

MAKERERE UNIVERSITY
SCHOOL OF COMPUTING AND INFORMATION SCIENCES
MTH 2203: NUMERICAL ANALYSIS Semester:Two 2021/2022 COURSE WORK
ONE DUE DATE Date: 28th July Time: 5:00PM

INSTRUCTIONS:

1. Work in groups of maximum five (with at least one guy or a lady in each group)
2. To develop these linear equations one needs to be able to address problems like the ones provided below. The problems below are testing your logic and problem solving skills as well as numerical analysis skills as is regarded by the course unit of numerical analysis
3. The submission should be done both in softcopy via Muele
4. Make sure to avail each group member's names, regNos and StudNos in the documents you will upload.
5. You are kindly advised by all means to desist from sending your work to my WhatsApp or personal email address as it shall result to a zero in that coursework.
6. Finally I kindly ask all groups to desist from plagiarism

Question One: Errors

- a. Evaluate the absolute error in each of the following calculations and hence give the answer to a suitable degree of accuracy.

- (a) $9.01 + 9.96$
- (b) $4.65 - 3.429$
- (c) 0.7425×0.7199
- (d) $\frac{0.7078}{0.87}$

- b. Find absolute error in each of the following calculations (all numbers are rounded):

- (a) $187.2 + 93.5$
- (b) 0.281×3.7148
- (c) $\sqrt{28.3156}$
- (d) $\frac{6.2342 \times 0.82137}{27.268^{1/2}}$

Question Two: Newton-Raphson method

Non-linear methods iteration creates password for each file to gain access to files. An employee leaves an IT organization unexpectedly, and the employee's manager is granted access to the former employee's account to retrieve important project information that is required to finalize a certain project that he was working on. The manager finds some six files that appear to be related to the project, but cannot access the contents of the files.

This is because on trying to open any of those files, a dialogue box showcasing four digits which are to 4dp for the last six iterations to the root of the equation $x^3 - 2x^2 - 3 = 0$ keeps popping out. He is then tasked to recruit you as the new IT specialist to crack the password.

1. Using Newton-Raphson's iteration find the solution to the equation
2. Determine the passwords for each of the said six files
3. What if the passwords can only be determined using the 4dp of the last six iterations while using Newton's formula for the reciprocal of a positive number 6. Determine the passwords

Question Three: Bisection Method

Non-linear methods to generate the characters of the password. The IT team in your company developed a system in such a way that it forces the users to change their password every week, enter their user names and passwords at login keeping in line with their security policy guidelines that the password should be at least 20 characters long, consist of uppercase and lowercase letters, numbers, and special characters. The users are not allowed to reuse any password they have used before. It should also be noted that every password of all the users in the company should consist of the roots to 5dp from these two equations respectively at the beginning and at the end of the 20 character long password. The equations are (a) $2x - e^{-x} = 0$ (b) $e^{-3x} + 2x^{-2} = 0$.

1. Determine the roots of these equations with an error less than 10^{-4} using the bisection method.
2. Generate atleast ten passwords Using the method explained above. (NB kindly make sure that the lower and upper case letters are for the names of the group members anything outside that will clearly show that the group plagiarized their work)

Question Four: Secant method

A company making social networking systems is seeking to create a location-aware application to alert users when their friends are less than 50m away. The application should work in three public environments: parks, city streets and indoor spaces such as shopping centres with the functions below providing the exact distance within each respective environment the alert will be sent and they are as showcased below.

- i. $x - \cos x = 0$
- ii. $\cos x = 3x - 1$
- iii. $f(x) = e^x \cos x + 1$, $a = 0$, $b = 2$

The app will run on smartphones, which may be assumed to have radios for 3G/4G cellular networks, WiFi, Bluetooth, and GPS. These radios can be assumed to be permanently enabled. Use the method below and apply it to each respective function above per its environment to get the exact distance the alert will be transmitted or triggered. Employ initial guesses of your own choice and perform iterations until the approximate relative error falls below 5% for the root of the equations or solutions and the answers should be accurate to within 10^{-4}

1. Using the secant method
2. Using the Newton-Raphson Method
3. Kindly explain the differences in your answers and which method you would prefer with a clear explanation

Question Five: Lagrange's Interpolation

Lagrange to generate room numbers and pickup times for customers depending on time they paid for ticket.

The board of directors of Destiny Paradise wishes to grow by acquisition of travel agencies in Maldives and Indonesia. Thereby, providing complete travel package to its customers from air ticket bookings, airport transfers to accommodation and city/travel tours. The management believes this should be done within a period of 1 year to outperform its competitors. The second strategic move is to acquire smaller hotels in the coastal areas of Sri Lanka and Maldives. The target hotels will be 2-3 star hotels which may not be of the size of Destiny Paradise. After acquisition, Destiny Paradise needs to spend on the infrastructure, IT and bring these hotels up to a 4 star hotel status by refurbishing. It should be noted that the board directs you to come up with an algorithm that provides rooms to customers who do ticket bookings to given that all customers at the hotels are treated like VIPs.

1. Use the Lagrange interpolation polynomial from the data below to generate the room numbers for the customers

x	0	1	2	3
y	3	2	9	18

2. Using the function of algorithm generated above determine the room numbers for the first 15 customers given that x is the customers position in calling in to book a room.
3. What if the first four customers to call in have their net premiums as stated in the table given below, Use Lagrange to determine the algorithm that will generate the net premiums of the rest of the customers

Age	20	24	28	32
Annual net premium	0.01427	0.01581	0.01772	0.01996

4. Determine the net premiums for the first 15 customers from the algorithm generated in (3) above

Question Six: Numerical Integration

1. A watertight capsule containing scientific instruments is dropped from a high-altitude plane into the ocean where it must approach close to the sea bottom before floating up for retrieval by a boat. The capsule is pre-programmed with a function routine that computes its viscosity at various varying temperatures as it moves within the water to the point it gets to float. Collision with the ocean bottom is a mission failure. Using the pre-programmed function as the definite integral below Compute the viscosity values generated by the definite integral

- (a) Using Trapezium rule
- (b) Using simpsons rule or 1/3rd rule
- (c) Using simpsons 3/8th rule

By dividing the range of its movement into four equal parts before it floats you should also compute the error margin at each of the methods used above.

2. Supposing the software designer responsible for the system running on the capsule uses the same system and the integral above to manage the shutdown and reboot of the system running the nuclear power stations on various telecommunication masts. It should however be noted that the integral function determines the time taken to shutdown and reboo, given that the varying component is the distance within which the shutdown and reboot should occur. In normal shutdown mode fuel rods are shutdown and a reboot that check all system functions is performed. Compute the time values generated for each restart at each of the masts by the definite integral

- (a) Using Trapezium rule
- (b) Using simpsons rule or 1/3rd rule
- (c) Using simpsons 3/8th rule

By dividing the distance ranges of within which the shutdown and reboot will occur into six equal parts before restart you should also compute the error margin at each of the methods.