Charles Darwin University

Final Examination

Family Name						
Given Name/s						
Student Number						
Teaching Period	Semester 2 Special/Summer Semester, 2017					

SBI209 – Design and Analysis of Biological Studies	DURATION	
	Reading Time:	10 minutes
	Writing Time:	180 minutes

INSTRUCTIONS TO CANDIDATES

Answers should be written in the booklet provided.
Please ensure that your Name and Student Number are written clearly in the space provided at the top of the booklet.
Note that questions ARE of equal value.
Read ALL questions carefully.
Writing on scrap paper during Reading Time is permitted.

EXAM CONDITIONS

You may begin writing from the commencement of the examination session. The reading time indicated above is provided as a guide only.

This is a RESTRICTED OPEN BOOK examination

Any calculator is permitted

No handwritten notes are permitted

Hard copy, unannotated English translation dictionary only

ADDITIONAL AUTHORISED MATERIALS	EXAMINATION MATERIALS TO BE SUPPLIED
No additional printed material is permitted	1 x 8 Page Book 1 x 20 Page Book Formula Sheet/s Statistical Table/s

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

THIS PAGE HAS BEEN INTENTIONALLY LEFT BLANK.

Twelve (12) short-answer questions

Total number of marks for this section: 180

Answers should be written in the booklet provided.

Please ensure that your Name and Student Number
are written clearly in the space provided at the top of the booklet.

Note that questions ARE of equal value.

Read ALL questions carefully.

Do not commence writing until instructed to do so.

Writing on scrap paper during Reading Time is permitted.

Marks for each question are indicated.
Suggested time allocation for this section: 180 minutes.
Note: All data are invented.

Question 1

For each of the following three (3) situations, state which kind of sampling scheme would be best and discuss why this would be better than the alternatives.

(i) Estimating numbers of species (kinds) of plants down the side of a mountain.

(ii) Estimating the weight of pumpkins growing in rows on a farm.

(iii) Estimating the amount of seagrass in different patches of seagrass in several bays.

(15 minutes = 15 marks)

Question 2

A large aquarium (fish tank) has five (5) male fish and five (5) female goldfish. Because the fish are growing large, five (5) fish must be moved into new tank. Calculate the probability of the following outcomes.

(i) All five (5) fish in the new tank are male.

(ii) Three (3) fish in the new tank are male and two (2) are female.

(iii) Four (4) fish in the new tank are male and one (1) is female.

(15 minutes = 15 marks)

Question 3

A study counts the numbers of left handed, and right handed, male and female children at a school. Using the data in the table below, test the following hypothesis:

H_0: The ratio of left handed to right handed is the same for males and females.

Table 1: Counts of left and right handed male and female children at a school.

	Left handed	Right handed
Male	34	206
Female	28	252

(15 minutes = 15 marks)

Question 4

A new warm up procedure is developed to reduce injuries during soccer practice. A study will be done to test the following null hypothesis: "H_0: The new procedure will result in no greater injuries than the normal procedure." Discuss the consequences of making Type I, and Type II, errors when testing this null hypothesis.

(15 minutes = 15 marks)

Question 5

A radar gun is used to check the speeds of cars on a highway [1]. The speeds are normally distributed with a mean of 90 km/hr and a standard deviation of 10 km/hr. Calculate the proportion of cars seen driving at the following speeds:

(i) Faster than 90 kph.

(ii) Faster than 105 kph.

(iii) Faster than 110 kph.

(15 minutes = 15 marks)

Question 6

An environmentalist is testing the effects of sewage pollution on a lake. She goes to the spot where the sewage is released into the lake, takes a water sample and counts the number of species of small water animals, getting a total of 52 species. She then walks 100 m along the shore and repeats the process, this time getting 37 species. She concludes that the sewage has caused a reduction in the number of species. Is this conclusion valid? If not, why not?

(15 minutes = 15 marks)

Question 7

At a hospital, records are kept of the times when babies are born. These records are then summarised to determine how many babies are born each hour. Over one day (24 hours), zero (0) births in the hour happened three (3) times; eight (8) times there was one (1) birth; six (6) times there were two (2) births; and so on as per Table 2 below. Test the following null hypothesis:

H_0: Babies were born at random times through the day.

Table 2: Counts of numbers of babies born in an hour.

Babies→	**0**	**1**	**2**	**3**	**4**
Count→	3	8	6	4	3

(15 minutes = 15 marks)

Question 8

The "fog index" is a number which measures how difficult a piece of written text is for readers, with higher scores indicating writing that is more difficult to understand. In one study [2], the fog index was calculated for advertisements taken from three different magazines: *Scientific American*, *Fortune* and the *New Yorker*. For each of the magazines, six (6) advertisements were randomly selected and the fog index was calculated for each. Table 3 has the means and Table 4 has a partly completed analysis of these data. Complete the analysis below, and do any other procedures required, to test the following null hypothesis:

H_0: Mean fog index is the same for all three magazines.

Table 3: Mean score for three different magazines.

Magazine→	***Scientific American***	***Fortune***	***New Yorker***
Score	11.0	10.7	7.4

Table 4: Partially completed analysis of data.

Source	**SS**	**df**
Among	48.53	2
Within	52.22	15
Total	100.75	17

(15 minutes = 15 marks)

Question 9

Hyperventilating is the practice of breathing deeply several times to flush carbon dioxide out of the lungs and the blood. Seven (7) students recorded the time (seconds) they could hold their breath after breathing normally and also after hyperventilating for one minute. Using the data in the table, test the null hypothesis below:

H_0: Hyperventilation time is not correlated with normal breathing time.

Table 5: Time (secs) holding breath after normal breathing and hyperventilating.

Student→	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Normal→	56	56	65	65	50	25	87
Hyperventilation→	87	91	85	91	75	28	122

(15 minutes = 15 marks)

Question 10

Resting heart rate is a commonly used measure of heart health: a lower rate is good because it indicates that the heart is working efficiently and is not stressed. For men in the age group 56 to 65, the rate should be 72 to 75 beats per minute (bpm) [4]. The resting heart rate was measured for two groups of subjects in a clinical trial. The results are in the table. For Group 1 and Group 2 (separately), test the following null hypothesis (you will do two tests):

H_0: The average heart rate for patients in the group is less than or equal to 75.

Table 6: Measured heart rates(bpm) for Group 1 and Group 2.

Group 1→	**Subject 1**	**Subject 2**	**Subject 3**	**Subject 4**	**Subject 5**
Rate→	78	73	71	75	73

Group 2→	**Subject 1**	**Subject 2**	**Subject 3**	**Subject 4**	**Subject 5**
Rate→	81	84	86	83	83

(15 minutes = 15 marks)

Question 11

A researcher wanted to know if someone's interest in politics was influenced by their education and sex. A random sample of 60 participants – 30 males and 30 females – was selected to take part in the study, which looked at students at three levels of education: high school, college and university. There were ten (10) participants in each of the six (6) groups. Each person completed a questionnaire that scored their interest in politics on a scale of 0 to 100, with higher scores indicating a greater interest in politics. State appropriate null hypotheses, complete the analysis in Table 8 and draw conclusions about these hypotheses and the study.

Table 7: Mean political interest in each of the six (6) groups.

	Male	**Female**
School	39	45
College	46	46
University	64	58

Table 8: Partially completed analysis of data.

Source	**SS**	**df**	**MS**	**F**
A: Gender	6.9	1	6.9	
B: Education	5486.9	2		
A × B	216.9	2		
Within/Error	769.0	52		
Total	6457.8	57		

(15 minutes = 15 marks)

Question 12

Researchers were looking at the effect of alcohol on reaction time [6]. Six (6) drivers were recruited ("free beer!") and their reaction times in an obstacle course were measured before they drank alcohol and then after they drank two (2) cans of beer. Using the data in the table, test the following null hypothesis:

H_0: Mean reaction time before drinking beer equals mean reaction time after.

Table 9: Reaction time (secs) before and after drinking two (2) beers for six (6) subjects.

	Subject					
	1	**2**	**3**	**4**	**5**	**6**
Before	6.25	2.96	4.95	3.94	4.69	4.56
After	6.85	4.78	5.57	4.01	3.72	4.99

(15 minutes = 15 marks)

Sources

[1] Normal Distribution Problems with Answers (undated). From: Free Mathematics Tutorials. http://www.analyzemath.com/statistics/normal_distribution.html. Accessed: 14/11/17.

[2] Casado, D (2015). Solved Exercises and Problems of Statistical Inference. http://www.casado-d.org/edu/ExercisesProblemsStatisticalInference.pdf. Accessed: 15/11/17.

[3] Anonymous (2017). Faculty of Health and Applied Sciences, University of the West of England, Bristol (2017). Pearson's Correlation Coefficient. http://learntech.uwe.ac.uk/da/Default.aspx?pageid=1442. Accessed: 15/11/17.

[4] Top End Sports (undated). Resting Heart Rate Table. http://www.topendsports.com/testing/heart-rate-resting-chart.htm. Accessed: 17/11/17.

[5] Laerd Statistics (undated). Two way ANOVA in Stata. https://statistics.laerd.com/stata-tutorials/two-way-anova-using-stata.php. Accessed: 17/11/17.

[6] University of Floriday (2017). Biostatistics, Open Learning Textbook. Paired samples. http://bolt.mph.ufl.edu/6050-6052/unit-4b/module-13/paired-t-test/. Accessed: 17/11/17.

FORMULAS

Note – you may **NOT** need to use all of these.

1. $\Pr(r) = \frac{n!}{r!(n-r)!} \times p^r (1-p)^{n-r}$

2. $\Pr(r) = \frac{e^{-\mu}\mu^r}{r!}$

3. $t = \frac{\bar{X}_1 - \bar{X}_2}{\text{SE}}$

where

$$\text{SE} = \sqrt{\frac{s_c^2(n_1+n_2)}{n_1 \times n_2}}$$

$$s_c^2 = \frac{s_1^2(n_1-1)+s_2^2(n_2-1)}{(n_1+n_2-2)}$$

$$df = (n_1 + n_2 - 2)$$

4. $r = \frac{C_{\text{xy}}}{\sqrt{\text{SS}_x \times \text{SS}_y}}$

where

$$C_{\text{xy}} = \sum \text{XY} - \frac{\sum X \sum Y}{n}$$

$$\text{SS}_x = \sum X^2 - \frac{(\sum X)^2}{n}$$

$$\text{SS}_y = \sum Y^2 - \frac{(\sum Y)^2}{n}$$

5. $r_s = 1 - \frac{6\sum d^2}{(n^3-n)}$