^{-1})')
```

4 Complex numbers

4.1 a

4.2 b

4.3 c

4.4 d