



**JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY**

**SCHOOL OF MATHEMATICS AND ACTUARIAL SCIENCE**

**UNIVERSITY EXAMINATION FOR DEGREE OF BACHELOR OF SCIENCE**

**ACTUARIAL**

**2<sup>nd</sup> YEAR 2<sup>nd</sup> SEMESTER 2018/2019 ACADEMIC YEAR**

**REGULAR (MAIN)**

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**COURSE CODE: SAS 306 / SAC 306**

**COURSE TITLE: STATISTICAL MODELING**

**EXAM VENUE:**

**STREAM: (BSc. Actuarial)**

**DATE: 1/5/19**

**EXAM SESSION: 12.00 – 2.00pm**

**TIME: 2.00 HOURS**

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**Instructions:**

- 1. Answer question 1 (Compulsory) and ANY other 2 questions**
- 2. Candidates are advised not to write on the question paper.**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room.**

## QUESTION ONE

- 1.a)** Explain the linearity of regression. (2mks)
- b)** Give the appropriate linear form of the following non-linear functions when subjected to transformation
- i)**  $Y = \beta_0 e^{\beta_1 x}$
- ii)**  $Y = \beta_0 x^{\beta_1}$
- iii)**  $Y = \beta_0 10^{\beta_1 x}$  ( 6mks)
- c)** Explain the significance of residual analysis in a simple linear regression model. (2mks)
- d)** Explain ways by which test of hypothesis and analysis of variance is similar and different as far as test of significance of regression coefficient of linear model is concerned. (3mks)

- e)** Given the regression estimates as;  $\hat{\beta}_0 = \bar{y}$  and  $\hat{\beta}_1 = \beta_1 + \frac{\sum_{i=1}^n (x_i - \bar{x}) \varepsilon_i}{\sum_{i=1}^n (x_i - \bar{x})^2}$ , find the variances of the estimates  $\hat{\beta}_0$  and  $\hat{\beta}_1$ . (10mks)

- f)** Given the data below on the number of hours (x) which 9 students studied for statistics test and their scores (y) on the test

X	4	9	10	14	4	7	12	22	1
Y	31	58	65	73	37	44	60	91	21

- Find the normal regression line that approximates the regression of the test scores on the number of hours studied. (7mks)

## QUESTION TWO

2. The following data shows Maths achievement test scores and the SAC 306 grades for 10 university students.

Students	1	2	3	4	5	6	7	8	9	10
Maths achievement test scores(X)	39	43	21	64	57	47	28	75	34	52
Final SAC 306 Grades(Y)	65	78	52	82	92	89	73	98	56	75

- a) Calculate  $\bar{X}$  and  $\bar{Y}$
- b) Calculate least square estimates of  $\hat{\beta}_0$  and  $\hat{\beta}_1$ .
- c) Determine the fitted line
- d) Determine whether the value of  $\hat{\beta}_1$  provides sufficient evidence to indicate that  $\hat{\beta}_1$  differs from zero (linear relationship exists between students Maths achievement score X and his final SAC 306 grades Y) at  $\alpha = 0.05$ . (20mks)

## QUESTION THREE

3. a) Explain the meaning of standardized residuals as far as testing the adequacy of linear regression model is concerned. (2mks)

b) An article in the *Journal of Sound and Vibration* (Vol. 151, 1991, pp. 383–394) described a study investigating the relationship between noise exposure and hypertension.

The following data are representative of those reported in the article.

Y	1	0	1	2	5	1	4	6	2	3	5	4	6	8	4	5	7	9	7	6
X	60	63	65	70	70	70	80	90	80	80	85	89	90	90	90	90	94	100	100	100

- (a) Fit the simple linear regression model using least squares.
- (b) Obtain  $\widehat{\sigma}^2$
- (c) Test the adequacy of the regression model by residual analysis (18mks)

### QUESTION FOUR

4. In a simple linear regression given as  $Y_i = \beta_0 + \beta_1(x_i - \bar{x}) + \varepsilon_i$ ,  $\beta_0$  and  $\beta_1$  are often estimated with  $\hat{\beta}_0$  and  $\hat{\beta}_1$  respectively.

a) Show that  $\hat{\beta}_0$  and  $\hat{\beta}_1$  are unbiased estimates of  $\beta_0$  and  $\beta_1$  respectively. (10mks)

b) Obtain the regression line of Y on X for the following data.

X	1	2	3	4	5	6	7	8	9
Y	9	8	10	12	11	13	14	16	15

(10mks).

### QUESTION FIVE

5 a) Explain the meaning of non-linear regression. (2mks)

b) A shop sells home computers. The numbers of computers sold in each of five successive years are given in the table below;

Years(X)	1	2	3	4	5
Sales(Y)	10	30	70	140	210

i) Assuming that the sales (Y) and the year (X) are related by the equation  $y = ab^x$  find the least square regression line, hence estimate the constants  $a$  and  $b$ .

ii) The shop manager uses this relationship to predict the sales in the sixth year. Find the predicted sales.

iii) Obtain a 95% confidence interval for the slope of the regression line. (18mks)