Graphing Calculator Use – Math 226 & 227

We will be taking a dual approach to calculators: a mixture of calculator and non-calculator exams and quizzes. The use of this graphing calculators (and computer technology) is meant to **aid** in the analysis and understanding of functions, not to replace the learning and techniques necessary to solve problems. The TI-89 is the best calculator since it has symbolic manipulation and will be the most applicable to other math and engineering courses. The TI-83, TI-84 or TI-86 are the next-best alternatives. Calculators with QWERTY keyboards (such as the TI-92) are deemed to be unfair, and therefore, may not be used.

When calculators are used, they may only be used for the following four capabilities. Any problems or exercises requiring additional calculations beyond these four capabilities will need to have all additional steps shown. Little or no credit will be given for problems or exercises that utilize the calculator beyond these capabilities without all additional steps shown. No work need be shown, however, when using these four capabilities; just write down your integral, for example, and then write its solution.

1. **Graphing Functions - Zooming and Tracing**
2. **Solving equations - finding the zeros of a function**
3. **Numerical derivatives**
4. **Numerical integration**

*All final solutions are to be rounded to the nearest thousandth (3 places after the decimal); do not do any rounding until the very end.

I. Graphing Functions - Zooming and Tracing

You are allowed to use the calculator to examine graphs, finding coordinates, vertices and asymptotes.

II. Solving Equations - finding the zeros of a function

On the TI-89, choose **1: solve(** from the **F2: Algebra** menu
Syntax: **Solve(*equation* , *variable*)**
Example: Solve(2x-1=17 , x)

On the TI-83, choose **0: Solver**... from the **MATH** menu
Enter the equation after **0=** then hit **ENTER.**
Give a guess for x within the bounds. (Your calculator uses Newton's Method)
Hit **ALPHA** then **SOLVE** while cursor is on the **x=** line.

You must be careful when solving equations, knowing how to use your calculator. For example, when solving an equation like $2\sin^2 x - 1 = 0$, you need to be sure that you are in radian mode. You must also realize that there are two solutions and know how to access them on your calculator.

On the TI-89, type in $Solve(2\sin(x)\text{^}2 - 1 = 0, x)$ to get the answers $\left\{\frac{\pi}{4}, \frac{3\pi}{4}, \frac{5\pi}{4}, \frac{7\pi}{4}\right\}$.

On the TI-83, you must graph to find the approximate solutions so that you have some appropriate "guesses" and you know how many solutions to look for using the Solver.

III. **Numerical Derivatives**

On the TI-89, choose **A: nDeriv(** from the **F3: Calc** menu
Syntax: **nDeriv(*expression* , *variable* [,h*])**
*h is the step value; it defaults to 0.001 if omitted.
Example: nDeriv(cos(x) , x) | x=π / 2 returns −1 as the solution.
Note: The "|" symbol means "with" or "evaluated at"
The derivative of $\cos(x)$ is $-\sin(x)$ and $-Sin\left(\frac{\pi}{2}\right) = -1$

On the TI-83, use 8: **nDeriv(** from the **MATH** menu
Syntax: **nDeriv(*expression* , *variable* , value)**
Example: nDeriv(cos(x) , x , π / 2) returns −1 as the solution.
Note: Be sure you are in radian mode.

IV. **Numerical Integration**

On the TI-89, choose $2:\int($ from the **F3: CALC** menu
Example: $\int(x\wedge 2, x, 0, 1)$ yields the solution $\frac{1}{3}$.

On the TI-83, select **9: fnInt(** from the **MATH** menu.
Syntax: **fnInt(*function* , *variable* , *lowerbound* , *upperbound*)**
Example: fnInt(x^2 , x , 0 , 1) returns 0.33333

Drawbacks to Calculator Use:

Calculators can mislead you sometimes; you may sometimes be tempted to write down a solution without demonstrating any understanding of how the problem is solved. Here are a few things to watch out for:

1. **Rounding partial solutions.** Although it is fine to round final solutions to three decimal places, you should realize that rounding values at intermediate steps will lead to error accumulations that can yield inaccurate solutions.
2. **Not showing the understanding that is being assessed by the question.** Sometimes an answer by itself is not sufficient; you must "show all work" that leads up to a particular calculation and sometimes even explain your rationale. ***A correct answer is not sufficient evidence that you know how to solve the problem.***
3. **Confusing exploration with justification.** Indeed the calculator might well enable you to stumble upon a solution for reasons that you may not know. It is essential, therefore, that you verify with calculus that the answer actually works. For example, if you are asked for the equations of all lines through the point $(-3,2)$ that are tangent to the graph of $y = x^2 - 3x$, a little exploration on your calculator might well suggest the line $y = -x - 1$ probably satisfies the conditions. You could then verify analytically that this line goes through the point $(-3,2)$ and is tangent to the parabola at $(1,-2)$. However, by not taking an analytical approach to this problem, you might miss the other solution: $y = -17x - 49$.
4. **Attempting to find improper integral on the calculator.** Here is another example of where the calculator should be used for exploration, but not necessarily justification.

You should read the directions of each problem that requires a calculator so that you are aware of the expected accuracy of answers and what specific outcomes are required.