Dept of Mathematics and Statistics
King Fahd University of Petroleum & Minerals

STAT460: Time Series
Dr. Mohammad H. Omar
Major 1 Exam Term 162 FORM A
Tuesday Mar 14 2017
6.30pm-7.50pm

Name_____ ID#:_____ Serial #:___

Instructions.

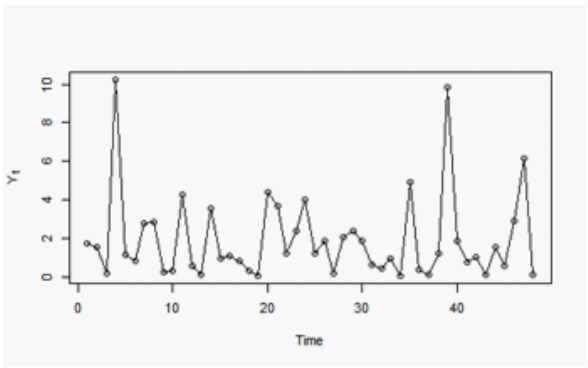
1. Please turn off your cell phones and place them under your chair. Any student caught with mobile phones on during the exam will be considered under the **cheating rules** of the University.
2. If you need to leave the room, please do so quietly so not to disturb others taking the test. No two person can leave the room at the same time. No extra time will be provided for the time missed outside the classroom.
3. Only materials provided by the instructor can be present on the table during the exam.
4. Do not spend too much time on any one question. If a question seems too difficult, leave it and go on.
5. Use the blank portions of each page for your work. Extra blank pages can be provided if necessary. If you use an extra page, indicate clearly what problem you are working on.
6. Only answers supported by work will be considered. Unsupported guesses will not be graded.
7. While every attempt is made to avoid defective questions, sometimes they do occur. In the rare event that you believe a question is defective, the instructor cannot give you any guidance beyond these instructions.
8. Mobile calculators, I-pad, or communicable devices are disallowed. Use regular scientific calculators or financail calculators only. Write important steps to arrive at the solution of the following problems.

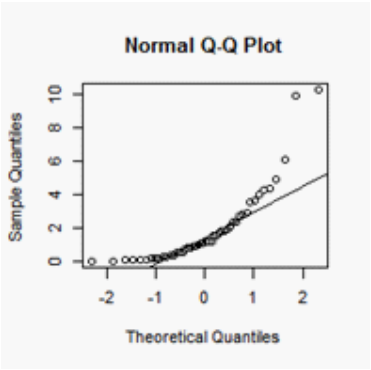
The test is 80 minutes, GOOD LUCK, and you may begin now!

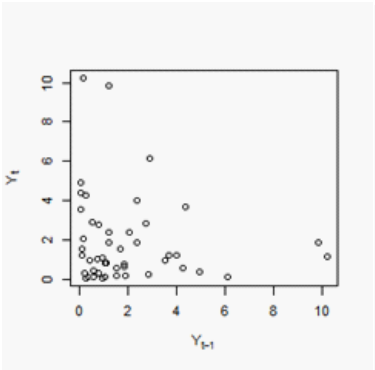
Question	Total Marks	Marks Obtained	Comments
1	2*4+3=11		
2	3+3=6		
3	5+4+2=11		
4	3+3=6		
5	3+3+4=10		
6	2+2+2=6		
Total	50		

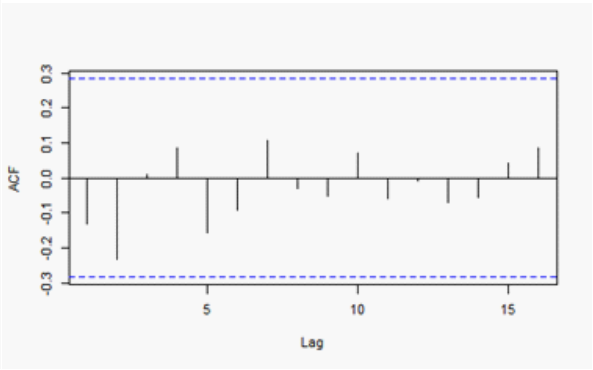
Extra blank page

1. (2*4+3=11 points) For the time series of length 48 depicted in the figures below, answer the following questions









a)Describe the data in regards to the following:

i) Normality: _____

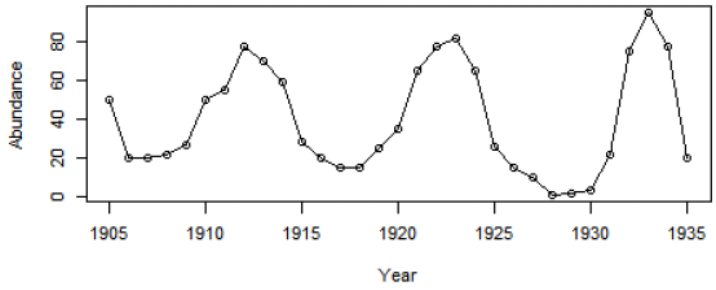
ii) Trends: _____

iii) Seasonality: _____

iv) Independence: _____

b) What is the best possible model for this time series data?

2. (3+3=6 points).The Exhibit below shows **annual** abundance of Canadian hare over about 30 years.



a) Describe any noteworthy pattern in the time series.

b) What models appear possible for this time series? Provide your justifications.

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3. (3+3=6 points) Suppose $Cov(X_t, X_{t-k}) = \gamma_k$ is free of t but that $E(X_t) = 5t$.

(a) Is $\{X_t\}$ stationary?
(b) Let $Y_t = 7 - 5t + X_t$. Is $\{Y_t\}$ stationary?

4. (5+4+2=11 points) Let $\{X_t\}$ be a **zero-mean**, **unit variance** stationary process with **autocorrelation function** ρ_k. Suppose that μ_t is a **nonconstant** function and that σ_t is a positive valued **nonconstant** function. The observed series is formed as $Y_t = \mu_t + \sigma_t X_t$.

(a) Find the **mean** and **covariance** function for the $\{Y_t\}$ process.
(b) Show that the **autocorrelation function** for the $\{Y_t\}$ process depends only on the time lag. Is the process $\{Y_t\}$ **stationary**?
(c) Is it possible to have a time series with a constant mean and with $Corr(Y_t, Y_{t-k})$ free of t but with $\{Y_t\}$ **not stationary**? Why or why not?

5. (3+3+4=10 points) The following partial data from tempdub file provides the monthly temperature for 24 months from Jan 1973 to December 1975 in Dubuque, Iowa.

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1973	22.5	25.7	42.3	45.2	55.5	68.9	72.3	72.3	62.5	55.6	38.0	20.4
1974	17.6	20.5	34.2	49.2	54.8	63.8	74.0	67.1	57.7	50.8	36.8	25.5
1975	20.4	19.6	24.6	41.3	61.8	68.5	72.0	71.1	57.3	52.5	40.6	26.2

$\sum_{t=1}^{36} Y_t = 1689.1$, $\sum_{t=1+1}^{36} Y_t Y_{t-1} = 89126.15$, and $\sum_{t=1}^{36} Y_t^2 = 91661.69$.

With these data,

a) compute the **missing estimates below** for the effects of monthly temperature

Coefficient	**Estimate**	**Std. Error**	*t*-**value**	*Pr(>|t|)*
January	20.167	2.177	9.265	2.14e-09 ***
February		2.177	10.076	4.24e-10 ***
March	33.700	2.177	15.482	5.44e-14 ***
April	45.233	2.177	20.780	< 2e-16 ***
May	57.367	2.177	26.354	< 2e-16 ***
June		2.177	30.810	< 2e-16 ***
July	72.767	2.177	33.429	< 2e-16 ***
August	70.167	2.177	32.235	< 2e-16 ***
September	59.167	2.177	27.181	< 2e-16 ***
October		2.177	24.333	< 2e-16 ***
November	38.467	2.177	17.672	2.91e-15 ***
December	24.033	2.177	11.041	6.87e-11 ***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 3.77 on 24 degrees of freedom
Multiple R-squared: 0.9963, Adjusted R-squared: 0.9944
F-statistic: 535.4 on 12 and 24 DF, p-value: < 2.2e-16

b) Compute the **missing estimates below** of the contrast in monthly temperature

Coefficient	**Estimate**	**Std. Error**	*t*-**value**	*Pr(>|t|)*
Intercept	20.167	2.177	9.265	2.14e-09 ***
February	1.767	3.078	0.574	0.571380
March		3.078	4.396	0.000193 ***
April	25.067	3.078	8.143	2.30e-08 ***
May		3.078	12.084	1.08e-11 ***
June	46.900	3.078	15.235	7.73e-14 ***
July	52.600	3.078	17.087	6.17e-15 ***
August	50.000	3.078	16.242	1.90e-14 ***
September		3.078	12.669	4.03e-12 ***
October	32.800	3.078	10.655	1.40e-10 ***
November	18.300	3.078	5.945	3.90e-06 ***
December	3.867	3.078	1.256	0.221182

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
Residual standard error: 3.77 on 24 degrees of freedom
Multiple R^2: 0.9725, Adjusted R^2: 0.9599
F-statistic: 77.19 on 11 and 24 DF, p-value: 5.667e-16

c) **Calculate** and **interpret** the **lag 1 sample autocorrelations** for the data.

6. (2+2+2=6 points) The file, tempdub, provides the monthly temperature for 144 months from Jan 1964 to December 1975 in Dubuque, Iowa. The following partial output was produced in the analysis of this data.

Coefficient	**Estimate**	**Std. Error**	t-**value**	$Pr(>\|t\|)$
Intercept	46.2660	0.3088	149.82	< 0.0001
$\cos(2\pi t)$	-26.7079	0.4367	-61.15	< 0.0001
$\sin(2\pi t)$	-2.1697	0.4367	-4.97	<0.0001

Residual standard error: 3.706 on 141 degrees of freedom
Multiple R^2: 0.9639, Adjusted R^2: 0.9634
F-statistic: 1882 on 2 and 141 DF, $p-$value: $<$ 2.2e-16

Based on this information,
a) Write the **full model** used in the analyzsis of this data.
b) Compute the estimate for Φ and interpret this quantity
c) Compute the estimated **amplitude** for this model

END OF TEST PAPER