

**Department of Mathematics**

**Differential Calculus Using Maxima**

**(MAT 151)**

**Mathematics Lab Instructional Manual**

**2017**

**1. Introduction**

The advancement of technology is offering immense possibilities to make the teaching-learning process in Mathematics more fruitful at all levels, especially in higher education. The accessibility of several free and open source tools makes it easier for the student to become self- reliant in learning. It is in this context that the department of Mathematics has revised the curriculum for undergraduate mathematics by introducing Mathematics Lab based course for all the semesters.

The course *Differential Calculus Using Maxima* is aimed at enabling the students to appreciate and understand core concepts of Differential Calculus with the help of the free and open source mathematical software *Maxima*. It is designed to gain hands on experience in using *MAXIMA* to perform plotting of standard curves, to find limits of a function, illustrate differentiability and solve applied problems on differentiation.

**2. Learning Objectives**

On successful completion of the course, the students should be able to

* Acquire proficiency in using Maxima to study Differential Calculus.
* Demonstrate the use of Maxima to understand and interpret the core concepts in Differential Calculus.

**3. Maxima**

Maxima is a Computer Algebra System (CAS); a software program that facilitates symbolic calculations in mathematics. It is a free and open source software that can be effectively utilized for solving differential calculus problems. Maxima has a user friendly graphical user interface (GUI) **wxMaxima**, which was developed by Andrej Vodopivec, a Mathematician at the University of Ljubljana, Slovenia. The working environment of wxMaxima is very simple and could be understood easily. It allows one to work in screen mode, incorporates a text editor and includes a wide collection of displayable menus. Therefore, wxMaxima will be used for the course.

**4. Lab Sessions**

Mathematics Lab is a place where students learn and explore mathematical concepts and verify mathematical facts and theorems through a variety of Mathematics software. The Maxima lab sessions are held twice a week and each session will be of one-hour duration. The weekly schedule prepared for the smooth conduct of the lab sessions has to be followed without fail. A list of sample problems is given for exploration. This list is not exhaustive and you are encouraged to try out new problems. You are having permission to use Maxima Lab (MCA lab on I Floor of Block II) for further learning and practice from 9.00 am to 1.00 pm on Saturdays and 4:00- 6:30 pm on other working days.

**5. Submission of wxMaxima File**

The wxMaxima worksheet that is given to each batch has to be completed during the lab sessions. Uploading of the *wxmx* file is to be done once in two weeks through *My course*. Save your \*.wxmx files as Register number Date for quick reference for evaluation. Specific instructions with regard to the lab assignments/exercises will be given in the class.

**6. Lab Record**

A lab record based on the lab sessions is to be maintained in a well-organized manner. The solution to the problems are to be obtained by the standard problem solving procedure as well as using the wxMaxima. The specific set of topics to be documented is mentioned in this manual. Follow the instruction given in the class while preparing the record. Submission of the completed record is mandatory for the successful completion of the course.

**7. Assessment and Evaluation**

The course is evaluated based on regular lab work, lab tests, record work and attendance. The parameters for evaluation in each of these components and their weightage are given in the following table.

|  |  |  |  |
| --- | --- | --- | --- |
| **Component** | **Parameter** | **Mode of**  **Assessment** | **Maximum**  **Points** |
| CIA I | Familiarity with the commands and execution  of them in solving problems.  Sketch the graph of various functions. | Lab Assignments/  Exercises /Problem solving | **20** |
| CIA II  MSE | Conceptual clarity and analytical skills in  using Maxima to find limit, continuity and differentiability of functions. | Lab Exam based on  the Lab exercises | **10** |
| Lab Record | Systematic Documentation of the Lab exercise | Record work | **07** |
| Attendance | Regularity and Punctuality | Lab attendance | **03**  95-100%: 3  90-94%: 2  85-89% : 1 |
| CIA III | Proficiency in executing the commands  appropriately to find the successive and partial differentiation.  Tracing of curves.  curve tracing. | Comprehensive  Lab Examination | **10** |
| **Total** | | | **50** |

**8. Assessment rubric for CIA**

Your mastery in using maxima to solve the problems under each topic given below will be evaluated during the lab sessions. CIA I will be your average score based on lab exercises.

**Evaluation scale:**

**4:** Correct use of maxima commands; completes the task within the stipulated time.

**3:** Mostly correct commands and solutions with small errors; completes the task on time.

**2:** Error in the commands; does not complete the given task on time.

**1:** Attempted all the problems with incorrect method and incorrect output

**0:** No attempt.

**Lab Record**

Every activity written in the record will be assessed for 10 marks (scaled down to 7)

**Evaluation scale:**

|  |  |
| --- | --- |
| Score | If… |
| 4 | Statement of the objective, description/explanation of the procedure |
| 2 | Result and conclusion |
| 2 | Neatness |
| 2 | Submits work on time |

**Maxima Lab Sessions**

|  |  |  |
| --- | --- | --- |
| **No.** | Dates | **Topic** |
| 1. | 05/06/17 to 17/06/17 | Introduction to Maxima - Use of built-in functions: General Math, Algebra and Calculus. |
| 2. | 19/06/17 to 01/07/17 | Sketch the graph of various functions: explicit-implicit-parametric-polar. |
| 3. | 03/07/17 to 15/07/17 | Evaluation of Limits using built-in function in MAXIMA and illustration of the same graphically. |
| 4. | 17/07/17 to 30/07/17 | Demonstration of continuous functions and types of discontinuities. |
| 5. | 07/08/17 to 12/08/17 | Determination of derivatives - Graphical interpretation of derivatives. |
| 6. | 14/08/17 to 19/08/17 | Verification of Mean value theorems. |
| 7. | 21/08/17 to 26/08/17 | Maxima and minima - Evaluation of extreme points. |
| 8. | 28/08/17 to 02/09/17 | Successive differentiation - Calculation of nth derivatives of functions. |
| 9. | 04/09/17 to 09/09/17 | Partial differentiation - Partial differentiation of functions of two variables. |
| 10. | 11/09/17 to 23/09/17 | Curve tracing - Tracing of standard functions. |

**Remark:**

For all the sessions on differential calculus, you are expected to

* *Solve the problems analytically*
* *Obtain the solution using Maxima*
* *Plot the concerned graph and*
* *Analyze the results.*

**Essential Text Books:**

1. Zachary Hannan, *wxMaxima for Calculus I (Creative Commons Attribution-Non Commercial-Share Alike 4.0 International)*, 1st ed: Zachary Hannan - Solano Community College, 2015.
2. Zachary Hannan, *wxMaxima for Calculus II (Creative Commons Attribution-Non Commercial-Share Alike 4.0 International)*, 1st ed: Zachary Hannan - Solano Community College, 2015.

**Recommended Reading:**

1. Sandeep Koranne, *Handbook of Open Source Tools*, Springer Science & Business Media, 2010.

**Online Resources:**

1. <http://maxima.sourceforge.net>

2. <http://math.stanford.edu/~paquin/MaximaBook.pdf>

3. <http://www.math.harvard.edu/computing/maxima/>

4. <http://www.neng.usu.edu/cee/faculty/gurro/Maxima.html>

5. <http://web.csulb.edu/~woollett/#mbe>