An-Najah National University  
Faculty of Engineering  
Mechanical Engineering Department  
Introduction to Mechatronics Programming (67371)  
Second Exam

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Exam Notes:
1. Solve all the problems.
2. Closed books and notes.
3. Read each problem carefully before attempting to solve it.
4. Write all work on this exam paper.
**Question 1. (25 points)**
For the relation \( y = x^2 \cdot \cos(x) \cdot \sin(x) \), write a Matlab program that does the followings:
1) Plots the relation over the interval \([-\pi, \pi]\) with a step of 0.1.
2) Calculates the maximum and the minimum and indicate their position on the same figure by red circle as shown.

\[
\begin{align*}
x &= -\pi : 0.1 : \pi \; ; \\
y &= x \cdot \cos(x) \cdot \sin(x) \; ; \\
[y_{\text{max}}, \text{loc}] &= \text{max}(y) \; ; \\
\text{plot}(x, y) \; ; \\
\text{hold on} \\
\text{plot}(x(\text{loc}), y_{\text{max}}, 'or') \\
[y_{\text{min}}, \text{loc}] &= \text{min}(y) \; ; \\
\text{plot}(x(\text{loc}), y_{\text{min}}, 'or')
\end{align*}
\]

**Question 2. (30 points)**
Write a function that receives from the user a number \( n \) (the input of the function) and returns to the user (output of the function) the product of the odd numbers from 1 to \( n \). The program should check that \( n \) is 1) number (not a string) 2) scalar (not a matrix) 3) positive and 4) integer. Otherwise it produces the following error message: "erroneous input".

\[
\begin{align*}
\text{function} & \quad \text{out} = \text{product}([n]) \\
\text{if} & \quad \text{isnumeric}([n]) \; \&\; \text{length}([n]) = 1 \; \&\; n > 0 \; \&\; \text{mod}(n, 2) = 0 \\
& \quad \text{error('erroneous input')}
\end{align*}
\]

\[
\begin{align*}
\text{end} \\
\text{if} & \quad n == 0 \; ; \quad \text{prod} = 0 \; \text{else} \; ; \quad \text{prod} = 1 \; \text{end} \; . \\
\text{for} & \quad i = 1 : 2 : n \\
& \quad \text{prod} = \text{prod} \times i \; ; \\
\text{end} \\
\text{out} = \text{prod} ;
\end{align*}
\]
Question 3. (30 points)
Write a function that sorts a row or column array in ascending order. This function has one input (the array to be sorted), and two outputs: the first one is the sorted array and the other one is an array of the same size that contains collection of index vectors which describes the rearrangement of the elements of the sorted array. For example:
if the input is  \( A = [2 \ 5 \ 7 \ 1 \ 5 \ 7 \ 3] \)
the output is  \( \text{Asort} = [1 \ 2 \ 3 \ 5 \ 5 \ 7 \ 7] \),  \( \text{index} = [4 \ 1 \ 7 \ 2 \ 5 \ 3 \ 6] \)

```matlab
function [Asort, ind] = newsort(A)
    ind = zeros(size(A));
    ind(1:end) = 1:length(A);
    for i = 1:length(A)-1
        for j = i+1:length(A)
            if A(j) > A(i)
                temp = A(i);
                A(i) = A(j);
                A(j) = temp;
                temp2 = ind(i);
                ind(i) = ind(j);
                ind(j) = temp2;
            end
        end
    end
    Asort = A;
end
```

Question 4. (15 points)
Write the Matlab text string that will produce the flowing expression. Note the italic and bold faced letters.
a) \( f(x) = \sin(\theta) \cos(2\phi) \)
\[
\textsf{lbf m}\textsf{m}(\textsf{x}) = \sin(\textsf{i} \textsf{t} \textsf{h} \textsf{e} \textsf{d} \textsf{a} \textsf{r} \textsf{m}) \cos(2\textsf{i} \textsf{t} \textsf{h} \textsf{e} \textsf{d} \textsf{a} \textsf{r} \textsf{m})
\]
b) Plot of  \( \sum x^2 \) versus  \( x \)
\[
\textsf{lbf Plot of} \ \sum_{\textsf{x}} x^2 \ \textsf{versus} \ x
\]
c)  \( B_5 \)
\[
\textsf{lbf} \textsf{B}_5 \textsf{u}\textsf{l}\textsf{e}\textsf{s}
\]