Lab 2
William Keilsohn
Section 32
2/27/2014

1) Graphically determine the largest and smallest values of the given function on the interval [5,9] and also determine where local maximum and minimum are obtained.

```
Quit[]
```

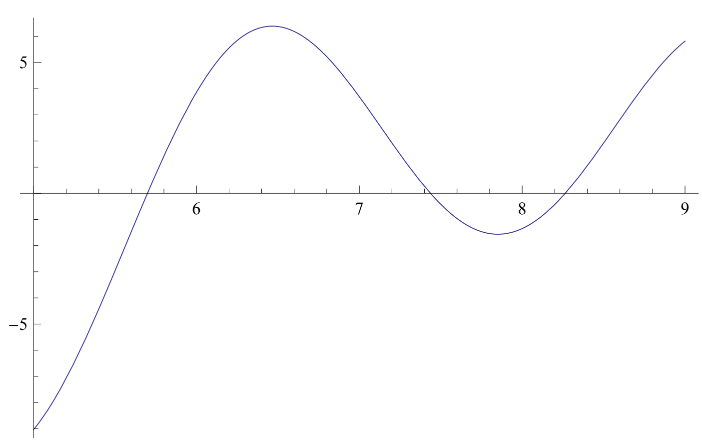
In[2]:= `f[x_] = 6 Cos[2 x] + (5 * x * Sin[x]) / (x + 1)`

Out[2]= $6\,\mathrm{Cos}[2\,x] + \frac{5\,x\,\mathrm{Sin}[x]}{1+x}$

$$6\,\mathrm{Cos}[2\,x] + \frac{5\,x\,\mathrm{Sin}[x]}{1+x}$$

$$6\,\mathrm{Cos}[2\,x] + \frac{5\,x\,\mathrm{Sin}[x]}{1+x}$$

```
Plot[f[x], {x, 5, 9}]
```




```
? Plot
```

Plot[f, {x, x_{min}, x_{max}}] generates a plot of f as a function of x from x_{min} to x_{max}.
Plot[{f_1, f_2, …}, {x, x_{min}, x_{max}}] plots several functions f_i. ≫

```
FindMinimum[f[x], {x, 6.5}]
```

{-1.56482, {x → 7.85072}}

```
FindMinimum[{f[x], 5 ≤ x ≤ 9}, {x, 6.5}]
```

{-1.56482, {x → 7.85072}}

Then check end points.

In[7]:= `f[5]`

Out[7]= $6\,\mathrm{Cos}[10] + \frac{25\,\mathrm{Sin}[5]}{6}$

In[8]:= $\mathbf{N}\left[6\,\mathrm{Cos}[10] + \frac{25\,\mathrm{Sin}[5]}{6}\right]$

Out[8]= -9.02995

In[9]:= `f[9]`

Out[9]= $6\,\mathrm{Cos}[18] + \frac{9\,\mathrm{Sin}[9]}{2}$

In[10]:= $\mathbf{N}\left[6\,\mathrm{Cos}[18] + \frac{9\,\mathrm{Sin}[9]}{2}\right]$

Out[10]= 5.81643

Therefore, there areMinimums of f(x) on the interval [5,9], which are -1.56482 and it is attained at x=7.85072 and -9.02995 which is attained at x=5

```
FindMaximum[{f[x], 5 ≤ x ≤ 9}, {x, 7.75}]
```

{6.39064, {x → 6.46531}}

Check end points.

In[12]:= `f[5]`

Out[12]= $6\,\mathrm{Cos}[10] + \frac{25\,\mathrm{Sin}[5]}{6}$

In[13]:= $\mathbf{N}\left[6\,\mathrm{Cos}[10] + \frac{25\,\mathrm{Sin}[5]}{6}\right]$

Out[13]= -9.02995

In[14]:= `f[9]`

Out[14]= $6\,\mathrm{Cos}[18] + \frac{9\,\mathrm{Sin}[9]}{2}$

In[15]:= $N\left[6\,\mathrm{Cos}[18] + \frac{9\,\mathrm{Sin}[9]}{2}\right]$

Out[15]= 5.81643

Therefore, there are two Maximums. One attained at x=6.46531 which equals 6.39064 and one attained at x=9 which equals 5.81643

2) Now use the algebriac tools to determine, with greater accuracy, the absolute and local extreme values of f(x) on the given interval. Prove with second derivative test.

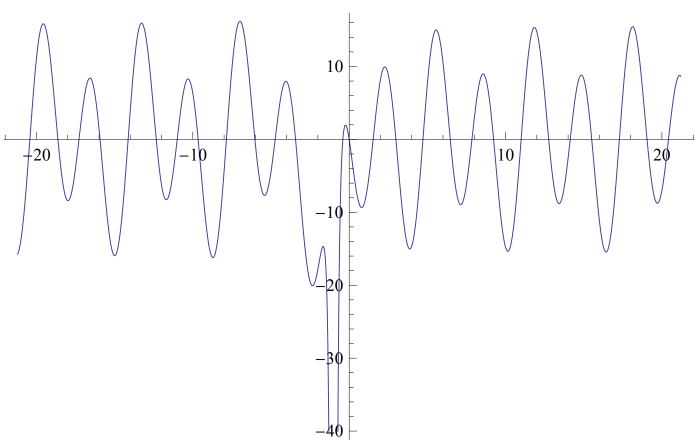
f[x]

$$6\,\mathrm{Cos}[2\,x] + \frac{5\,x\,\mathrm{Sin}[x]}{1+x}$$

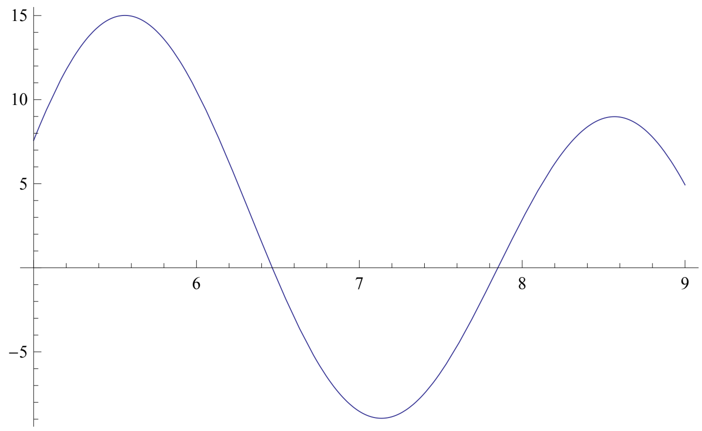
f'[x]

$$\frac{5\,x\,\mathrm{Cos}[x]}{1+x} - \frac{5\,x\,\mathrm{Sin}[x]}{(1+x)^2} + \frac{5\,\mathrm{Sin}[x]}{1+x} - 12\,\mathrm{Sin}[2\,x]$$

$$\mathrm{Plot}\left[\frac{5\,x\,\mathrm{Cos}[x]}{1+x} - \frac{5\,x\,\mathrm{Sin}[x]}{(1+x)^2} + \frac{5\,\mathrm{Sin}[x]}{1+x} - 12\,\mathrm{Sin}[2\,x],\ \{x, -21.2058, 21.2058\}\right]$$



```
Plot[f'[x], {x, 5, 9}]
```




```
FindRoot[f'[x] == 0, x]
```

FindRoot::fdss : Search specification x should be a list with 1 to 5 elements. ≫

```
FindRoot[f′[x] == 0, x]
```

```
In[1]:= ? FindRoot
```

FindRoot[f, {x, x_0}] searches for a numerical root of f, starting from the point $x = x_0$.
FindRoot[lhs == rhs, {x, x_0}] searches for a numerical solution to the equation lhs == rhs.
FindRoot[{f_1, f_2, …}, {{x, x_0}, {y, y_0}, …}] searches for a simultaneous numerical root of all the f_i.
FindRoot[{eqn_1, eqn_2, …}, {{x, x_0}, {y, y_0}, …}] searches for a numerical solution to the simultaneous equations eqn_i. ≫

```
critnos = x /. FindRoot[f'[x], {x, 6.5, 7.9}]
7.85072

FindRoot[f'[x], {x, 6.5}]
{x → 6.46531}

FindRoot[f'[x], {x, 7.8}]
{x → 7.85072}

In[4]:= critnum1 = x /. FindRoot[f'[x], {x, 6.5}]
Out[4]= 6.46531

In[5]:= f'[critnum1]
Out[5]= 6.21725 × 10^-15

f''[critnum1]
-23.0376
```

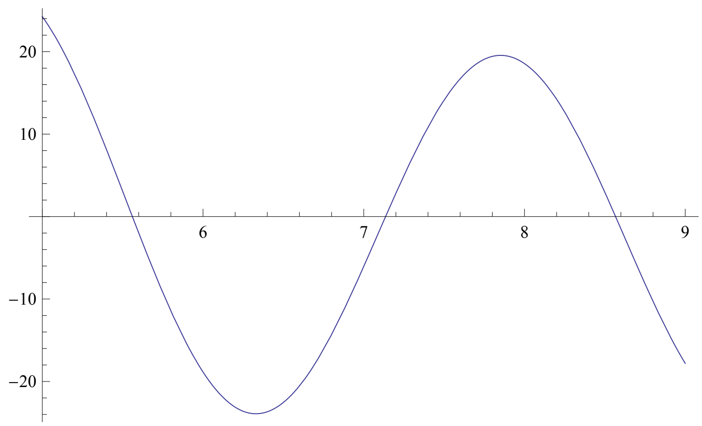
Therefore, the extreme max is 6.39064 and it is attained at x=6.46531.
The local max is 5.81643 and it is attianed at x=9.

In[6]:=
```
critnum2 = x /. FindRoot[f'[x], {x, 7.8}]
```
Out[6]= 7.85072

In[7]:=
```
f'[critnum2]
```
Out[7]= -7.32747×10^{-15}

```
f''[critnum2]
```
19.5504

Therefore, local min is -1.56482 and it is attained at x=7.85072.
The extreme min is -9.02995 and it is attained at x=5.

In[11]:=
```
Plot[f''[x], {x, 5, 9}]
```
Out[11]=


In[8]:=
```
Quit[]
```