ROSE-HULMAN INSTITUTE OF TECHNOLOGY

Department of Mechanical Engineering

Exam 2 -- Written Portion

NAME_____

SECTION NUMBER_____

CAMPUS MAILBOX NUMBER_____

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Short Answer	**_____/50**
Coding Problem	**_____/50**
Total	**_____/100**

All short answer problems have equal weight

PROBLEM 1

Suppose that we take a bar (helicopter blade) and spin it around with a motor. At first, the blade is stationary, and as we apply a motor torque the blade travels faster and faster. The motor needs to overcome the inertia of the blade, and the drag due to the air. When all of this information is collected in a differential equation for the angular velocity of the blade, we have

$$\frac{d\omega}{dt} = \frac{T_m}{I} - \frac{k}{I}\omega^2 \qquad \omega(0) = 0$$

where

       ω   =   Angular velocity of blade (rad/s)

       T_m =   Motor torque

       I =   Rotational inertial of blade

       k =   Net air drag coefficient

In the space below, write the Euler formula that you could use to solve this problem. For full credit, use "*n*" as the index and *Δt* as your interval. Express your answer in the form $\omega_{n+1} = ...$

PROBLEM 2

What is the value of `a` after this program scrap runs?

```
clear variables
b=6;
if (b < 3)
    a=3;
elseif (b < 5)
    a=5;
end
```

    a.   0
    b.   3
    c.   5
    d.   It is not defined.
    e.   None of the above (Explain)

PROBLEM 3
The program below is supposed to create an array of x values that start at zero and then grow larger. However, there is a line missing and Matlab says:

```
??? Undefined function or method 'x' for input arguments of type
'double'.

Error in ==> written at 7
while (x(n,1) < xmax)
```

Add the missing line to the code so that it will run correctly:

```
clc

clear variables

xmax=10;

dx=2;

_____

n=1;

while (x(n,1) < xmax)

    n=n+1;

    x(n,1)=x(n-1,1)+dx^n;

end
```

PROBLEM 4

Consider the differential equation for the draining of a tank:

$$\frac{dh}{dt} = -k\sqrt{h}$$

with the initial condition:

$$h(0) = 10$$

The program below is intended to implement this using Euler's method:

```
clc

clear variables

t(1,1)=0;

h(1,1)=10;

n=1;

dt=.1;

k=2.3;

while h(n,1) > 0

    h(n+1,1) = h(n,1) - k*sqrt(h)*dt;

    t(n+1,1) = t(n,1) + dt;

    n=n+1;

end
```

However, Matlab says

```
??? Subscripted assignment dimension mismatch.



Error in ==> written at 9

    h(n+1,1) = h(n,1) - k*sqrt(h)*dt;
```

Fix the code so that it will run correctly.

PROBLEM 5

Suppose that we have two files. One is called 'temp.m' and contains the lines

```
clc

clear variables

a=2;

b=3;

y=sumfun(a,b);

fprintf('\n %3i \n',y)
```

The other file is called 'sumfun.m' and contains the lines

```
function z=sumfun(x,y)

clear variables

z=x*x+y;
```

We make sure that both files have been saved, and we run the program temp.m. We get an error that says

```
??? Reference to a cleared variable x.



Error in ==> sumfun at 3

z=x*x+y;



Error in ==> temp at 5

y=sumfun(a,b);
```

Mark the change(s) you would need to make to have the program/function run correctly.

Department of Mechanical Engineering

ME123   Comp Apps I

Exam 2

Separate your code into two m-files. Your top level code must be called (all lower case)

> lastname_main.m

while the function must be called

> lastname_traj_exact.m

Include your name, section number, and CM number in the comments in the header of each file. There should be no output other than what is asked for.

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The exact solution for the trajectory of a projectile without drag has an x and a y component:

$$x = x_0 + (V_0 \cos \theta)t$$
$$y = y_0 + (V_0 \sin \theta)t - \frac{1}{2}gt^2$$

Suppose we want to find the trajectory up to a certain x-distance x_{max}. Write a function that takes x_0, y_0, V_0, θ, and the maximum distance x_{max} as inputs. The function should return an array of values for x and y at 0.1 second intervals. Use $g=9.8 \ m/s^2$.

Create a main routine that calls the function and plots the trajectory. Use $x_0 = 0 \ m, y_0 = 0 \ m, V_0 = 60 \ m/s$, $\theta = 30°$, and $x_{max} = 200 \ m$.

_____

When you are done, post your m-files to the correct folder:

> 1. Double-click on "My Network Places". If it is not on your desktop, look in your start menu.
> 2. Double-click on "[DFS] Root". *Not [AFS] Root*.
> 3. Log in with your email address and password.
> 4. Double-click on Academic Affairs.
> 5. Double-click on ME.
> 6. Double-click on ME123.
> 7. Double-click on Exams.
> 8. Double-click on the folder with your section number.
> 9. Copy and paste your m-file to this folder.