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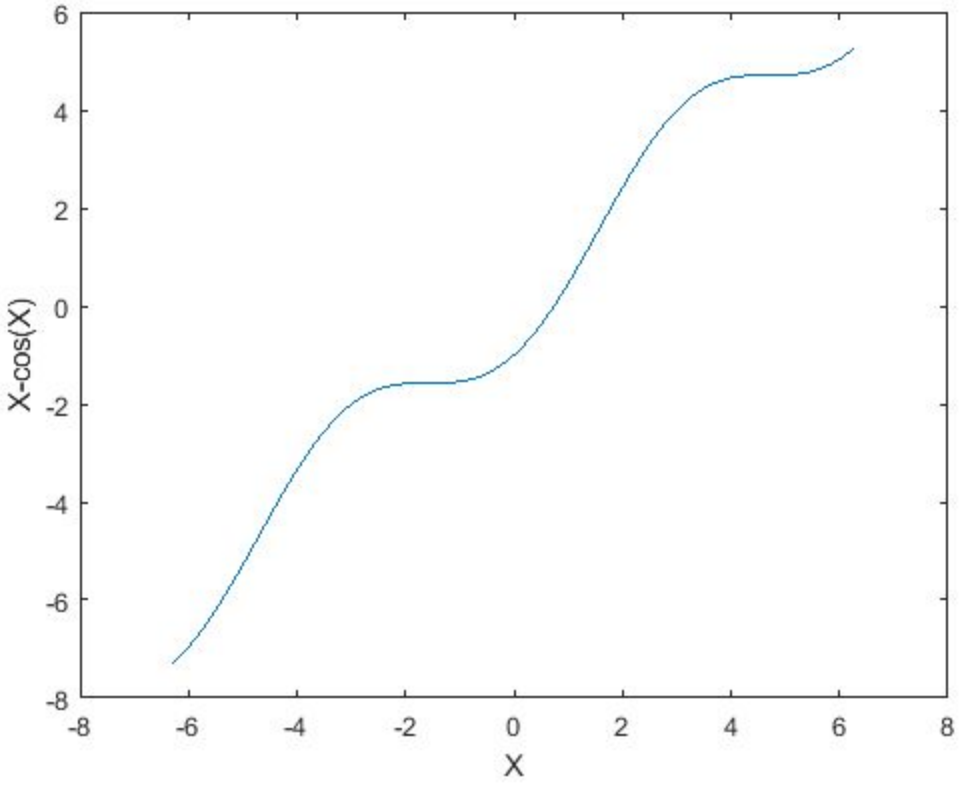
Jan 19th 2018
ENSC 180 Group 1 Assignment 2

1. Consider the equations cos(x) = x and tan(x) = x. Plot these functions and write a MATLAB code to find their roots in the range -2π <x < 2π to a precision of 0.01 radians. (15 marks)

```
>> x = -2.*pi : 0.01 : 2.*pi;
>> y = x - cos(x);
>> plot(x,y)
>> xlabel('X');
>> ylabel('X-cos(X)');
```

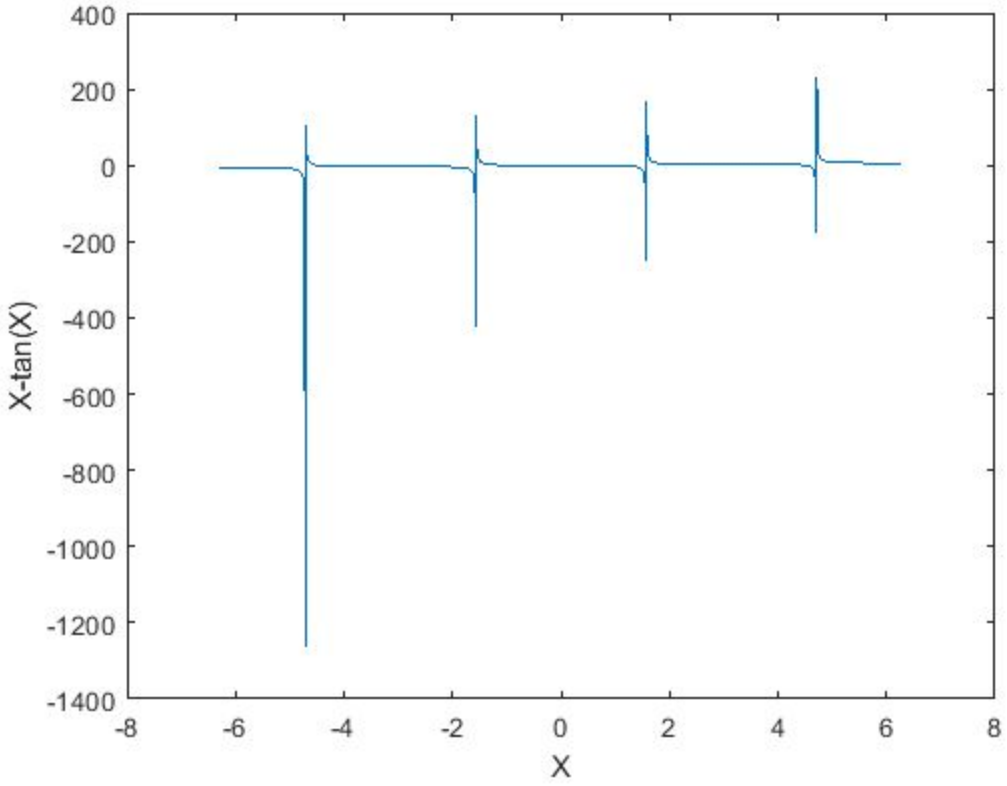


```
for i=1:1256
    if y(i)*y(i+1) < 0
        disp(x(i))
    end
end
```

The root is 0.7368

b)

```
>> x = -2.*pi : 0.01 : 2.*pi;
>> y = x - tan(x);
>> plot(x,y)
>> xlabel('X');
>> ylabel('X-tan(X)');
```



```
for i=1:1256
   if y(i)<1 && y(i+1) <1
   if y(i)*y(i+1) < 0
      disp(x(i))
   end
   end
end
```

```
The roots are
  -4.5032

  -0.0032

   4.4868
```

2. Students in a class have the following final marks. x= [73 92 65 41 37 80 67 54 90 82 85 69 76 74 82 87 69 78 85] The grading scheme is: >= 90 A+; 80-89 A; 75-79 B+; 68-74 B; 60-67 C+; 50-59 C; 40-49 D; <40 F. Write a MATLAB code to assign grades for this class. Print the marks and corresponding grades in two columns. (20 marks)

```
x=[73,92,65,41,37,80,67,54,90,82,85,69,76,74,82,87,69,78,85];
studentgrade=strings([1,19]);
for i=1:19
   if x(i) >= 90
     studentgrade(i)= 'A+';
   elseif x(i)>=80
     studentgrade(i)= 'A';
   elseif x(i)>=75
     studentgrade(i)= 'B+';
   elseif x(i)>=68
     studentgrade(i)= 'B';
   elseif x(i)>=60
     studentgrade(i)= 'C+';
```

```
    elseif x(i)>=50
      studentgrade(i)= 'C';
    elseif x(i)>=40
      studentgrade(i)= 'D';
    else
      studentgrade(i)= 'F';
    end
end
disp([x',studentgrade'])
    "73"    "B"
    "92"    "A+"
    "65"    "C+"
    "41"    "D"
    "37"    "F"
    "80"    "A"
    "67"    "C+"
    "54"    "C"
    "90"    "A+"
    "82"    "A"
    "85"    "A"
    "69"    "B"
    "76"    "B+"
    "74"    "B"
    "82"    "A"
    "87"    "A"
    "69"    "B"
    "78"    "B+"
    "85"    "A"
>>
```

3. Wind tunnels are extensively used in airplane and spacecraft design to assess drag, which is the force generated by an object when moving through a fluid such as air. Inside a wind tunnel an object (e.g., model of a plane) is held stationary and air flows through the tunnel at different speeds. The object is instrumented to collect data. Drag is calculated using the following equation. Fd = Cd(ϱV 2A/2) where Cd, ρ, V and A denote the drag coefficient, air density, velocity of the aircraft and the surface area over which the air flows. Write a MATLAB code that requests the measured drag force, air velocity, surface area and air density as input, calculate the drag coefficient and plot drag force over the velocity range 0 to 300 km/h. (15 marks)

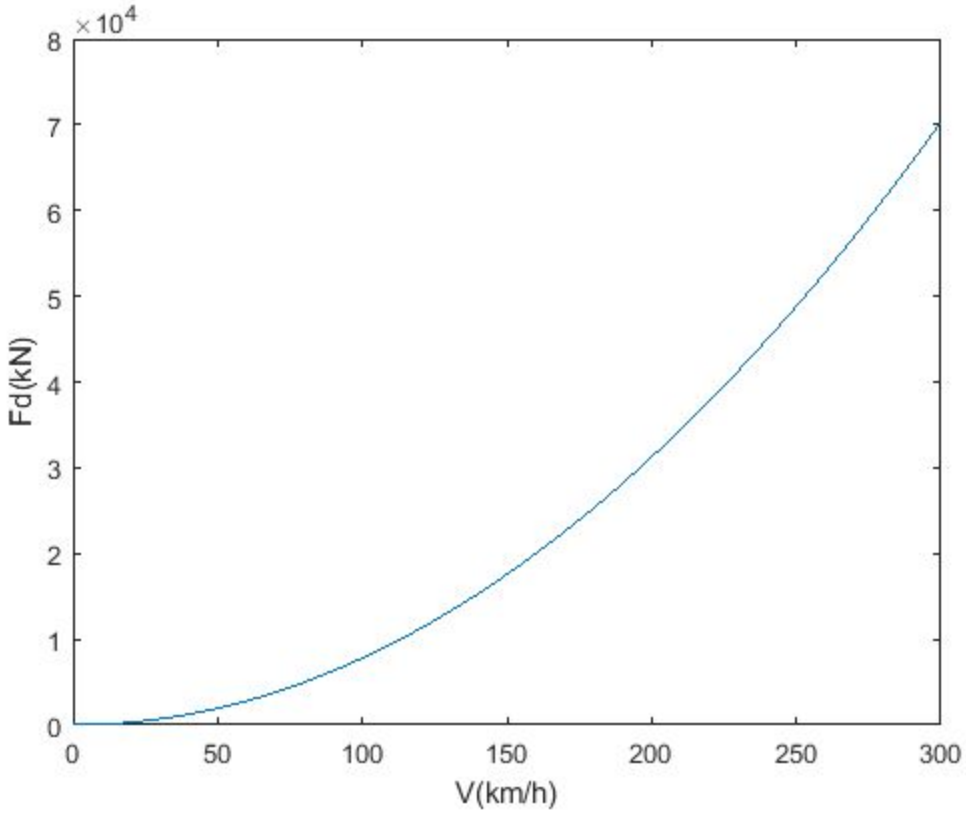
```
Fd=input('Input the measured drag force ');
p=input('Input the air density ');
V=input('Input the velocity ');
A=input('Input the surface area ');
```

```
Cd = Fd/(p*V^2*A/2);

V = 0:1:300;
Fd = Cd.*p.*V.^2.*A./2;

plot(V,Fd)
xlabel('V(km/h)');
ylabel('Fd(kN)');
```

Inputs: Drag force= 20000N; air density = 1*10E-06 kg/m3; V=160 km/h; and area=0.9 m2.

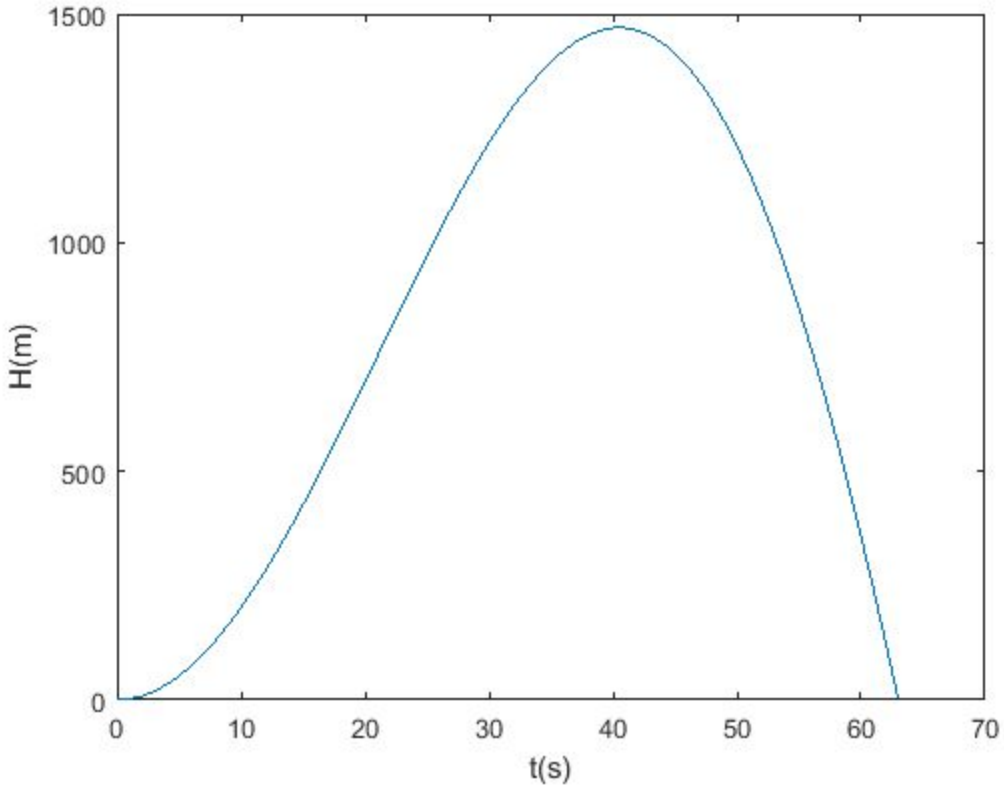


4)The height of a rocket is approximated by the following equation. H = 2.13t 2 – 0.0013t 4 + 0.000034t 4.751 where H is the height (meters) and t is the time (seconds). Calculate the maximum height reach by the rocket using MATLAB, time to reach the maximum height (one second accuracy) and the time the rocket hit ground (one second accuracy). Compare your answers using analytical methods. Plot H and t from t=0 to until the rocket hit ground. (20 marks)

```
t = 0 : 1 : 100;
H = 2.13.*t.^2-0.0013.*t.^4+0.000034.*t.^4.751;
for i=2:100
   if H(i)*H(i+1)<0
      disp(t(i))
      ground = t(i);
   end
   if H(i)>H(i-1) && H(i)>H(i+1)
      disp(H(i))
      disp(t(i))
   end
end
t = 0 : 1 : ground;
H = 2.13.*t.^2-0.0013.*t.^4+0.000034.*t.^4.751;
plot(t,H)
xlabel('t(s)')
ylabel('H(m)')
```

The max height is 1.4695e+03m
The time of max height is 40s
The time of impact with the ground is 63s

To do analytical check
disp(max(H)) is 1.4695e+03 so I confirmed



5) The parking hours to be used by three people at Vancouver Airport over 10 days are given below. 4.0 1.5 6.0 48.0 0.0 5.5 1.0 1.5 5.0 0.75 12.0 1.00 3.00 8.0 1.5 72.0 0.0 2.00 1.5 2.0 1.5 0.0 4.0 2.75 2.5 4.0 1.5 1.75 12.0 2.0 The rate structure for parking is: Short-term parking: First 30 minutes $2.50 and each additional 15 minutes or fraction thereof is $ 1.00. Daily maximum is $ 25.00. Long-term parking: First 3 hours $ 10.00 and each additional hour or fraction thereof is $3.00. Daily maximum is $ 18.00. Weekly maximum is $ 80.00. Write a MATLAB code to decide which parking lot (short-term or long-term) should be used each time to minimize the cost and calculate the total minimum parking bill over the 10 days for each person. (30 marks)

```
%Original inputs
timeA=[4 1.5 6 0.75 12 72 0 0 4 2.75];
timeB=[48 0 5.5 1 3 2 1.5 2.5 4 1.5];
timeC=[1 1.5 5 8 1.5 2.0 1.5 1.75 12.0 2.0];

%variables
ltHoursA = zeros([1,10]);
ltHoursB = zeros([1,10]);
ltHoursC = zeros([1,10]);
```

```
stcostA = zeros([1,10]);
stcostB = zeros([1,10]);
stcostC = zeros([1,10]);

ltcostA = zeros([1,10]);
ltcostB = zeros([1,10]);
ltcostC = zeros([1,10]);

bestcostA = zeros([1,10]);
bestcostB = zeros([1,10]);
bestcostC = zeros([1,10]);

weekcostA = zeros([1,4]);
weekcostB = zeros([1,4]);
weekcostC = zeros([1,4]);

pklotA = strings([1,10]);
pklotB = strings([1,10]);
pklotC = strings([1,10]);

%check if hours greater than 24 and distribute
for i=1:10
   if timeA(i) > 24
      timeA(i+1) = timeA(i) - 24;
   end
   if timeB(i) > 24
      timeB(i+1) = timeB(i) - 24;
   end
   if timeC(i) > 24
      timeC(i+1) = timeC(i) - 24;
   end
   %round up hours for long term pricing calculation
   ltHoursA(i) = ceil(timeA(i));
   ltHoursB(i) = ceil(timeB(i));
   ltHoursC(i) = ceil(timeC(i));
end

%calc short term costs
for i=1:10
   if timeA(i)<= .5
      stcostA(i) = 2.5;
   elseif timeA(i) <= 6
      stcostA(i) = timeA(i)*4+.5;
```

```
    else
        stcostA(i) = 25;
    end

    if timeB(i)<= .5
        stcostB(i) = 2.5;
    elseif timeB(i) <= 6
        stcostB(i) = timeB(i)*4+.5;
    else
        stcostB(i) = 25;
    end

    if timeC(i)<= .5
        stcostC(i) = 2.5;
    elseif timeC(i) <= 6
        stcostC(i) = timeC(i)*4+.5;
    else
        stcostC(i) = 25;
    end

end

%calc long term costs
for i=1:10
    if ltHoursA(i) <= 3
        ltcostA(i) = 10;
    elseif ltHoursA(i) <= 5
        ltcostA(i) = ltHoursA(i) * 3 + 1;
    else
        ltcostA(i) = 18;
    end
    if ltHoursB(i) <= 3
        ltcostB(i) = 10;
    elseif ltHoursB(i) <= 5
        ltcostB(i) = ltHoursB(i) * 3 + 1;
    else
        ltcostB(i) = 18;
    end
    if ltHoursC(i) <= 3
        ltcostC(i) = 10;
    elseif ltHoursC(i) <= 5
        ltcostC(i) = ltHoursC(i) * 3 + 1;
    else
```

```
        ltcostC(i) = 18;
    end
end

%compare short term cost vs long term cost and use the cheaper option
for i=1:10
    if stcostA(i) < ltcostA(i)
        bestcostA(i) = stcostA(i);
        pklotA(i) = 'STday';
    else
        bestcostA(i) = ltcostA(i);
        pklotA(i) = 'LTday';
    end
    if stcostB(i) < ltcostB(i)
        bestcostB(i) = stcostB(i);
        pklotB(i) = 'STday';
    else
        bestcostB(i) = ltcostB(i);
        pklotB(i) = 'LTday';
    end
    if stcostC(i) < ltcostC(i)
        bestcostC(i) = stcostC(i);
        pklotC(i) = 'STday';
    else
        bestcostC(i) = ltcostC(i);
        pklotC(i) = 'LTday';
    end
end

%check to see if the options for weeks of long term parking
for i = 1:4
    weekcostA(i) = sum(bestcostA(i:i+6));
    weekcostB(i) = sum(bestcostB(i:i+6));
    weekcostC(i) = sum(bestcostC(i:i+6));
end

%change the bestcost for the week by replacing the cheapest week with the
%lt 80 dollars week rate
if max(weekcostA) > 80
    for i = 1:4
        if weekcostA(i) == max(weekcostA)
            bestcostA(i) = 80;
            pklotA(i) = 'LTweek';
```

```
            for i = i+1:i+6
                bestcostA(i) = 0;
                pklotA(i) = 'LTweek';
            end
        end
    end
end

if max(weekcostB) > 80
    for i = 1:4
        if weekcostB(i) == max(weekcostB)
            bestcostB(i) = 80;
            pklotB(i) = 'LTweek';
            for i = i+1:i+6
                bestcostB(i) = 0;
                pklotB(i) = 'LTweek';
            end
        end
    end
end

if max(weekcostC) > 80
    for i = 1:4
        if weekcostC(i) == max(weekcostC)
            bestcostC(i) = 80;
            pklotC(i) = 'LTweek';
            for i = i+1:i+6
                bestcostC(i) = 0;
                pklotC(i) = 'LTweek';
            end
        end
    end
end

disp(sum(bestcostA))
disp(pklotA)

disp(sum(bestcostB)) is 109.5000
disp(pklotB)

disp(sum(bestcostC)) is 99.5000
disp(pklotC)
```

The best parking lot choices by day for person A, and the total cost over 10 days is:
"LTday" "STday" "LTweek" "LTweek" "LTweek" "LTweek" "LTweek" "LTweek" "LTweek" "LTday"
Sum total C = 109.5000

The best parking lot choices by day for person B, and the total cost over 10 days is:
"LTweek" "LTweek" "LTweek" "LTweek" "LTweek" "LTweek" "LTweek" "LTday" "LTday" "STday"
Sum total B = 109.5000

The best parking lot choices by day for person C, and the total cost over 10 days is:
"STday" "STday" "LTweek" "LTweek" "LTweek" "LTweek" "LTweek" "LTweek" "LTweek" "STday"
Sum total C = 99.5000