

Mathematics Applications Units 3 & 4
Test 3 2017

Section 1 Calculator Free

Time Series Analysis

SOLUTIONS

STUDENT'S NAME: _____

DATE: Monday 15th March

TIME: 15 minutes

MARKS: 18

INSTRUCTIONS:

Standard Items: Pens, pencils, pencil sharper, eraser, correction fluid/tape, ruler, highlighters, Formula Sheet.

Questions or parts of questions worth more than 2 marks require working to be shown to receive full marks.

1. (3 marks)

Consider the following media report on the likely improvement in employment.

8 MAY 2017 - 12:26PM

April job ads lift suggests strength: ANZ

Job ads in April grew at a stronger rate than they did in March, suggesting that employment could strengthen further in coming months, says the ANZ Bank.

Source: AAP

Tweet

8 MAY 2017 - 12:26 PM UPDATED YESTERDAY 12:26 PM

Recommend 0

A solid rise in the number of jobs advertised in April, following a more modest lift in March, suggests that employment is likely to strengthen over the coming months, the ANZ Bank says.

Jobs advertisements rose 1.4 per cent in April, in seasonally adjusted terms surpassing a rise of 0.8 per cent in March, according to the latest job ads survey by the bank.

Annual growth in job ads jumped to 10.1 per cent, from 7.1 per cent in March.

(a) State the:

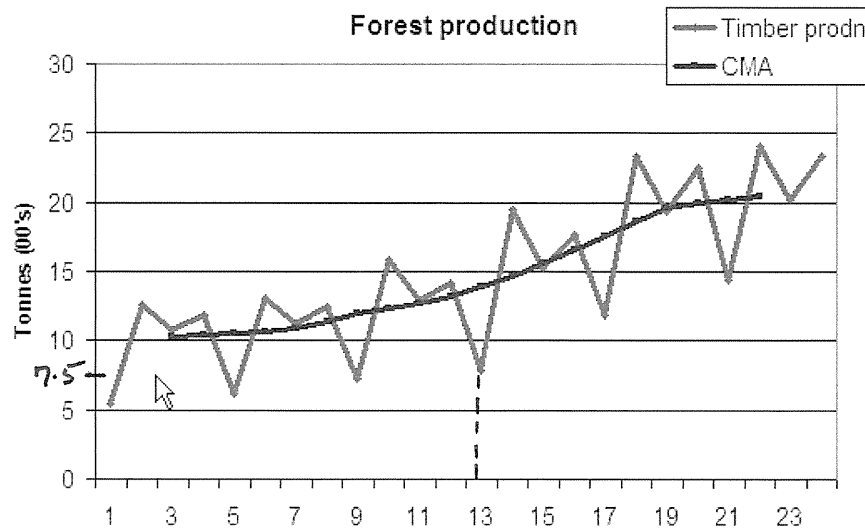
(i) explanatory (independent) variable: Time. ✓ [1]

(ii) response (dependent) variable: Number of jobs advertised. ✓ [1]

(b) Circle the phrase in the report which suggests the response variable contains a cyclic component. See above ✓ [1]

2. (6 marks)

Consider the following *Time Series* graph showing Forest Timber Production.



(a) Is the underlying production trend on the increase, stable or decreasing? [1]

Increasing ✓

(b) One graph shows a cyclic component in the data. State the length of the cycle. [1]

4 ✓

(c) State the actual timber production when $t = 13$. [1]

$$\begin{aligned} &\approx 7.5 \times 100 \\ &= \underline{\underline{750}} \text{ tonnes} \quad \checkmark \end{aligned}$$

(d) In the ledger key, what does CMA stand for? [1]

Centred Moving Average (CMA) ✓

(e) Two graphs are shown. How do the two graphs relate? [2]

The CMA graph is a smoothing, of the actual timber production, using CMA's. ✓
✓

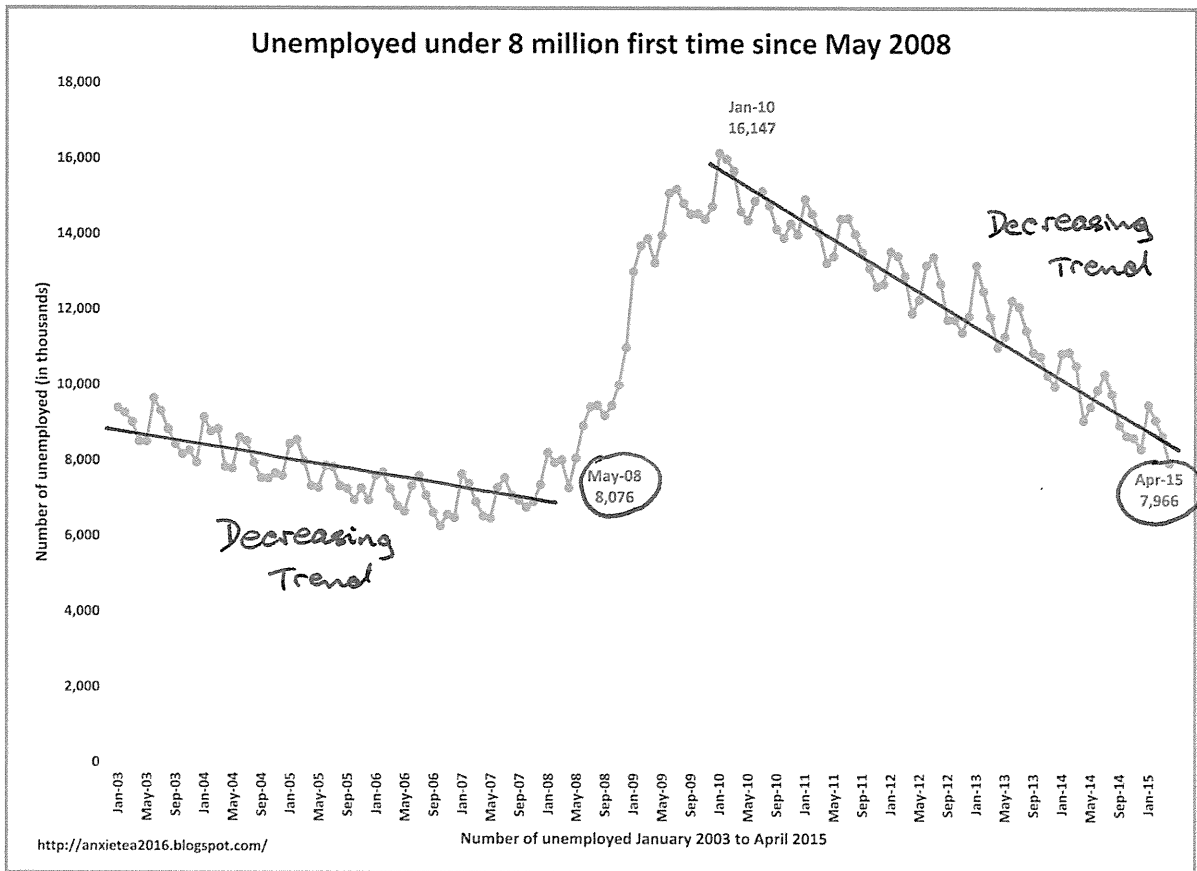
3. (5 marks)

Complete the following statements:

- A seasonal index is a measure of how a season compares with the average for the 'season'. [1]
- Seasonal indices are calculated so that their average is 100% or 1. [1]
- If a seasonal index is 1.15, this means that this season is 15% above than the average. [1]
- *Deseasonalising* is the process that is used to remove the seasonal effects from a set of data. This allows any underlying trends to be made clearer. [1]
- To calculate deseasonalised data, each actual figure is divided by its appropriate seasonal index. [1]

4. (4 marks)

Consider the following unemployment figures for an unknown country.



(a) Provide numerical evidence to support the graph's title. [2]

May 2008 8 076 000 ✓
 April 2015 7 966 000 < 8 million. ✓

(b) Draw on the graph two trend lines that indicate, except for a brief period, that unemployment was generally reducing over time. [1]

see above ✓

(c) During which two years did unemployment rise sharply? [1]

2008 and 2009 ✓

End of Section I Questions

Mathematics Applications Units 3 & 4
Test 3 2017

Section 2 Calculator Assumed

Time Series Analysis

STUDENT'S NAME: _____ SOLUTIONS

DATE: Monday 15th March
y

TIME: 35 minutes

MARKS: 37

INSTRUCTIONS:

Standard Items: Pens, pencils, pencil sharper, eraser, correction fluid/tape, ruler, highlighters, Formula Sheet retained from Section 1.

Special Items: Drawing instruments, templates, three calculators, notes on one side of a single A4 page (these notes to be handed in with this assessment).

Questions or parts of questions worth more than 2 marks require working to be shown to receive full marks.

5. (5 mark)

The *Seasonal Indices* for the first 3 quarters of a company's sales figures are:

- Q1: 127%
- Q2: 71%
- Q3: 114%

(a) Determine the seasonal index for Q4 [1]

$$1.27 + 0.71 + 1.14 + x = 4$$

$$\therefore Q4 \text{ S.I is } 0.88 = 88\% \checkmark$$

(b) If the Q2 actual sales figures are 1240, calculate the deseasonalised value. [2]

$$\frac{1240}{0.71} = \underline{\underline{1746}} \text{ (nearest unit)} \checkmark$$

(c) A fitted trend line to the smoothed data, indicates that the seasonally adjusted figure for Q2 of the following year, is 1820. Determine a prediction for the actual sales figures. [2]

$$\begin{aligned}
 & 1820 \times 0.71 \checkmark \\
 & = 1292.2 \\
 & = \underline{\underline{1292}} \text{ (nearest unit.) } \checkmark
 \end{aligned}$$

6. (19 mark)

The school canteen records icecream sales quarterly. The data is detailed below:

Year	Quarter	t	Sales	CMA	Seasonally Adjusted Sales
2014	1	1	300		265
	2	2	250		252
	3	3	200	286.25	288
	4	4	320	B 322.50	272
2015	1	5	450	342.88	397
	2	6	390	360.50	393
	3	7	223	384.88	329
	4	8	438	407.00	372
2016	1	9	527	436.88	465
	2	10	490	470.63	493
	3	11	362		521
	4	12	A 569		483

(a) State the moving average used in the table above and explain the reason. [2]

4 pt. CMA ; it best smooths data when
 ✓ the cycle is 4 (quarters) ✓

(b) Comment on the trend of the data. [1]

It is increasing. ✓

- (c) Calculate the missing values A and B in the table. [4]

$$B = \frac{\frac{1}{2}(250) + 200 + 320 + 450 + \frac{1}{2}(390)}{4} = 322.5$$

$$\frac{\frac{1}{2}(438) + 527 + 490 + 362 + \frac{1}{2}A}{4} = 470.63$$

The table below shows the seasonal indices for the above data:

$$\therefore A = \underline{569}$$

Year	Q1	Q2	Q3	Q4	Average
2014	300	250	200	320	267.5
2015	450	390	223	438	375.25
2016	527	490	362	569	487
Seasonal Indices	1.1342	0.9933	<u>0.6951</u>	<u>1.1773</u> or 1.1774 accept.	check 3.9999 \approx 4 as expected

- (d) Calculate the missing seasonal indices in the table above. [4]

$$\left(\frac{200}{267.5} + \frac{223}{375.25} + \frac{527}{487} \right) / 3 = 0.6951 \text{ (4 d.p.)} \checkmark \checkmark$$

$$\left(\frac{320}{267.5} + \frac{438}{375.25} + \frac{569}{487} \right) / 3 = 1.1773 \text{ (4 d.p.)} \checkmark \checkmark$$

(NB) $Q4 = 4 - (Q1 + Q2 + Q3) = 1.1774$

The least squares line of regression, using the CMA, is $\hat{y} = 24.754t + 215.542$

- (e) Using the CMA line of regression, and the seasonal indices, predict the sales for Q2, 2017. [2]

$$\hat{y} = 24.754(4) + 215.542 = 562.098$$

$$\therefore \text{Pred. sales} = 562.098 \times 0.9933 = \underline{558} \text{ (nearest unit.)} \checkmark$$

- (f) Determine the least squares line of regression $\hat{y} = at + b$ using the Deseasonalised Data. [3]

list1	list2	list3
1	265	
2	252	etc
3	288	

Stat Calculation	
Linear Reg	
y = a · x + b	
a	= 24.755245
b	= 216.59091

$$\hat{y} = 24.755t + 216.591 \checkmark \checkmark \text{ (3 d.p.)} \checkmark$$

- (g) Using the Deseasonalised line of regression, predict the sales for Q2, 2017 and explain why your prediction is different from that of part (e). [3]

$$\hat{y} = 24.755(4) + 216.591 = 563.161$$

$$\therefore \text{Pred. sales} = 563.161 \times 0.9933 = \underline{559} \text{ (nearest unit.)} \checkmark$$

We are using two different fitted lines based on two different methods of 'smoothing' the data. \checkmark

7. (13 mark)

The data in the table below shows Year 12 mean daily attendance for the term over three years:

Year	Terms	t	Mean Daily Attendance	Yearly Average	Attendance as a % of the Yearly Average	Adjusted Attendance
2013	1	1	178	$\frac{178+150+179}{3} = 169$	$\frac{178}{169} = 105.33\%$ (2d.p)	$178 \div 1.0546 = 169$
	2	2	150		88.76%	$150 \div 0.8826 = 170$
	3	3	179		105.92%	$179 \div 1.0629 = 168$
2014	1	4	175	165	106.06%	166
	2	5	145		87.88%	164
	3	6	175		106.06%	165
2015	1	7	168	160	105%	159
	2	8	141		88.13%	160
	3	9	171		106.88%	161

(a) Complete the tables above and below to deseasonalise the attendance figures. [11]

	T1	T2	T3	
2013	1.0533	0.8876	1.0592	✓
2014	1.0606	0.8788	1.0606	✓
2015	1.05	0.8813	1.0688	✓
Seasonal Index	1.0546	0.8826	1.0629	✓

(b) Comment on the reliability of using this time series data to predict Term 2 attendance in 2017.
 T2 2017 is beyond one future cycle, thus not reliable. [2]

End of Questions