Charles Darwin University

Final Examination

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

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

INSTRUCTIONS TO CANDIDATES

EXAM CONDITIONS
<u>You may begin writing from the commencement of the examination session.</u> 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 1 x Scrap Paper Formula Sheet/s Statistical Table/s

THIS EXAMINATION IS PRINTED DOUBLE-SIDED.

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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

Briefly describe the four main types of sampling schemes (as covered in the unit), and state when each would be preferred (or better).

(15 minutes = 15 marks)

Question 2

There are 14 people who are going to play a friendly game of "sevens rugby": 7 are male and 7 are female. They are going to choose teams by tossing a coin: heads, the player is in the red team; tails, they are in the blue team. Calculate the probability of the following outcomes.

(i) All seven (7) players in the blue team are female (0 males in the blue team).

(ii) Three (3) players in the blue team are female (4 males in the blue team).

(iii) Six (6) players in the blue team are female (1 male in the blue team).

(15 minutes = 15 marks)

Question 3

A study of primary schools counts numbers of male and female children attending three different schools. Using the data in the table below, test the following hypothesis:

H_0: The ratio of male to female is the same at the three schools.

Table 1: Counts of male and female children in three schools.

	School 1	**School 2**	**School 3**
Male	48	104	201
Female	52	96	199

(15 minutes = 15 marks)

Question 4

A new drug for allergic sinusitis (sinus allergy) is being developed. A study will be done to test the following null hypothesis: "H_0: The new drug will have no greater side effects than the usual treatment." Discuss the consequences of making Type I, and Type II, errors when testing this null.

(15 minutes = 15 marks)

Question 5

Assume cheetah speeds are normally distributed with a mean of 95.8 kph (kilometres per hour) and standard deviation of 6.9. Calculate the proportion of cheetahs able to run at the following speeds:

(i) Faster than 99.3 kph.

(ii) Faster than 102.7 kph.

(iii) Faster than 106.2 kph.

(15 minutes = 15 marks)

Question 6

An ecologist is testing the effects of very dilute oil pollution on mangrove crabs. He marks out a 1 m × 1 m plot and counts the number of crab burrows, getting a total of 43. He then pours on the oil, goes back the next day and recounts the burrows, getting a total of 45. He concludes that the oil has not effect on the crabs. Is this conclusion valid? If not, why not?

(15 minutes = 15 marks)

Question 7

A study is being done of fires in the Northern Territory. Using remote sensing technology, 150 study plots were established (on satellite images) and the number of fires occurring during the year counted and recorded. The data table below shows that 41 plots had zero (0) fires, 52 plots had one (1) fire, 24 plots had two (2) fires, and so on. Test the following null hypothesis:

H_0: Fires occur at random in the study plots.

Table 2: Counts of plots with specified number of fires observed.

Fires→	**0**	**1**	**2**	**3**	**4**	**5**	**6**
Plots→	41	52	24	12	9	8	4

(15 minutes = 15 marks)

Question 8

Teacher Susan Sound thinks that students will learn most effectively with a constant background sound, compared to an unpredictable sound or no sound at all. She randomly divides her class of twenty-four (24) students into three (3) groups of eight (8). The students study some text for 30 minutes. Those in group 1 study have a sound at a constant volume in the background. Those in group 2 study with a sound that is changing volume periodically. Those in group 3 study with no sound at all. All students then do a multiple choice test of ten (10) questions, for ten (10) points total (1 point per question). Complete the analysis below, and do any other procedures required, to test the following null hypothesis:

H_0: Mean score is the same for all conditions.

Table 3: Mean score for three different dound conditions.

Group→	**Constant**	**Random**	**None**
Score (/10)	6.0	4.0	3.4

Table 4: Partially completed analysis of data.

Source	**SS**	**df**
Among	30.08	2
Within	87.88	21
Total	117.96	23

(15 minutes = 15 marks)

Question 9

The manager of a wildlife park is interested in the speed of his cheetahs. One day when the park is closed, he estimates the body length (centimetres) and speed (km/hour) of seven (7) cheetahs. Using the data in the table, test the null hypothesis below:

H_0: Running speed is not correlated with body length.

Table 5: Speed and vody length of seven (7) cheetahs.

Sample→	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Speed (kph)→	91	95	95	90	89	94	88
Size (cm)→	134	128	124	128	133	131	132

(15 minutes = 15 marks)

Question 10

A study of joint position sense (ability to know what position joints are in without looking) has five (5) volunteers bend their knee to a 120° angle for a few seconds, then return the knee to a 90° angle. The measurement variable is the actual angle of the knee, and the theoretical expectation from the null hypothesis is 120°. The results are in the table. For males and females (separately), test the following null hypothesis (you will do two tests):

H_0: The mean angle is equal to 120°.

Table 6: Measured angles for male and females.

Males→	**Subject 1**	**Subject 2**	**Subject 3**	**Subject 4**	**Subject 5**
Angle→	115.31	116.17	123.53	118.21	115.98

Females→	**Subject 1**	**Subject 2**	**Subject 3**	**Subject 4**	**Subject 5**
Angle→	124.07	117.25	119.07	114.99	114.77

(15 minutes = 15 marks)

Question 11

Investigators wished to know if there was a difference in plasma calcium levels of male and female birds given a hormone treatment [2]. There were five (5) replicate birds for each combination of sex and hormone treatment. State appropriate null hypotheses, complete the analysis, draw conclusions about the hypotheses, and about the effects of the hormone and sex.

Table 7: Mean calcium for the birds in each of the four (4) groups.

	No hormone	**Hormone**
Male	13	28
Female	15	31

Table 8: Partially completed analysis of data.

Source	**SS**	**df**	**MS**	**F**
A: Hormone	1386.11	1	1386.11	
B: Sex	70.31	1		
A × B	4.90	1		
Within/Error	366.37	16		
Total	1827.70	19		

(15 minutes = 15 marks)

Question 12

Volunteers count the number of breeding horseshoe crabs on some US beaches every year, as part of environmental surveys [3]. Using the data in the table, test the following null hypothesis:

H_0: Mean number of crabs in 2011 equals the mean number in 2012.

Table 9: Counts of horseshoe crabs for 2 years at 6 beaches.

	Beach					
	1	**2**	**3**	**4**	**5**	**6**
2011	35,282	359,350	45,705	49,005	68,978	8,700
2012	21,814	83,500	13,290	30,150	12,5190	4,620

(15 minutes = 15 marks)

Sources

[1] Hall, R. (1998). Between subjects one-way ANOVA example. Source: https://web.mst.edu/~psyworld/anovaexample.htm

[2] Smith, P. (undated). Two factor analysis of variance. Source: http://www.csub.edu/~psmith3/Teaching/310-9.PDF

[3] McDonald, J.H. (2014). Handbook of Biological Statistics (3rd ed.). Sparky House Publishing, Baltimore, Maryland. This web page contains the content of pages 180-185 in the printed version.

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

where

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

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

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

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

where

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

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

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

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