

**NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY**  
**FACULTY OF THE BUILT ENVIRONMENT**  
**BACHELOR OF QUANTITY SURVEYING (HONOURS) DEGREE**  
**PART II SUPPLEMENTARY EXAMINATIONS – JULY 2014**  
**STATISTICS II - AQS 2209**

**Time: 3 hours**

**Total Marks: 100**

**INSTRUCTIONS TO CANDIDATES**

Answer ONLY FOUR questions  
Each question carries (25 marks).

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- A1.** The results of a survey at a big Construction and Quantity Surveying Consultancy firm made to determine whether the age of a driver 21 years of age and older has any effect on the number of automobile accidents in which he or she is involved are shown in the table below.

	Age of Driver				
Number of Accidents	21-30	31-40	41-50	51-60	61-70
0	748	821	786	720	672
1	74	60	51	66	50
2	31	25	22	16	15
Greater than 2	9	10	6	5	7

- (a) Test at 5% level of significance that the number of accidents is independent of the age of the driver. [10 marks]
- (b) Test at 10% level of significance that the number of accidents is independent of the age of the driver. [10 marks]
- (c) What possible sources of difficulty in sampling techniques, as well as other considerations, could affect your conclusions? [5 marks]

**A2.** The table below shows the heights to the nearest millimetre and weights to the nearest pound (lb) of a sample of 12 pavers drawn at random from a brick manufacturing company.

Height, X (mm)	70	63	72	60	66	70	74	65	62	67	65	68
Weight, Y (lb)	155	150	180	135	156	168	178	160	132	145	139	152

(a) Draw a scatter diagram of y against x on graph paper. Fit the least squares straight line to these data and draw your fitted line on your scatter diagram.

[10 marks]

(b) Carry out an analysis of variance (ANOVA) to test at the 5 % level of significance whether the slope is significantly different from zero. From your ANOVA table, compute the coefficient of determination,  $r^2$ , and interpret it.

[9 marks]

(c) Predict the weight of the paver if the height is 63.

[3 marks]

(d) Predict the height when the weight is known to be 168 lb.

[3 marks]

**A3.** (a) Define the following terms as they are used in experimental design:

- I. Randomisation
- II. Blocking
- III. Treatment

[6 marks]

(b) A product development engineer is interested in investigating the tensile strength of a new reinforcement that will be used to make lintels. The engineer knows from past experience that the strength of the lintels is affected by the weight of reinforcement used. The engineer decides to test 5 levels of reinforcement strengths (treatments) which are 15, 20, 25, 30 and 35 and decides to use 5 replicates as shown in the table below:

REINFORCEMENT STRENGTH	OBSERVATIONS				
	1	2	3	4	5
15	7	7	15	11	9
20	12	17	12	18	18
25	14	18	18	19	19
30	19	25	22	19	23
35	7	10	11	15	11

Test at 5% level of significance if the means are equal

[19 marks]

**A4.** (a) Explain the advantages of using Latin Squares in Experimental Design.

[5 marks]

(b) Consider the table below of a Latin Square design for analysing rocketed propellant where both batches of raw materials and operators represent randomisation.

BATCHES OF RAW MATERIALS	OPERATORS				
	1	2	3	4	5
1	A= -1	B= -5	C= -6	D= -1	E= -1
2	B= -8	C= -1	D= 5	E= 2	A= 11
3	C= -7	D= 13	E= 1	A= 2	B= -4
4	D= 1	E = 6	A = 1	B = -2	C = -3
5	E = -3	A= 5	B = -5	C = 4	D = 6

(b) Test at 0.05 level of significance if there is difference between batches and raw materials.

[20 marks]

**A5.** (a) Discuss the advantages and applications of factorial designs.

[5 marks]

(b) A manufacturer wishes to determine the effectiveness of four types of machines (A, B, C and D) in the production of bolts used in construction. To accomplish this, the numbers of defective bolts produced by each machine in the days of a given week are obtained for each of two shifts; the results are shown in the table below:

Factor 1: Machine	Factor 11: Shift	Replicates				
		Mon	Tue	Wed	Thur	Fri
A	1	6	4	5	5	4
	2	5	7	4	6	8
B	1	10	8	7	7	9
	2	7	9	12	8	8
C	1	7	5	6	5	9
	2	9	7	5	4	6
D	1	8	4	6	5	5
	2	5	7	9	7	10

Perform an analysis of variance to determine at 0.05 level of significance whether there is a difference:

- (a) Between the machines
- (b) Between the shifts

[20 marks]

**A6.** A construction firm wishes to investigate the effects of advertising on the sales. The advertising and sales data for the past three years 2011 to 2013 are shown in the table below:

Advertising expenditure, X, (US\$)	1000	1200	1800	1500	800	1700	2000	1500	1100	1900
Sales, Y, (US\$)	22000	25000	26000	30000	23000	27000	32000	27000	25000	29000

- (a) Draw a scatter diagram of y against x on graph paper. [3 marks]
- (b) Find the least squares straight line to these data and draw your fitted line on your scatter diagram. [10 marks]
- (b) Compute the correlation coefficient and interpret it. [9 marks]
- (c) Predict the sales when the advertising cost is \$1950 [3 marks]

**END OF EXAMINATION**