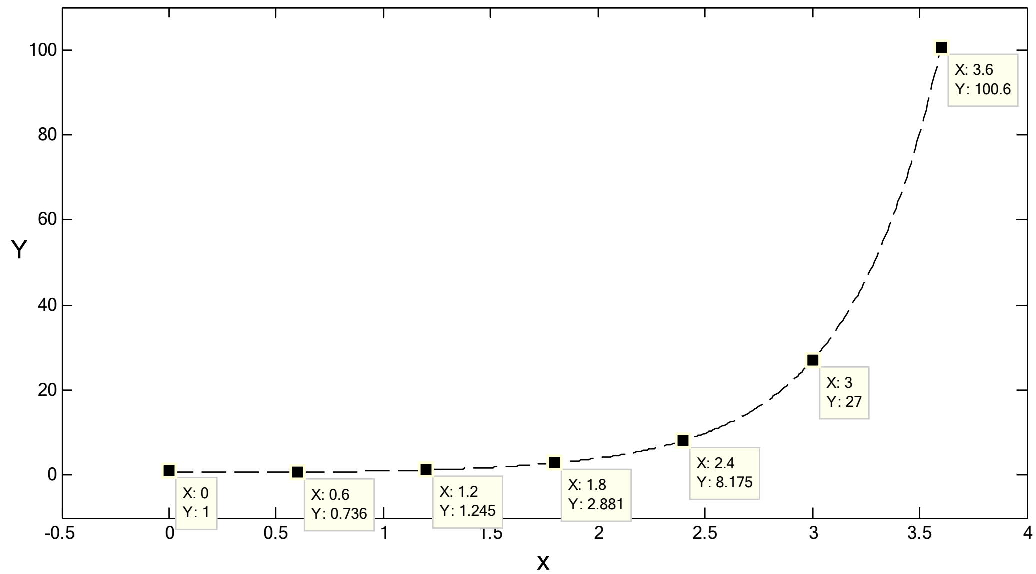
# ENED 1091 HW#8
## Due Week of April 9th at beginning of Recitation

**Problem 1:** Use the data points show below and the trapezoidal rule to estimate the integral of the curve shown below from t = 0 to 3.6. **Be sure to clearly show your calculations – don't just give an answer.**




Data Points from Graph:

| X | 0 | 0.6 | 1.2 | 1.8 | 2.4 | 3 | 3.6 |
|---|---|---|---|---|---|---|---|
| Y | 1 | 0.736 | 1.245 | 2.881 | 8.175 | 27 | 100.6 |

**Integral Estimate (Trapezoid): __________54.5022____________**

**Calculations:**

```
[0.5 * 1 + 0.736 + 1.245 + 2.881 + 8.175 + 27 + 0.5 * 100.6]
* 0.6 = 54.5022
```

**Problem 2:** The curve shown in problem 1 is for the function $y = x^x$. There is no expression for the indefinite integral of this function. However, we can estimate the definite integral using numerical integration as you have done in Problems 1. Write a MATLAB script that will:

- Begin with 3 data points (x-values) evenly distributed from 0 to 3.6 inclusive (Hint: use the MATLAB command, linspace).

- Calculate the corresponding y-values for the function y = x^x.
- Estimate the integral of y from 0 to 3.6 using the Trapezoid Rule.
- Double the number of data points and get a new estimate for the integral of y from 0 to 3.6 using the trapezoid rule.
- Compare the new estimate to the previous estimate. If the absolute value of the difference between the two estimates exceeds 0.01, then double the number of data points again and repeat.
- Continue doubling the number of data points until the absolute value of the difference between the new estimate for the integral and the previous estimate for the integral does not exceed 0.01.
- Once your estimate has met the convergence specifications, add fprintf statements to display your final estimate of the integral, the final number of sections, and the final DeltaX value.

**PASTE Results of fprintf statements here:**
**The estimated integral of x^x is: 47.794**
**The number of sections was: 383**
**The final DelataX value was: 0.00940**
**PASTE Script file here:**

```
clear; close all; clc; commandwindow;
N = 3;
x = linspace(0,3.6,N);
DeltaX = x(2)-x(1);
y = x.^x;
Old_Int_Trap = DeltaX*(0.5*y(1) + sum(y(2:N-1)) +
0.5*y(N));
Difference = 1;
while Difference > 0.01
    N = 2*N;
    x = linspace(0,3.6,N);
    DeltaX = x(2) - x(1);
    y = x.^x;
    New_Int_Trap = DeltaX*(0.5*y(1) + sum(y(2:N-1)) +
0.5*y(N));
    Difference = abs(New_Int_Trap - Old_Int_Trap);
    Old_Int_Trap = New_Int_Trap;
end
fprintf('The estimated integral of x^x is:  %0.3f
\n',New_Int_Trap)
fprintf('The number of sections was: %i \n',N-1);
fprintf('The final DelataX value was:  %0.5f \n',DeltaX);
```

**Problem 3:** For this problem, you will need the P3.mat file on the metasite. Save the file in your current MATLAB folder.

The P3.mat file contains two vectors: one for time, t, and another with power measurements, Power, measured in kW.

The energy consumption (kWh) is related to the integral of the power (kW) as follows:

$$\text{Energy} = \left(\frac{1}{3600}\right)\int \text{Power } dt$$

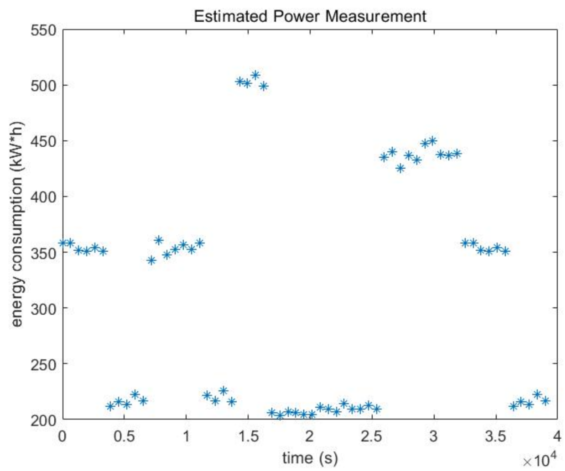
Write a script file to do the following:

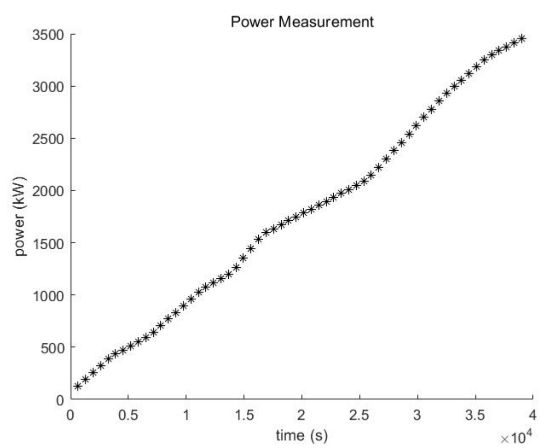
- Load the data file, P3.mat.
- Plot the power measurements over time as data points – not connected by lines.
- Estimate the energy consumption over time assuming Energy(0) = 65 kWh by applying the Trapezoid Estimate for the integral to the power measurements.
- Use the figure command to open a new plot window. Plot the estimates for energy consumption over time as data points on the same plot.
- Add an fprintf statement to display the final value for energy consumption.

**PASTE Results of fprintf statements here:**

**Final value for energy consumption : 3455.7 kW*h**

**PASTE PLOTS HERE:**




**PASTE SCRIPT FILE HERE:**

```
clear all;clc;
load P3
figure(1)
plot(t,Power,'*');
hold on;
xlabel('time (s)'); ylabel('energy consumption (kW*h)');
title('Estimated Power Measurement');
Energy(1)=65;
```

```
DeltaT = t(2)-t(1);
figure(2)
hold on;
xlabel('time (s)'); ylabel('power (kW)'); title('Power
Measurement');
for k = 2:length(Power)
   Energy(k) = Energy(k-1)+1/3600*(1/2*(Power(k)+Power(k-
1))*DeltaT);
   plot(t(k),Energy(k),'k*');
end
fprintf('Final value for energy consumption : %0.1f kW*h
\n',Energy(end));
fprintf('Final number of sections : %0.1f
\n',length(Power)-1);
fprintf('Final DeltaX value : %0.1f s \n',DeltaT);
%final estimate of the integral, the final number of
sections, and the final DeltaX value.
```

**Problem 4**: For this problem, you will need the P4.mat file on the metasite. Save the file in your current MATLAB folder.

The P4.mat file contains two vectors: one for time, t, and one for fluid velocity measurements, F_Vel in units of m/s.

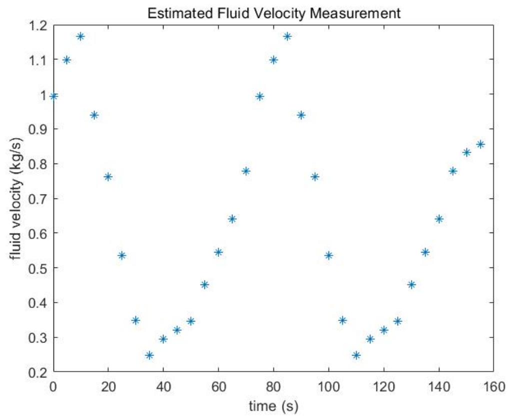
The fluid flow, Q, (kg) through a pipe is related to the integral of the fluid velocity (m/s) as follows:

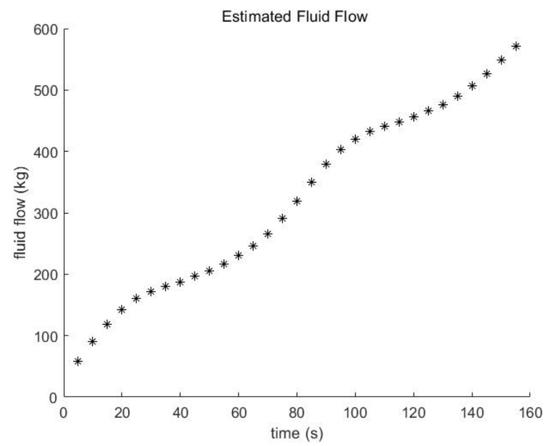
$$Q = \rho A \int \mathrm{Fluid}_{\mathrm{Velocity}}\, dt$$

Write a script file to do the following:

- Load the P4.mat file.
- Plot the fluid velocity measurements over time as data points – not connected by lines.
- Using values of $\rho = 1100$ and $A = 0.005$ and assuming $Q(0) = 30$ kg, estimate the fluid flow, Q, over time by applying the Trapezoid Estimate for the integral to the fluid velocity measurements.
- Use the figure command to open a new plot window. Plot the estimates for fluid flow over time as data points on the same plot.
- Add an fprintf statement to display the final value of the fluid flow.

**PASTE Results of fprintf statements here:**
Final value for Fluid Velocity : 571.4 kg
**PASTE PLOTS HERE:**




**PASTE SCRIPT FILE HERE:**

```
clear all;clc;
load P4
figure(1)
plot(t,F_Vel,'*');
hold on;
xlabel('time (s)'); ylabel('fluid velocity (kg/s)');
title('Estimated Fluid Velocity Measurement');
hold on;
Q(1)=30;
rho=1100;
A = 0.005;
DeltaT = t(2)-t(1);
figure(2)
hold on;
xlabel('time (s)'); ylabel('fluid flow (kg)');
title('Estimated Fluid Flow ');
for k = 2:length(F_Vel)
   Q(k) = Q(k-1)+rho*A*(1/2*(F_Vel(k)+F_Vel(k-1))*DeltaT);
   plot(t(k),Q(k),'k*');
end
hold off;
fprintf('Final value for Fluid Velocity : %0.1f kg
\n',Q(end));
```