Queen Mary
University of London
School of Mathematical Sciences

MTH6139 TIME SERIES

Test 1, 6 November 2008, 12.00

NOTE:

The test consists of two parts: a practical Minitab output for a set of data and a set of theory questions. You should attempt all questions in both parts.

It is a multiple choice test with 20 problems altogether. Choose only one statement for each problem, which you think is true, and mark it on the answer sheet by crossing a box.

For each correct answer you get 1 mark, for no answer you get 0 and for a wrong answer you get minus 0.25. The total is then scaled to 0 – 100 range.

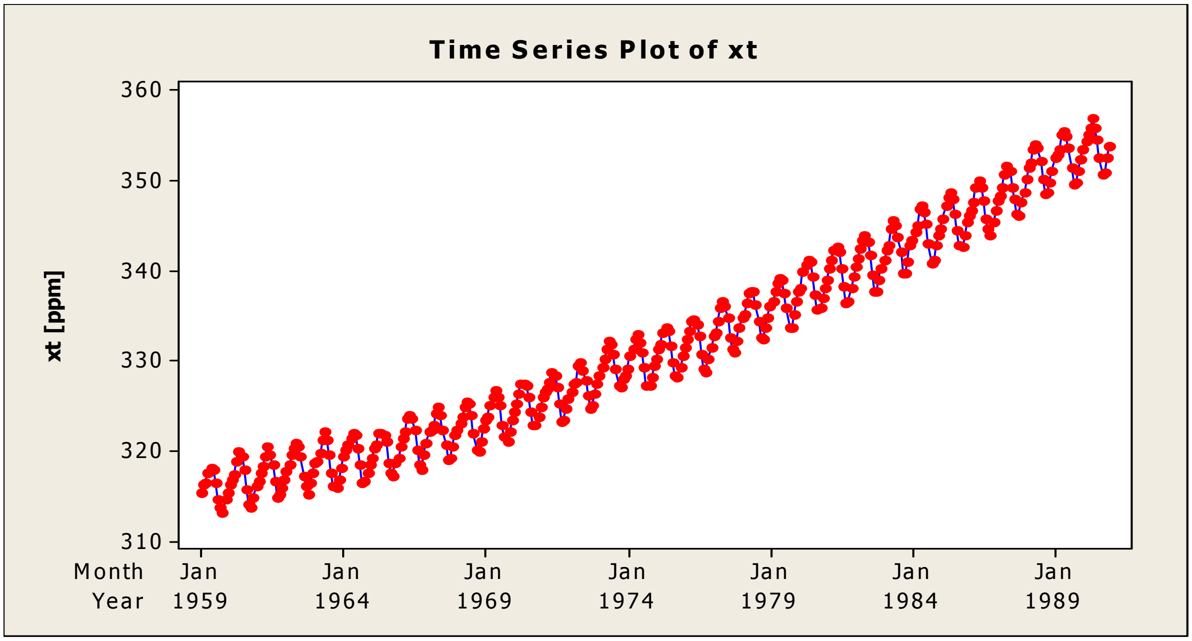
Total time for the test is 40 minutes. Calculators are not permitted in this test.

You must not start to read the questions

until instructed to do so by the invigilator.

Part 1

Below there is a Minitab output with comments on a time series analysis of monthly measurements of carbon dioxide (X_t) above Mauna Loa, Hawaii, Jan 1959 - Dec 1990. Units: parts per million (ppm). Choose the right comment.



1 The time series plot indicates that:

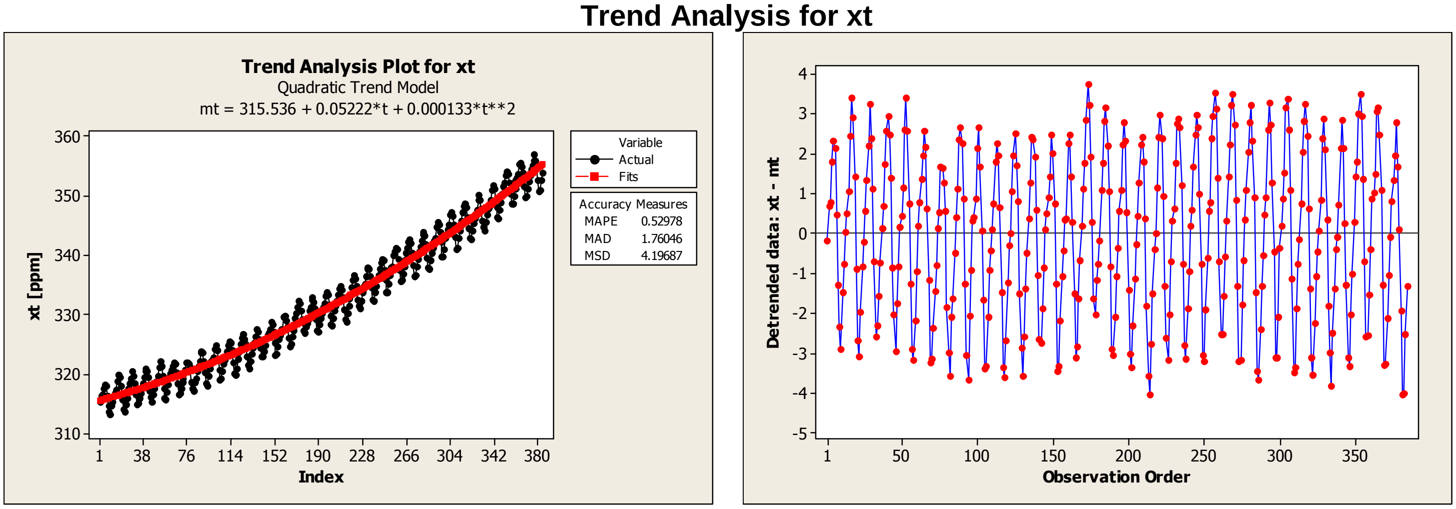
(a) There is a clear seasonality and also an increasing trend in the data.

(b) There is neither trend nor seasonality, only increasing variability of the data.

(c) There is an increasing trend as well as increasing variability and also seasonality in the data.

(d) There is seasonality and increasing variability in the data, but no trend

Trend Analysis for xt



2 The plot of detrended data indicates that:

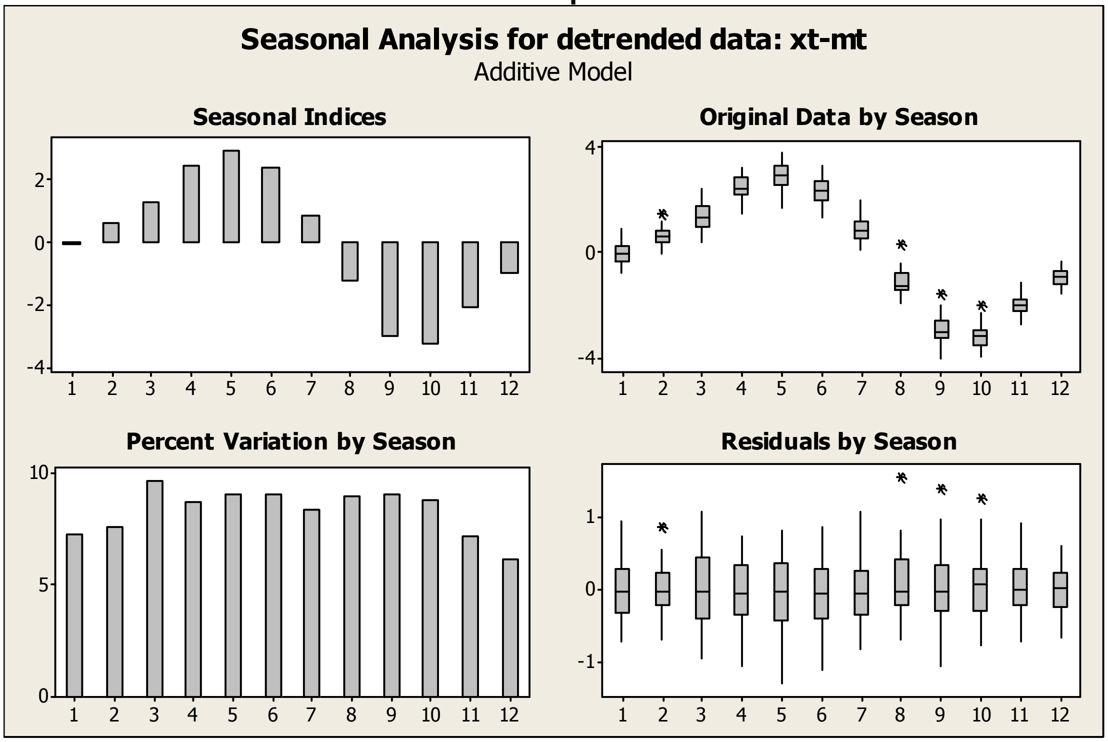
(a) The detrended data represent seasonality effects only.

(b) The seasonality effects are successfully removed from the data.

(c) A linear trend function would have better fitted the data.

(d) The detrended data oscillate about zero, but seasonality effects and noise effects are still present.

Time Series Decomposition for xt-mt



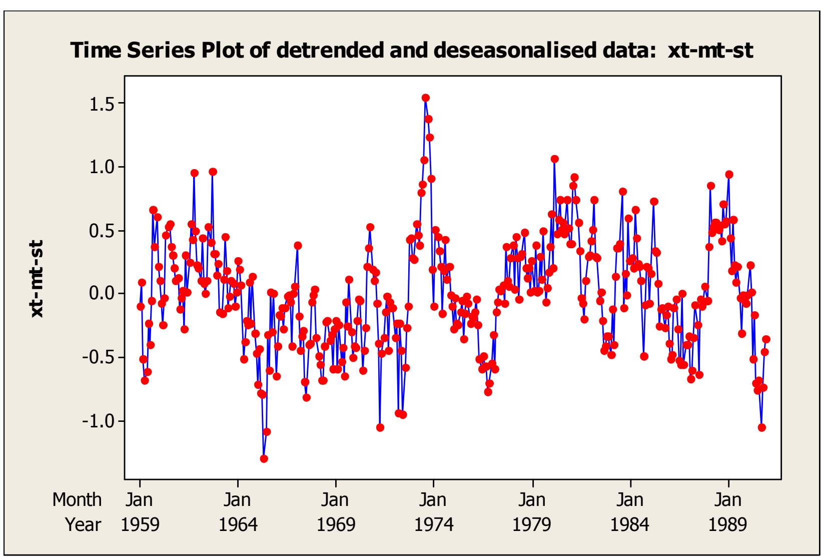
3 The plots of the analysis of seasonal effects indicate that:

(a) On average, the carbon dioxide levels are highest in May and lowest in October.

(b) October is the season with greatest variability in levels of carbon dioxide.

(c) The plot 'Original Data by Season' shows that the seasonal effects are the same in each month.

(d) The plot 'Residuals by Season' shows there is no noise in the data.



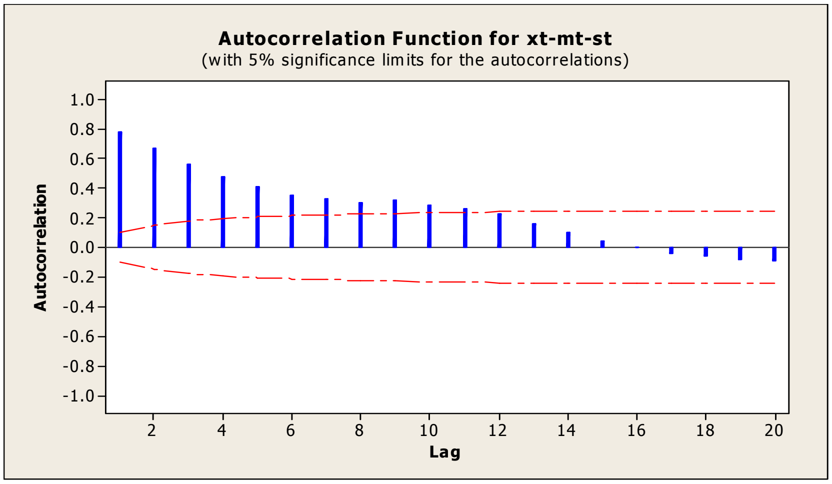
4 The time series plot of the detrended and deseasonalised data indicates that:

(a) There is increasing variability in the detrended and deseasonalised data.

(b) There is neither a global trend nor seasonality shown in the plot, but some local trends are present.

(c) The seasonality effects are not successfully removed from the detrended data.

(d) The detrended and deseasonalised data are a realization of an IID process.



Lag	ACF	T	LBQ
1	0.774106	15.17	231.91
2	0.672069	8.88	407.17
3	0.558764	6.22	528.64
4	0.476878	4.84	617.34
5	0.408946	3.92	682.75
6	0.354856	3.27	732.12
7	0.322205	2.89	772.94
8	0.303689	2.67	809.30
9	0.320679	2.77	849.94
10	0.284275	2.40	881.97

5 The sample ACF of the detrended and deseasonalised data indicates that:

(a) The correlations have a tailing off pattern.

(b) The correlations cut off after lag 15.

(c) All correlations are non-significantly different from zero.

(d) The correlations suggest a White Noise model for the detrended and deseasonalised data.

ARIMA Model: xt-mt-st

Final Estimates of Parameters

Type		Coef	SE Coef	T	P
AR	1	0.8618	0.0331	26.06	0.000
MA	1	0.2203	0.0633	3.48	0.001

Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag	12	24	36	48
Chi-Square	14.6	22.2	37.3	51.5
DF	10	22	34	46
P-Value	0.147	0.451	0.320	0.267

6 The numerical output given above (for the detrended and deseasonalised data y_t) shows that the fitted model is

(a) $y_t - 0.2203\, y_{t-1} = z_t + 0.8618\, z_{t-1}$,

(b) $y_t - 0.2203\, y_{t-1} = y_t - 0.8618\, z_{t-1}$,

(c) $y_t - 0.8618\, y_{t-1} = z_t + 0.2203\, z_{t-1}$,

(d) $y_t - 0.8618\, y_{t-1} = z_t - 0.2203\, z_{t-1}$,

where z_t is a realization of $WN(0,\sigma^2)$.

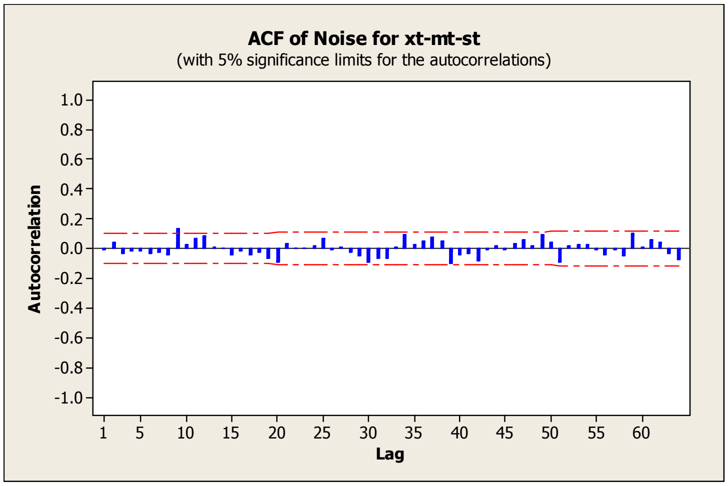
7 The Ljung-Box Chi-square statistic shown in the numerical output of the ‘ARIMA Model’ indicates that

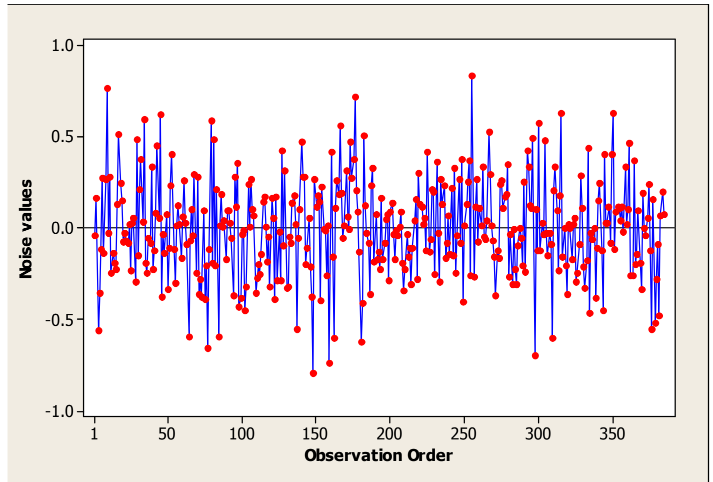
(a) The groups of autocorrelations of the detrended and deseasonalised variables for all lags up to 12, 24, 36 and 48 are non-significant.

(b) The autocorrelations of the detrended and deseasonalised variables which are exactly 12, 24, 36 and 48 lags apart are non-significant.

(c) The autocorrelations of the model noise variables which are exactly 12, 24, 36 and 48 lags apart are non-significant.

(d) The groups of autocorrelations of the model noise variables for all lags up to 12, 24, 36 and 48 are non-significant.





8 The graphs given above suggest that the noise values are a realization of:

(a) An uncorrelated random process with zero mean and possibly a constant variance.

(b) An identically, independently distributed random variable.

(c) An MA(1) process with zero mean.

(d) A strictly stationary process.

ARIMA Model: xt-mt-st

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Type        Coef  SE Coef      T      P
AR    1   0.6357   0.0512  12.41  0.000
AR    2   0.1933   0.0599   3.23  0.001
AR    3  -0.0143   0.0514  -0.28  0.782

Modified Box-Pierce (Ljung-Box) Chi-Square statistic

Lag             12      24      36      48
Chi-Square    12.9    20.0    33.8    47.6
DF               9      21      33      45
P-Value      0.169   0.519   0.431   0.369
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9 The numerical output, given above, for another model of the detrended and deseasonalised data, shows that (when compared to the previous model, see question 6), it is:

(a) A better model because it is more parsimonious than the previous one.

(b) A worse model because the p-values in the Ljung-Box tests are larger than in the previous one.

(c) A worse model because it is over-parameterized, that is, there is an insignificant parameter in the model.

(d) A worse model because one of the AR parameters is negative.

10 Let $m_t = 315.536 + 0.05222\, t + 0.000133\, t^2$ denote the estimated trend, $s_t = s_{t+12}$ be the estimated seasonal effects and y_t be a stationary random process. The carbon dioxide levels above Mauna Loa, in years 1959 – 1990, can be represented as:

(a) $x_t = m_t\, s_t + y_t$

(b) $x_t = m_t + s_t\, y_t$

(c) $x_t = m_t\, s_t\, y_t$

(d) $x_t = m_t + s_t + y_t$