Programming Review

EML3041: Computational Methods

More than just teach you how to program, programming courses teach you how to think more methodically and how to solve problems more effectively. As such, its lessons are applicable well beyond the boundaries of computer science itself. With this skill comes the ability to solve real-world problems in ways and at speeds beyond the abilities of most humans - David Malan.

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Main concepts

- Sequential programming
- Conditions (if-end; if-else-end)
- Loops (for-end; while-end)
- Functions

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Some common MATLAB functions

Find cos of 60 degrees

```
Val=cos(60*pi/180),  Val=cosd(60)
```

Find ln(5)

```
Val=log(5)
```

Find $e^{1.3}$

```
Val=exp(1.3)
```

Go ahead and try sin(90°), $\sin^{-1}(0.5)$

Answer: 1, 0.5236

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Some important MATLAB statements

```
disp
disp('My name is Slim Shady')

fprintf
a=12.4; b=12
fprintf('\n Value of a=%g and b=%g',a,b)
% Search help for %g, %e, %f, %s

two lines statement
syms x
func=x^2-3*x+ ...
    4
```

```
comment
% Project One – EML3041

sections
%% Problem One

help
% do this in command window
help syms
```

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Plotting

Plot $y = x^2$ from $x = 2$ to $x = 15$

```
x=2: 0.02: 15
y=x.^2
plot(x,y, 'bo','LineWidth',2)
xlabel('x')
ylabel('y')
title ('x^2 graph')
legend('y=x^2')
grid on
```

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Some common mistakes

- Using single letter names for variables
- Filenames such as program 2.m or just 2.m or cos.m
- Using " ; " while first writing the program
- Using reserved words, e.g. "length" for a variable
- Not commenting the program
- Not breaking a problem into smaller parts
- Not following the format of given sample project
- Not writing separate programs to learn single tasks

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Differentiate a function

Find $\frac{d}{dx}(\sin(2x))$ at $x = 2.3$

```
syms x
Func=sin(2*x)
Df=diff(Func,x,1)
Df2pt3=subs(Df,x,2.3)
Df2pt3=vpa(Df2pt3,12)
```

Find $\frac{d^2}{dx^2}(\ln(x^2))$ at $x = 2.5$

Answer: -0.32

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Solve a nonlinear equation

Solve $3 \times 10^{-3}x^2 - 4x = 6$

```
syms x
Func=3E-3*x^2-4*x==6
% See use of both
Soln=solve(Func,x)
% can use
% Soln=vpasolve(Func,x,[-5,6])
```

Solve $x^2 - x = 6$; Choose positive root only

Answer: 3

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Simultaneous linear equations

Solve $\begin{bmatrix} 2 & 3 \\ 4 & 7 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -1 \\ -3 \end{bmatrix}$

```
A=[2  3; 4  7]
C=[-1; -3]
% Can use C=[-1 -3]'
Soln=A\C
% Can also use Soln=linsolve(A,C)
% Can also use Soln=inv(A)*C
```

Solve $2x + 3y = 12; 3x + 2y = 60$

Answer: 31.2, -16.8

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Interpolation

Interpolate (2,4), (4,16), (5,25) to a 2nd order polynomial

```
X=[2 4  5]
Y=[4  16  25]
n=length(X)
Coef=polyfit(X,Y,n-1)
syms x
Poly=Coef(1)*x^2+Coef(2)*x+Coef(3)
```

Interpolate (2,4), (4,16), (5,25), (8,23) to a 3rd order polynomial.

-0.5694*x^3+7.2639*x^2 -21.6389*x+ 22.7778

Extra: Use a loop to generate the polynomial

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Regression

Regress (2,4), (4,16), (5,25) to a 1st order polynomial

```
X=[2 4  5]
Y=[4  16  25]
Coef=polyfit(X,Y,1)
syms x
Poly=Coef(1)*x+Coef(2)
```

Regress (2,4), (4,16), (5,25), (8,23) to a 1st order polynomial.

Answer: 3.0933*x + 2.3067

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Solve an integral

Integrate $\int_5^{13} 9x^3 dx$

```
syms x
func=9*x^3
val=int(func,x,5,13)
val=vpa(val)
%use vpaintegral(func,x,5,13)
```

Integrate $\int_5^{3.2} 4\ln(7x)\, dx$

Answer: -24.111

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Solve ordinary differential equations

Solve $4\frac{dy}{dx} + 7y = 5e^{-2x}, y(0) = 12.$ Find $y(13)$

```
syms y(x) x
eqn=4*diff(y,x,1)+7*y==5*exp(-2*x)
cond=[y(0)==12]
soln=dsolve(eqn,cond)
y13=subs(soln,x,13)
y13=vpa(y13)
```

Solve $6\frac{d^2y}{dx^2} + 4\frac{dy}{dx} + 7y = 5e^{-2x},$

$y(0) = 12, \frac{dy}{dx}(0) = 15.$ Find $y(21)$

Answer:-0.00288938

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Find the sum of a series (example of loop)

Find $\sum_{i=2}^{7}(3i+2)$

```
sums=0
for i=2:1:7
     sums=sums+(3*i+2)
end
```

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Find the sum of a series (example of break)

Find $\sum_{i=2}^{n}(3i+2)$

only till the sum of the series becomes more than 20 the first time

```
sums=0
for i=2:1:7
     sums=sums+(3*i+2)
     if sums>20
         break;
      end
end
i
```

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Find the sum of a series (example of continue)

Find $\sum_{i=2}^{11}(3i+2)$ without including $i = 5$ term

```
sums=0
for i=2:1:7
    if i==5
       continue;
    end
sums=sums+(3*i+2)
end
```

Redo problem using if statement instead of continue

Redo problem using while−end statement

Answer: 7

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BMI problem (example of if-end)

Find the BMI of a person and find if they are healthy

```
Weight=190; Height=69;
BMI=Weight/Height^2*703
if BMI>25 | BMI<19
   disp('Unhealthy Weight')
else
   disp('Healthy Weight')
end
```

Redo problem where you display underweight for BMI<19; healthy for $19 \leq BMI \leq 25$; overweight for $25 < BMI \leq 30$; obese for $BMI > 30$.

Answer: Overweight

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Functions

```
% How to use the function
bas=8;
ht=15;
[AreaRAT,PerimRAT] = RAT(bas,ht)

function [area,perimeter]=RAT(base, height)
hypotenuse=sqrt(base^2+height^2);
perimeter=base + height + hypotenuse;
area=0.5*base*height;
end
```

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Resources

- ~~Take the practice test on CANVAS?~~
- How do I do that in the MATLAB series? This series is highly helpful when you are doing the projects for the course: https://blog.autarkaw.com/2020/12/22/how-do-i-do-that-in-matlab-for-usf-students/
- MathWorks Onramp course: https://www.mathworks.com/learn/tutorials/matlab-onramp.html
- Still needing help, take the free Coursera course https://www.coursera.org/learn/matlab
- Still needing help, here are some lecture videos freely available from Vanderbilt University: https://blog.autarkaw.com/2020/05/08/need-help-with-programming-in-matlab/
- For help on commands, either enter help in the command window or go to https://www.mathworks.com/help/matlab/index.html

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