FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF MATHEMATICS AND STATISTICS

END OF SEMESTER EXAMINATION PAPER 2015

MODULE CODE: MA4505

SEMESTER: Autumn 2015

MODULE TITLE: Food Science

DURATION OF EXAM: 2.5 hours

LECTURER: Mr. Kevin O'Brien

GRADING SCHEME: 100 marks
70% of module grade

EXTERNAL EXAMINER: Dr. C.F. Ryback

INSTRUCTIONS TO CANDIDATES

Scientific calculators approved by the University of Limerick can be used.
Formula sheet and statistical tables provided at the end of the exam paper.
There are 5 questions in this exam. Students must attempt any 4 questions.

Question 1

What is going here?

- Basic Definitions (Type I and Type II error, what are p-values etc)
- Transformation of Data (Tukey's Ladder) (may be part of Q5)
- Outliers and Boxplots (Grubbs Test, Dixon Q-test)
- One Way ANOVA Tests for Multiple Means (may appear elsewhere) (HAND)
- Interpreting Output for Inference Procedures
    - Two sample t-tests and paired t-tests only
- F-test for Equality of Variance (var.test())

Question 2

What is going here?

- Using the Murdoch Barnes Table for Normal Distribution Problems
- Testing that Data is normally distributed (may appear elsewhere)
- Chi-Square Tests for independence of categorical variables (HAND)

Question 3

What is going here?

- One Way Anova Tests for Multiple Means (HAND) (possible Q1 also)
- Two Way ANOVA Testing (HAND)
    - No Replicates (i.e. give s_R^2 and S_C^2)
    - Replicates - Partial Completion
    - Be very clear about Degrees of Freedom
- Checking Model Assumptions
    - Bartlett Test
    - Constant variance of Residuals
    - Normality of Residuals
- Introduction to Experimental Design (Short Theory Questions)

Question 4

What is going here?

- Simple and Multiple Linear Regression
    - Reading R output for Model Summary
    - Hypothesis tests for Regression Coefficients
    - Confidence intervals for Regression Coefficients
- Correlation and Coefficient of Determination (HAND)
- Regression ANOVA (HAND)
- Model Fit Metrics such as AIC, and both R Squared
- Short Questions ofn sTheory Topics Such as Overfitting, Law of Parsimony, Multicollinearity
- Variable Selection Procedures
    - Forward Selection
    - Backward Selection
    - Diagrams are very useful here

Question 5

What is going here?

- Statistical Process Control
- Control Charts : Rules and Interpretation (very importiant)
    - State Rule
    - Sketch
    - Probability of event
- Process Capability Indices (HAND)
    - C_{pm} not included
    - Sketches are important
- Testing for Univariate Normality (may appear in Q1)

Critical Values for Dixon Q Test

N	$\alpha = 0.10$	$\alpha = 0.05$	$\alpha = 0.01$
3	0.941	0.97	0.994
4	0.765	0.829	0.926
5	0.642	0.71	0.821
6	0.56	0.625	0.74
7	0.507	0.568	0.68
8	0.468	0.526	0.634
9	0.437	0.493	0.598
10	0.412	0.466	0.568
11	0.392	0.444	0.542
12	0.376	0.426	0.522
13	0.361	0.41	0.503
14	0.349	0.396	0.488
15	0.338	0.384	0.475
16	0.329	0.374	0.463

Critical Values for Chi Square Test

n	$\alpha = 0.10$	$\alpha = 0.05$	$\alpha = 0.01$	$\alpha = 0.001$
1	2.705	3.841	6.634	10.827
2	4.605	5.991	7.378	9.21
3	6.251	7.815	9.348	11.345
4	7.779	9.488	11.143	13.277
5	9.236	11.07	12.833	15.086
6	10.645	12.592	14.449	16.812
7	12.017	14.067	16.013	18.475
8	13.362	15.507	17.535	20.09
9	14.684	16.919	19.023	21.666
10	15.987	18.307	20.483	23.209

Process Capability Indices

$$\hat{C}_p = \frac{\text{USL} - \text{LSL}}{6s}$$

$$\hat{C}_{pk} = \min\left[\frac{\text{USL} - \bar{x}}{3s}, \frac{\bar{x} - \text{LSL}}{3s}\right]$$

$$\hat{C}_{pm} = \frac{\text{USL} - \text{LSL}}{6\sqrt{s^2 + (\bar{x} - T)^2}}$$

Factors for Control Charts

Sample Size (n)	c4	c5	d2	d3	D3	D4
2	0.7979	0.6028	1.128	0.853	0	3.267
3	0.8862	0.4633	1.693	0.888	0	2.574
4	0.9213	0.3889	2.059	0.88	0	2.282
5	0.9400	0.3412	2.326	0.864	0	2.114
6	0.9515	0.3076	2.534	0.848	0	2.004
7	0.9594	0.282	2.704	0.833	0.076	1.924
8	0.9650	0.2622	2.847	0.82	0.136	1.864
9	0.9693	0.2459	2.970	0.808	0.184	1.816
10	0.9727	0.2321	3.078	0.797	0.223	1.777
11	0.9754	0.2204	3.173	0.787	0.256	1.744
12	0.9776	0.2105	3.258	0.778	0.283	1.717
13	0.9794	0.2019	3.336	0.770	0.307	1.693
14	0.9810	0.1940	3.407	0.763	0.328	1.672
15	0.9823	0.1873	3.472	0.756	0.347	1.653
16	0.9835	0.1809	3.532	0.750	0.363	1.637
17	0.9845	0.1754	3.588	0.744	0.378	1.622
18	0.9854	0.1703	3.64	0.739	0.391	1.608
19	0.9862	0.1656	3.689	0.734	0.403	1.597
20	0.9869	0.1613	3.735	0.729	0.415	1.585
21	0.9876	0.1570	3.778	0.724	0.425	1.575
22	0.9882	0.1532	3.819	0.720	0.434	1.566
23	0.9887	0.1499	3.858	0.716	0.443	1.557
24	0.9892	0.1466	3.895	0.712	0.451	1.548
25	0.9896	0.1438	3.931	0.708	0.459	1.541