



KARATINA UNIVERSITY
UNIVERSITY EXAMINATIONS
2024/2025 ACADEMIC YEAR

FIRST YEAR FIRST SEMESTER REGULAR
EXAMINATION

FOR THE DEGREE OF:
BACHELOR OF SCIENCE (P100, P101, P105, P106 & P107)
BACHELOR OF EDUCATION (E100, E101, E103, E111 &
E112)

COURSE CODE: MAT 116

COURSE TITLE: CALCULUS I

DATE: 21st January 2025 TIME: 3.00pm-5.00pm

INSTRUCTION TO CANDIDATES:

- SEE INSIDE

INSTRUCTIONS: Answer ***ALL*** questions in section A and any other ***TWO*** from section B.

SECTION A (30 marks)

QUESTION ONE (30 marks)

(a) Describe the uses of the following panels in RStudio. **(4 marks)**

- i) Console window
- ii) Source editor
- iii) Workspace environment
- iv) File browser

(b) Given the following event times x and y .

```
x = c(2,3,5,7,11,13)
y = c(15,10,25,20,5,12)
```

Write an R command that;

- (i) Calculates how many times y is greater or equal to 20 minutes and hence the percentage. **(3 marks)**
 - (ii) Calculates the number of times x is greater than 6 or less than 5. **(2 marks)**
 - (iii) Finds the longest time for y . **(1 mark)**
 - (iv) Computes the average time x using the formula $\bar{x} = \frac{\sum x}{n}$. **(1 mark)**
- (c) What will be the output of the following R code. **(2 marks)**

```
a <- 1:10
a[a >= 5] <- 20
print(a)
```

(d) Given that z is an empty vector structure of mode numeric. Create the empty vector z and hence a vector of length 5 by giving the third, fourth and fifth components as 4, 10 and 5 respectively. (3 marks)

(e) Given the area of a circle as $Area = \pi r^2$ where r is the radius of the circle. Write an R function called **Area** which calculates the area of a circle. Hence write an R code that will print the area of a circle when the radius $r = 5cm$. (4 marks)

(f) What will be the output of the following R code? (1 mark)

```
0/0
```

(g) Given the following R code;

```
x = c(5,NA,10,7,NA)
y = c(2,8,NA,3,4)
```

What will be the output of;

(i) `x+y`

(1 mark)

(ii) `sum(x>=5,na.rm=T)`

(1 mark)

(iii) `sum(x[x>=5],na.rm=T)`

(1 mark)

(h) Write an R code that would print the output "5", "6", "7", "8", "9", "10" for the code; (1 mark)

```
x<-5:10
```

- (i) Write an R command that would create an object called *fruits* and hence prints the following result; (3 marks)

```
> fruits
orange banana apple peach
      12      10      5      20
```

- (j) Write an R code that will remove the object *x* in part (e) above hence lists all the objects created in a session. (2 marks)

SECTION B (40 marks)

QUESTION TWO (20 marks)

- (a) The following table represents marks of 10 students taking STA 116 at KarU.

Program	ACS	ACS	EDS	AST	EDS	SCE	EDS	AST	ACS	EDS
Marks	71	84	40	57	52	60	40	80	42	66
Gender	M	F	F	M	M	F	M	F	F	M

Write an R program that performs the following;

- (i) Creates the object *Program* as a factor variable. (2 marks)
- (ii) Creates the variable *Marks*. (1 mark)
- (iii) Creates the object *Gender* as factor levels. (2 marks)
- (iv) Creates a data frame called *Students*, which contains all the three variables just created. (3 marks)
- (v) Computes the sample mean marks for each program and stores it in an object called *meanMarks*. (2 marks)
- (vi) Calculates the mean marks by splitting the students by both program and gender. (3 marks)

- (b) Create three numeric vectors *n1*, *n2*, and *n3* whose elements are the integers from 1 to 20, their squares, and their cubes respectively. **(3 marks)**
- (c) Create a new data frame called ***data*** from the three vectors in part (b) above. **(2 marks)**
- (d) Write a command that prints the first few lines of the data frame created in part (c) above. **(1 mark)**
- (e) Compute the mean of each variable in the data frame ***data*** created in part (c) above using `sapply` function. **(1 mark)**

QUESTION THREE (20 marks)

- (a) The accumulated amount deposit into a savings account *S* needed to reach an investment goal can be calculated by the formula

$$A = S(1 + r)^N$$

where *A* is the accumulated amount deposit, *S* is the amount saved in a fixed deposit account, *N* is the number of years, and *r* is the annual interest rate (%). The input arguments are *S* (amount saved in a fixed deposit account), *r* (the annual interest rate, %), and *N* (duration of the savings in years). The output *A* is the accumulated amount deposit.

- (i) Write an R function that calculates the accumulated amount into a savings account. **(4 marks)**
- (ii) Use the function to calculate the accumulated amount for a 10-year investment if the amount saved in a fixed deposit account is \$25,000 and the annual interest rate is 4.25%. **(1 mark)**
- (b) What will be the output of the following R code? **(1 mark)**

```
c(seq(2,10),seq(9,2))
```

- (c) What will be the output for the following R code? **(1 mark)**

```
x<-c("4","5","6")  
as.numeric(x)
```

- (d) Using data set saved on the desktop as stored externally as CSV file, write an R code that reads in the dataset into a data frame where the first line of the file designates the names of the variables in the data frame. **(3 marks)**

- (e) Given the vector $x = (1, 3, 5, NA, 7, NA, 2, 4, 6, -4)$. Write an R code that;

- (i) Re-creates an object y which contains the non-missing values of x . **(2 marks)**

- (ii) Extracts the first six elements of vector x . **(1 mark)**

- (iii) Excludes the first five elements of vector x . **(1 mark)**

- (iv) Creates an object z and places in it the values of a vector $(x + 2)$ for which the corresponding value in x is both non-missing and positive. **(2 marks)**

- (v) Coerces the vector into a character string. **(1 mark)**

- (vi) Computes the standard deviation for the object z created in part (iv) above using the following formula; **(3 marks)**

QUESTION FOUR (20 marks)

- (a) Given Matrix $X = \begin{bmatrix} 1 & 5 & 9 & 13 \\ 2 & 6 & 10 & 14 \\ 3 & 7 & 11 & 15 \\ 4 & 8 & 12 & 16 \end{bmatrix}$. Write an R program that performs the following;

- (i) Generates the matrix array (X). **(2 marks)**

- (ii) Generates an index array for extracting elements 13, 11 and 16. **(2 marks)**
 - (iii) Extracts the three elements in (ii) above. **(1 mark)**
 - (iv) Replaces the elements in (iii) above by zeros. **(1 mark)**
- (b) Given that matrix Y is created by the following R code.

```
Y<-matrix(c(10:19,20:29),4,5,byrow=T)
```

- Write down matrix Y. **(2 marks)**
- (c) Write an R code that performs the following for the above two matrices X in (a) and Y in (b);
- (i) Computes $W = X^{-1}Y$. **(2 marks)**
 - (ii) Computes $Z = X^TY$ **(2 marks)**
 - (iii) Computes the eigen values and eigen vectors of matrix X. **(1 mark)**
 - (iv) Solves the determinant of matrix X. **(1 mark)**
- (d) Given the command , `n<-10` what will be the output of the following sequences;

(i) `1:n-1`

(1 mark)

(ii) `1:(n-1)`

(1 mark)

(iii) `1:2*n-1`

(1 mark)

- (e) Write down the three ways of assigning an object $x = 20, 10, 15, 12, 23$ in R.

(3 marks)

QUESTION FIVE (20 marks)

- (a) Suppose a student survey is done to evaluate if the students who smoke study less.

The data was recorded as shown below.

Person	Smokes	Amount of studying
1	Yes	Less than 5 hours
2	No	5-10 hours
3	No	5-10 hours
4	Yes	More than 10 hours
5	No	More than 10 hours
6	Yes	Less than 5 hours
7	Yes	5-10 hours
8	Yes	Less than 5 hours
9	No	More than 10 hours
10	No	5-10 hours

Write an R program that does the following;

- (i) Creates a data frame named *smokelevel* where the first entry in each column corresponds to the variable names (Person, Smokes and Amount of studying).
(5 marks)
- (ii) Checks the structure type for each variable in the dataset above. (1 mark)
- (iii) Creates a contingency table of smokes and amount of studying for the above data.
(2 marks)
- (iv) Counts the number of students per amount of studying. (2 marks)
- (v) Computes the percentage of the number of students per amount of studying.
(3 marks)
- (vi) Summarizes the information in a well labelled bar plot for each of No or Yes variable for each level of smoking.
(5 marks)
- (vii) Write a function that makes each variable in *smokelevel* available directly by its name.
(2 marks)