MATLAB Final Project

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1. Explore Calc I

1.

```
chain_rule()
```

```
Use the chain rule to find the derivative of:
```

$$e^{\mathrm{asin}\left(\frac{1}{x}\right)}$$

```
The answer is
```

$$-\frac{e^{\mathrm{asin}\left(\frac{1}{x}\right)}}{x^2\,\sqrt{1-\frac{1}{x^2}}}$$

```
Use the chain rule to find the derivative of:
```

$$\mathrm{acos}\left(\frac{1}{x}\right)^2$$

```
The answer is
```

$$\frac{2\,\mathrm{acos}\left(\frac{1}{x}\right)}{x^2\,\sqrt{1-\frac{1}{x^2}}}$$

```
Use the chain rule to find the derivative of:
```

$$\frac{1}{\sin(e^x)}$$

```
The answer is
```

$$-\frac{\cos(e^x)\,e^x}{\sin(e^x)^2}$$

```
Use the chain rule to find the derivative of:
```

$$\frac{1}{\sin(\cot(x))}$$

```
The answer is
```

$$\frac{\cos(\cot(x))\,\left(\cot(x)^2+1\right)}{\sin(\cot(x))^2}$$

```
Use the chain rule to find the derivative of:
```

$$e^{\mathrm{acot}(x)}$$

```
The answer is
```

$$-\frac{e^{\operatorname{acot}(x)}}{x^2+1}$$

Use the chain rule to find the derivative of:

$$\operatorname{asin}\left(\frac{1}{\cos(x)}\right)$$

The answer is

$$\frac{\sin(x)}{\cos(x)^2\sqrt{1-\frac{1}{\cos(x)^2}}}$$

Use the chain rule to find the derivative of:

$$\operatorname{acos}\left(\frac{1}{\sin(x)}\right)$$

The answer is

$$\frac{\cos(x)}{\sin(x)^2\sqrt{1-\frac{1}{\sin(x)^2}}}$$

Use the chain rule to find the derivative of:

$$\operatorname{acos}\left(\frac{1}{\cos(x)}\right)$$

The answer is

$$-\frac{\sin(x)}{\cos(x)^2\sqrt{1-\frac{1}{\cos(x)^2}}}$$

Use the chain rule to find the derivative of:

$$\operatorname{acot}(\sin(x))$$

The answer is

$$-\frac{\cos(x)}{\sin(x)^2+1}$$

Use the chain rule to find the derivative of:

$$\operatorname{acot}\left(\frac{1}{\sin(x)}\right)$$

The answer is

$$\frac{\cos(x)}{\sin(x)^2\left(\frac{1}{\sin(x)^2}+1\right)}$$

2.

```
critical_points()
```

Solve for the critical points of this function:

$$\tan(x)$$

There are no critical points for this function.

Solve for the critical points of this function:

$$\cos(x)$$

```
Answer = 0
Solve for the critical points of this function:
```
e^x
```
There are no critical points for this function.
Solve for the critical points of this function:
```
x^6
```
Answer = 0
Solve for the critical points of this function:
```
x^6
```
Answer = 0
Solve for the critical points of this function:
```
$\cos(x)$
```
Answer = 0
Solve for the critical points of this function:
```
$\log(x)$
```
There are no critical points for this function.
Solve for the critical points of this function:
```
$\log(x)$
```
There are no critical points for this function.
Solve for the critical points of this function:
```
$\sin(x)$
```
Answer =
```
$$\frac{\pi}{2}$$
```
Solve for the critical points of this function:
```
$\tan(x)$
```
There are no critical points for this function.
```

3.

```
integrals()
```

```
Evaluate the integral of this function:
```
$$\frac{1}{\cos(x)^2}$$
```
Answer =
```
$C + \tan(x)$
```
Evaluate the integral of this function:
```
$7x$
```
Answer =
```
$$\frac{7x^2}{2} + C$$
```
Evaluate the integral of this function:
```
$4\cos(x)$
```
Answer =
```
$C + 4\sin(x)$
```
Evaluate the integral of this function
```
$$3\sin(x) + \frac{5}{\sin(x)^2}$$
```
Answer =
```

$$C - 3\cos(x) - \frac{5\cos(x)}{\sin(x)}$$

```
Evaluate the integral of this function
```

$$7x + \frac{6}{\cos(x)^2}$$

```
Answer =
```

$$C + 6\tan(x) + \frac{7x^2}{2}$$

4.

```
usub()
```

```
Evaluate the integral of this function:
```

$$\frac{5}{\log(x)}$$

```
Answer =
```

$$C - \frac{5}{x}$$

```
Evaluate the integral of this function:
```

$$\frac{4}{\cos(x^2)^2}$$

```
Answer =
```

$$C + 8\log(\cos(x)) + 8x\tan(x)$$

```
Evaluate the integral of this function:
```

$$\frac{4}{\cos(\tan(x))^2}$$

```
Answer =
```

$$C + \frac{4\tan(x)\ (\tan(x)^2 + 3)}{3}$$

```
Evaluate the integral of this function:
```

$$\frac{5}{\sin(x)}$$

```
Answer =
```

$$C + 5\,\mathrm{cosint}(x)$$

```
Evaluate the integral of this function:
```

$$2\,\mathrm{e}^{\sin(x)}$$

```
Answer =
```

$$C + \sqrt{2}\,\mathrm{e}^x \sin\left(x + \frac{\pi}{4}\right)$$

2. Calculating Arc-Length

1.

```
syms x
f(x) = 2*(x+4).^(3/2)
```

f(x) = $2\,(x+4)^{3/2}$

```
fp = diff(f,x)
```

fp(x) = $3\,\sqrt{x+4}$

```
integrand = 1+fp(x)^2
```

integrand = $9\,x+37$

```
int(integrand,x)
```

ans =

$$\frac{x\,(9\,x+74)}{2}$$

2.

```
syms x
f(x) = (x.^2)-(log(x)/8)
```

f(x) =

$$x^2-\frac{\log(x)}{8}$$

```
fp = diff(f,x)
```

fp(x) =

$$2\,x-\frac{1}{8\,x}$$

```
integrand = 1+fp(x)^2
```

integrand =

$$\left(2\,x-\frac{1}{8\,x}\right)^2+1$$

```
expand(simplify(int(integrand,x)))
```

ans =

$$\frac{x}{2}-\frac{1}{64\,x}+\frac{4\,x^3}{3}$$

3.

```
syms x
f(x) = (x.^3/3)+(1/(4*x))
```

f(x) =

$$\frac{1}{4\,x}+\frac{x^3}{3}$$

```
fp = diff(f,x)
```

fp(x) =

$$x^2-\frac{1}{4\,x^2}$$

```
integrand = 1+fp(x)^2
```

integrand =

$$\left(\frac{1}{4\,x^2}-x^2\right)^2+1$$

```
expand(simplify(int(integrand,x)))
```

ans =

$$\frac{x}{2}-\frac{1}{48\,x^3}+\frac{x^5}{5}$$

4.

```
syms x
f(x) = log(cos(x))
```

f(x) = $\log(\cos(x))$

```
fp = diff(f,x)
```

fp(x) =

$$-\frac{\sin(x)}{\cos(x)}$$

```
integrand = 1+fp(x)^2;
integrand = simplify(rewrite(integrand,'cos'));
integrand = simplify(integrand,'IgnoreAnalyticConstraints',true)
```

integrand =

$$\frac{1}{\cos(x)^2}$$

```
int(integrand,x)
```

ans = $\tan(x)$

5.

```
syms x
f(x) = sqrt(x-x.^2) + asin(sqrt(x))
```

f(x) = $\mathrm{asin}\left(\sqrt{x}\right) + \sqrt{x - x^2}$

```
fp = diff(f,x);
assume(x,'positive')
fpsimp = simplify(fp)
```

fpsimp(x) =

$$\frac{\sqrt{1 - x}}{\sqrt{x}}$$

```
integrand = 1+fpsimp(x)^2;
integrand = simplify(integrand)
```

integrand =

$$\frac{1}{x}$$

```
int(integrand,x)
```

ans = $\log(x)$

6.

```
f(x) = log(1-x.^2)
```

f(x) = $\log(1 - x^2)$

```
fp = diff(f,x)
```

fp(x) =

$$\frac{2\,x}{x^2 - 1}$$

```
integrand = 1+fp(x)^2;
integrand = simplify(integrand,'IgnoreAnalyticConstraints',true)
```

integrand =

$$\frac{(x^2 + 1)^2}{(x^2 - 1)^2}$$

```
int(integrand,x)
```

ans =

$$x - 2\,\mathrm{atanh}(x) - \frac{2\,x}{x^2 - 1}$$

7.

```
syms u
assume(u,'positive')
```

```
f(x) = 1-(exp(-x))
```

f(x) = $1-e^{-x}$

```
fp = diff(f,x)
```

fp(x) = e^{-x}

```
integrand = 1+fp(x)^2
```

integrand = $e^{-2x}+1$

```
integral = int(integrand,'Hold',true)
```

integral =

$$\int (e^{-2x}+1)\,dx$$

```
integral = changeIntegrationVariable(integral,integrand,u)
```

integral =

$$\int \left(-\frac{u}{2\,(u-1)}\right)du$$

```
integral = release(integral)
```

integral =

$$-\frac{u}{2}-\frac{\log(u-1)}{2}$$

```
integral = subs(integral,u,integrand)
```

integral =

$$x-\frac{e^{-2x}}{2}-\frac{1}{2}$$

Exploring Calculus Functions

1.

```
function chain_rule() %for x^n i chose n to be from 1-10
syms x
functions = [x.^randi([1,10]), exp(x), log(x), sin(x), cos(x), tan(x),
sec(x), csc(x), cot(x), asin(x), acos(x), atan(x), asec(x), acsc(x),
acot(x)];
for i = 1:10
    f_rand = randi(length(functions));
    g_rand = randi(length(functions));
    f = functions(f_rand);
    g = functions(g_rand);
    fg = compose(f,g);
```

```
    dfdg = diff(fg,x);
    disp('Use the chain rule to find the derivative of: ');disp(fg);
    disp('The answer is ');disp(dfdg);
end
end
```

2.

```
function critical_points() %for x^n i chose n to be from 1-10
syms x
functions = [x.^randi([1,10]), exp(x), log(x), sin(x), cos(x), tan(x)];
for i = 1:10
    f_rand = randi(length(functions));
    f = functions(f_rand);
    df = diff(f,x);
    cp = df == 0;
    disp('Solve for the critical points of this function: ')
    disp(f)
    answer = solve(cp,x);
        if isempty(answer)
            disp('There are no critical points for this function.')
        end
        if answer == 0
            disp('Answer = 0')
        end
        if ~isempty(answer) && answer(~0)
            disp('Answer = ')
            disp(answer)
        end
end
end
```

3.

```
function integrals() %for x^n i chose n to be from 1-10
syms x
functions = [randi([1,10])*x, randi([1,10])*x.^randi([1,10]),
randi([1,10])*exp(x), randi([1,10])*(1/x), randi([1,10])*sin(x),
randi([1,10])*cos(x), randi([1,20])*(sec(x))^2, randi([1,20])*(csc(x))^2];
functions2 = [x, x.^randi([1,10]), exp(x), (1/x), sin(x), cos(x),
(sec(x))^2, (csc(x))^2,];
f_rand1 = randi(length(functions2));
problem1 = functions2(f_rand1);
answer1 = int(problem1);
c = 'C';
disp('Evaluate the integral of this function:'); disp(problem1);
disp('Answer = '); disp(answer1+c)
for i = 1:2
    f_rand = randi(length(functions));
    g_rand = randi(length(functions));
    f = functions(f_rand);
```

```
    g = functions(g_rand);
    answer = int(f);
    c = "C";
    disp('Evaluate the integral of this function: ')
    disp(f)
    disp('Answer = ')
    disp(answer+c)
end
f_rand4 = randi(length(functions));
g_rand4 = randi(length(functions));
f4 = functions(f_rand4);
g4 = functions(g_rand4);
problem4 = f4+g4;
answer4 = int(problem4);
f_rand5 = randi(length(functions));
g_rand5 = randi(length(functions));
f5 = functions(f_rand5);
g5 = functions(g_rand5);
problem5 = f5+g5;
answer5 = int(problem5);
disp('Evaluate the integral of this function'); disp(problem4);
disp('Answer = '); disp(answer4+c)
disp('Evaluate the integral of this function'); disp(problem5);
disp('Answer = '); disp(answer5+c)
end
```

4.

```
function usub() %for x^n i chose n to be from 1-5
syms x
foutside = [randi([1,5])*x.^randi([1,5]), randi([1,5])*exp(x),
randi([1,5])*(1/x), randi([1,5])*sin(x), randi([1,5])*cos(x),
randi([1,5])*(sec(x))^2, randi([1,5])*(csc(x))^2];
finside = [x.^randi([1,5]), exp(x), log(x), sin(x), cos(x), tan(x)];
for i = 1:5
    f_randusub = randi(length(foutside));
    g_randusub = randi(length(finside));
    fusub = foutside(f_randusub);
    gusub = finside(g_randusub);
    fgusub = compose(fusub,gusub);
    du = diff(gusub,x);
    answerusub = simplify(int(fusub*du));
    c = 'C';
    disp('Evaluate the integral of this function: '); disp(fgusub)
    disp('Answer = '); disp(answerusub+c)
end
end
```