EXAMINATIONS OF THE HONG KONG STATISTICAL SOCIETY

HIGHER CERTIFICATE IN STATISTICS, 2012

MODULE 7 : Time series and index numbers

Time allowed: One and a half hours

Candidates should answer **THREE** *questions.*

Each question carries 20 marks.
The number of marks allotted for each part-question is shown in brackets.

Graph paper and Official tables are provided.

Candidates may use calculators in accordance with the regulations published in the Society's "Guide to Examinations" (document Ex1).

The notation log *denotes logarithm to base* ***e****.*
Logarithms to any other base are explicitly identified, e.g. $\log_{10}$.

Note also that $\binom{n}{r}$ *is the same as* ${}^{n}C_{r}$.

This examination paper consists of 4 printed pages, **each printed on one side only**.
This front cover is page 1.
Question 1 starts on page 2.

There are 4 questions altogether in the paper.

1. (a) Explain what p, d and q represent in the non-seasonal ARIMA(p, d, q) model.

(3)

Why might a time series need to be differenced before it can be modelled?

(1)

(b) Given a time series y_t, write down the equation for the smoothed estimate m_t of the series in terms of y_{t-1} and m_{t-1} using simple exponential smoothing. Use this method to smooth the annual time series below over the period 2004 to 2010 and to produce a one-step-ahead forecast for 2011. Use $\alpha = 0.4$ as the smoothing parameter and set the smoothed value for 2003 equal to the actual value in 2003. Give your answers correct to 2 decimal places.

(3)

Calculate the mean squared error of the smoothed values over the period 2004 to 2010, showing all your working.

(3)

With a smoothing parameter of $\alpha = 0.2$, the mean squared error of the smoothed values is 12.58. Based on this information, which smoothing parameter value, 0.2 or 0.4, would you choose in order to forecast this series? Explain your choice.

(2)

If trend and/or seasonality are present in a time series, why might simple exponential smoothing not be an appropriate forecasting method? Suggest an alternative forecasting method that may be used under these conditions.

(2)

Year	*Value*	*Smoothed Value*
2003	12	12
2004	17	
2005	11	
2006	14	
2007	16	
2008	10	
2009	18	
2010	11	
2011	–	

(c) State one advantage and one disadvantage of using ARIMA models, rather than exponential smoothing approaches, to produce one-step-ahead forecasts.

(2)

Show algebraically how a one-step-ahead forecast produced using simple exponential smoothing can be thought of as equivalent to that produced when the ARIMA(0, 1, 1) model is fitted to a time series.

(4)

Turn over

2. (i) Explain briefly the purpose of seasonal adjustment of a time series.

(3)

(ii) The first stage of a seasonal adjustment is prior adjustment. Explain the purpose of prior adjustment and identify three effects for which it is appropriate.

(5)

(iii) Explain how you might perform prior adjustment using seasonal adjustment software.

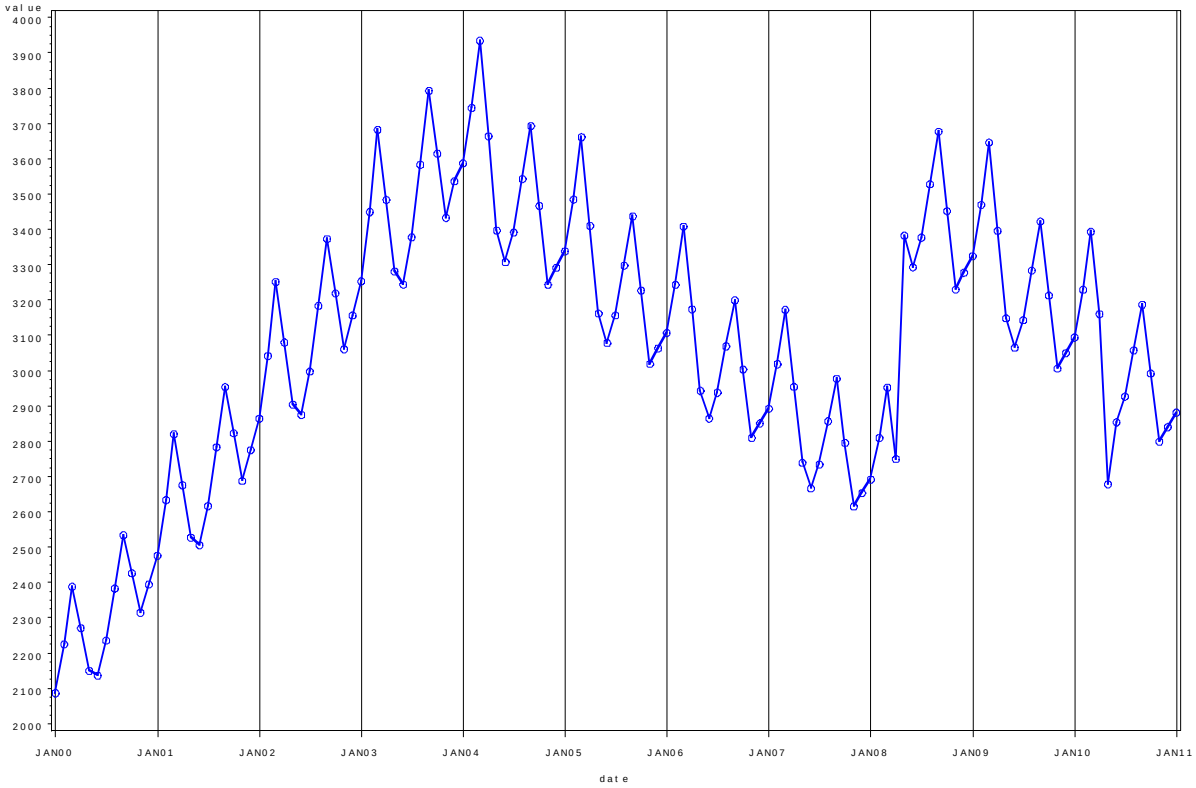
(2)

(iv) Identify the three components in the standard decomposition of a time series, give a brief description of each component, and explain how they are combined in the seasonally adjusted series.

(5)

(v) Discuss the main features of the series illustrated below, including the characteristics you think might be important in the seasonal adjustment of the series.

(5)



Turn over

3. (i) Consider a price index which is published at regular intervals, for example monthly. Suppose a supplier stops selling an item that contributes to the index, having earlier started selling a newer model. Hence there is a period when both models are available. Describe how you would include this newer model in the price index as a replacement for the original item.

(4)

(ii) Using data from the table below, calculate the Laspeyres price index for period 2 using period 0 as the base period. Note that you need to introduce item 4 as a replacement for item 3.

(4)

(iii) Calculate a chain-linked Laspeyres price index for period 2 by combining the Laspeyres price index for period 1 using period 0 as the base period with the Laspeyres price index for period 2 using period 1 as the base period. The chain-linked index should be referenced to period 0.

(9)

(iv) Compare your answers to parts (ii) and (iii) and state what is surprising about them. Give a reason for this anomaly.

(3)

	Period 0		*Period 1*		*Period 2*
	Price	*Sales*	*Price*	*Sales*	*Price*
Item 1	90c	4500c	100c	4000c	90c
Item 2	50c	8250c	35c	10500c	50c
Item 3	50c	3000c	55c	2750c	
Item 4			80c		70c

All sales are given in monetary values, the local currency being denoted by "c".

4. Consider a country which peacefully achieved independence at midnight last night. Today is the first day of operation of the State Statistics Office. As yet, the office has collected no data and published no statistics. Your task is to organise a new price index to measure the inflation of goods produced by the country's manufacturing sector. The index should be a monthly Laspeyres price index with annual chain-linking. It should be calculated for each of 10 (internationally defined) broad groupings of goods, together with an aggregate index covering all manufactured goods. Each base period should be an entire year. You have access to a basic business register which lists all enterprises in the country. The entry for each enterprise gives its contact details, its employee count and its industrial classification, but no information on which specific goods are produced by the enterprise. You also have access to an international classification of industries and an international classification of products. From this starting point, describe how you would set up and produce the index with limited resources.

(20)