Assignment 2, MACM 204, Fall 2026

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Due date 11pm Wednesday October 7th. Late penalty: -10% per hour late.

Do all questions in Maple. Do each question in a separate Maple worksheet. Please put your name and student ID number at the top of each worksheet. Export the worksheet to a .pdf file then upload it to crowdmark.

Question 1

Given a list C = $[c_1, c_2, ..., c_n]$ of coefficients, write a Maple procedure `makepoly` such that `makepoly(C,x)` outputs the polynomial $c_1 + c_2 \cdot x + c_3 \cdot x^2 + ... + c_n \cdot x^{n-1}$. Test your procedure on the examples below.

```
> C := [1,2,4,2];
```

$$C := [1, 2, 4, 2]$$

```
> makepoly(C,x);
```

$$2x^3 + 4x^2 + 2x + 1$$

```
> makepoly([],x);
```

$$0$$

```
> C := [1/2,3.14159,0,-5];
```

$$C := \left[\frac{1}{2}, 3.14159, 0, -5\right]$$

```
> makepoly(C,y);
```

$$\frac{1}{2} + 3.14159\,y - 5\,y^3$$

Solution 1

Question 2

Given a list **L** of numbers write a boolean Maple procedure

```
issorted := proc(L::list) ... end;
```

that returns true if the elements in L are sorted in ascending order and false otherwise.
Test your procedure on these examples.

```
> L1 := [1,4,3,4,5];
  issorted(L1);
```

$$L1 := [1, 4, 3, 4, 5]$$

$$false$$

```
> L := [-5,1,4,5,9];
  issorted(L);
```

$$L := [-5, 1, 4, 5, 9]$$

$$true$$

```
> issorted( [1] );
```

$$true$$

Solution 2

Question 3

Given a polynomial f in one or more variables with rational or decimal coefficients, the height of f is the magnitude of the largest coefficient as shown below. Write a Maple procedure `height(f::polynom)` that outputs the height of the polynomial. Use the `coeffs(f)` command to get the coefficients of the polynomial as shown below.

```
> f := 3*x^3-5*x+4;
```

$$f := 3x^3 - 5x + 4$$

```
> C := [coeffs(f)];
```

$$C := [3, -5, 4]$$

```
> height(f);
```

$$5$$

```
> f := 8*x^3+22*x-33*x^2-19;
```

$$f := 8x^3 - 33x^2 + 22x - 19$$

```
> height(f);
```

$$33$$

```
> height(0);
```

$$0$$

Test your procedure on these inputs.

Solution 3

Question 4

Consider the function $g(a,x) = a^2 \cdot x \cdot (1-x) \cdot (1 - a \cdot x + a \cdot x^2)$. We want to study the solutions of $g(a,x) = x$ for $0 \le a \le 4$ and $0 \le x \le 1$.
One way is to create an implicit plot of $g(a,x) = x$. Do this using the **implicitplot** command in the **plots** package.

Another way is to graph the function $g(a,x) - x$ in 3 dimensions for $0 \le a \le 4$ and $0 \le x \le 1$ and see where the z co-ordinate is 0. To do this visually we can graph the 0 function. Do this using the **plot3d** command (graph $g(a,x) - x$ and 0 on the same plot). Rotate the plot so that it matches the implicit plot.

Solution 4

Question 5

Consider the function $f(x,y) = 2 \cdot x^2 + 3 \cdot y^2 - x \cdot y - 6$.
We want to visualize the partial derivatives at the point $x = 1, y = 1$.
Part (a) First use Maple to compute the partial derivatives $f_x(1,1)$ and $f_y(1,1)$. You should get 3 and 5 respectively so both slopes are positive.

Part (b) We want to visualize the partial derivatives at the point $x = 1, y = 1$. Generate a 3 dimensional plot of $f(x, y)$ (using the **plot3d** command) and the curves $f(x, 1)$ and $f(1, y)$ in red and blue (using the **spacecurve** command in the plots package) and display all three plots on the same graph (using the **display** command in the plots package).

Part (c) Now we want to visualize the tangent plane at the point $x = 1, y = 1$. Construct the formula for the tangent plane and graph it together with $f(x, y)$ on the same plot using suitable options so we can see both surfaces clearly. Include a title for the plot.

Solution 5

Question 6

One of the main tools in Maple is it's integration facilities.
In Calculus II Integral Calculus you learned how to calculate the length of a curve $f(x)$ on an interval $a \le x \le b$.
For the following two functions find the length of the curve on the given interval

(a) $f(x) = \sin(x)$ *on* $0 \le x \le \pi$
(b) $g(x) = x \cdot e^{-x}$ *on* $0 \le x \le 1$

If you have your copy of Stewart, see section 8.1 Arc Length. Alternatively you can use google to find the formula.
I suggest you first graph the functions so you can estimate the length from the plot so that you don't end up with a nonsense answer.
For the first one Maple can calculate the antiderivative; it is a special function.
For the second one Maple cannot calculate the antiderivative but you can still compute the length by evaluating the integral numerically using evalf.
Maple will use a numerical integration method that is more accurate than Simpson's rule.

Solution 6

Question 7

Let $A = \int_a^b f(x)\,dx$. Recall from assignment 1 that the value of A may be approximated by the

Midpoint rule **Mn** on n intervals of width $h = \frac{(b-a)}{n}$ using the formula

$$Mn = h \cdot \left(f\left(a + \frac{h}{2}\right) + f\left(a + \frac{3}{2}h\right) + 2 \cdot f\left(a + \frac{5}{2} \cdot h\right) + \ldots + f\left(a + \frac{(2 \cdot n - 1)}{2} \cdot h\right) \right).$$

Write a Maple procedure MidpointRule(f(x), x, a, b, n) that computes Mn and uses 15 digits of precision for arithmetic calculations, i.e., your Maple procedure should begin by initializing **Digits := 15;** Execute the following

```
> MidpointRule( sin(x), x, 0, 1,  4 );
  MidpointRule( sin(x), x, 0, 1,  8 );
  MidpointRule( sin(x), x, 0, 1, 16 );
```

0.460897009411942
0.459997112932708
0.459772523245456

Now compute the error in these approximations as follows.

```
> Digits := 15;
> A := evalf( int(sin(x),x=0..1) );
```

$$A := 0.459697694131860$$

```
> for n in [4,8,16,32,64,128] do
      Mn := MidpointRule( sin(x),x,0,1,n );
      e[n] := abs( A-Mn );
      printf( "n=%3d  error=%.15f\n", n, e[n] );
  od:
```

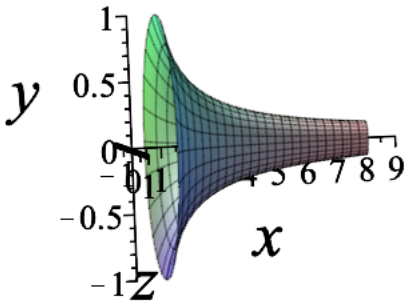
Based on the data that you get, what happens to the error as we double the number of intervals n ? Obviously the error should decrease. By how much does it decrease?

Solution 7

Question 8

In the Stewart Calculus text in Section 8.2 there is an exercise on **Gabriel's horn**. Gabriel's horn is the surface of revolution that you obtain by rotating $f(x) = \frac{1}{x}$ about the x axis for $x \geq 1$. I've drawn it below (using Maple of course!)

The calculus question is to compute the volume of Gabriel's horn on $[1, \infty]$ using an improper integral. This is easy to do in Maple. Do this. It's one of those integrals that has a "nice" answer. Note, if you still have your copy of Stewart, the formula for the volume of revolution is in Section 6.2. If not, you'll find formula on the web.



Solution 8