MANICALAND STATE UNIVERSITY OF APPLIED SCIENCES

FACULTY OF ENGINEERING

DEPARTMENT OF MINING & MINERAL PROCESSING ENGINEERING
DEPARTMENT OF CHEMICAL & PROCESSING ENGINEERING
DEPARTMENT OF METALLURGICAL ENGINEERING

MODULE: ENGINEERING MATHEMATICS IV

CODE: HGEN224

SESSIONAL EXAMINATIONS
OCTOBER 2021

DURATION: 3 HOURS

EXAMINER: MS L. MADZIVANYIKA

INSTRUCTIONS

1. *Answer **All** in Section A*
2. *Answer **three** questions in Section B.*
3. *Start a new question on a fresh page*
4. *Total marks 100*

Additional material(s): *Non-programmable electronic scientific calculator, Statistical tables, Graph paper.*

SECTION A *(ANSWER ALL THE QUESTIONS)*[40 Marks]

A1.

(a) State how you can check for the following in a given data set;

i. autocorrelation

ii. heteroscedasticity

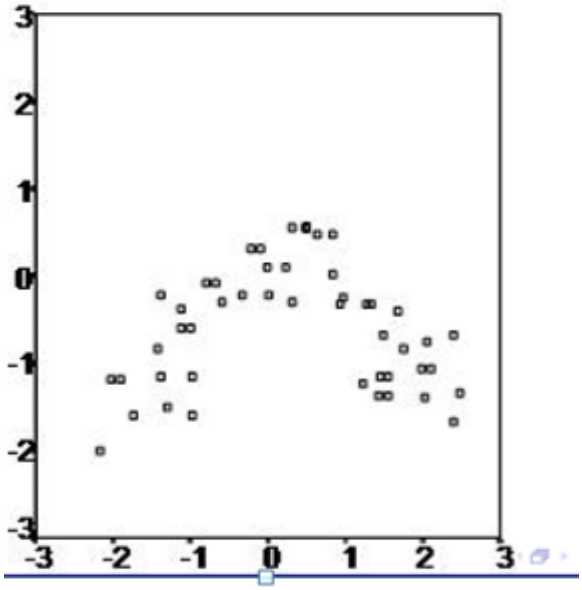
iii. normality

iv. multicollinearity

(b) What is correlation?

(2,2,2,2,2)

A2. Given the following scatter plot diagram



(a) Comment on the type of relationship displayed in the scatter plot below.

(b) Explain any transformation technique that can be applied to the data so that it becomes linear. **(4, 4)**

A3. Given the data in the table below

x	1	2	3	3	4	5
y	9	5	6	3	3	1

(a) Calculate Pearson's correlation coefficient

(b) Comment on the value that you got in part (a). **(6, 2)**

A4.

The table below displays a summary output of a certain data set from a statistical package.

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.982655
R Square	0.96561
Adjusted R Square	0.959879
Standard Error	26.01378
Observations	15

Y = B0 + B1 X1 + B2X2 + B3X3 - - - +/- Error
Total = Estimated/Predicted +/- Error

ANOVA

	df	*SS*	*MS*	*F*	*ignificance F*
Regression	2	228014.6	114007.3	168.4712	1.65E-09
Residual	12	8120.603	676.7169		
Total	14	236135.2			

	Coefficients	*tandard Err*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*
Intercept	562.151	21.0931	26.65094	4.78E-12	516.1931	608.1089
Temperature	-5.436581	0.336216	-16.1699	1.64E-09	-6.169133	-4.704029
Insulation	-20.01232	2.342505	-8.543127	1.91E-06	-25.1162	-14.90844

(a) Write the fitted regression model.

(b) What is the residual sum of squares for the data that was used?

(c) What is the mean square error for the data that was used?

(d) What is the estimated value of sigma squared σ^2.

(e) Compute the correlation coefficient, *r* and explain the strength of the relationship between the dependent and independent variables

(3, 2, 2, 3, 4)

SECTION B *(ANSWER 3 QUESTIONS ONLY)* [60 Marks]

B5.

Last semesters' Engineering Mathematics 4 examination marks, average assignment marks and average test marks for each student were collected to investigate the claim that average examination marks depend on average test marks and average assignment marks for each student doing Metallurgy Engineering. A sample of marks is listed below

Student	1	2	3	4	5	6	7
Ave test mark	50	35	72	45	85	47	79
Ave assignment mark	70	64	70	58	89	66	74
Examination mark	62	45	77	56	91	50	83

(a) State the model in matrix notation for analysing these data. Define all terms used.

(b) Given that $(\mathbf{X'X})^{-1}=\begin{pmatrix} 12.9932 & .0770 & -.2480 \\ .0770 & .0014 & -.0023 \\ -.2480 & -.0023 & .0054 \end{pmatrix}$.

i. Find $\hat{\beta}=(\mathbf{X'X})^{-1}\mathbf{X'Y}$.

ii. Construct the ANOVA table and perform t-tests for each parameter β_1 and β_2.

iii. Also perform an F test on overall model.

(3, 4, 10, 3)

B6.

(a) Derive the least squares estimators for the parameter vector, β, in a simple linear regression.

(b) The matrix $\mathbf{H = X(X'X)^{-1}X'}$ is called the hat matrix. Show that **H** idempotent matrix.

(c) If $\boldsymbol{e = Y' - Y}$, show that $\boldsymbol{E(e) = 0}$ and **Var (e)** = $\boldsymbol{\sigma^2}$

(8,5,7)

B7.

A study was done to check the effect of ambient temperature X on the electric power consumed by a chemical plant Y. Other factors were held constant, and the data was collected from an experimental pilot plant.

Y(BTU)	X(°C)	Y(BTU)	X(°C)
250	27	265	31
285	45	298	60
320	72	267	34
295	58	321	74

(a) Plot these data.
(b) Estimate the slope and intercept in a simple linear regression model.
(c) Predict power consumption for an ambient temperature of 65°C

(5, 10, 5)

B8.

An investigator interested in the dependence of the speed of sound on temperature obtained the following measurements.

X Temperature(°C)	-20	0	20	50	100
Y Speed (m/s)	323	327	340	364	384

(a) Find the regression equation for Y on X.
(b) Is the slope of the regression equation significantly different from 0 at the 5% level of significance?
(c) Test the hypothesis $\mathbf{H_0: y_0 = \beta_0 + 80\beta_1 = 300}$.

(5, 10, 5)

END OF QUESTION PAPER