MATLAB PRACTICE PROBLEMS

LEVEL: Dr. Bruce Banner

1. Compute $n!$ for positive integer n in two ways:
   (i) using `for` loop, and (ii) using MATLAB command `prod`.
2. Calculate the first n terms of Fibonacci series. The first two terms are 1 and 1. Thereafter, each term is sum of previous two terms. Thus: $f_i = f_{i-1} + f_{i-2}$
3. Write a general code and choose $n = 10$ to compare results with solved example. Find all terms of Fibonacci series that are less than 200.
4. The vertical location from ground when a ball is thrown upwards is given by: $y(t) = v_o t - 0.5\, gt^2$. Find the ball location at every 0.1 seconds interval until ball reaches ground again. Initial velocity is 20 m/s and $g = 9.8\ \text{m/s}^2$

5. Given vector `x = 0:0.1:5;` plot `sin(x)` and `cos(x)` in two ways:
   (i) Plot them using a single `plot` command;
   (ii) Plot `sin(x)` first, and then plot `cos(x)` without erasing the previous figure. Sine should be plotted as solid blue line, and cos as dashed red line.

6. Given a vector x, calculate the following:
   `oddSum` $= x(1) + x(3) + x(5) + \cdots$
   `funVal` $= x(1) - x(2) + x(3) - x(4) + \cdots$
   Your should create a **function** `vectorSum` that takes one input vector x, and returns two scalars, `oddSum` and `funVal`. Also update these results on the module assessment page for:
   1. `x=[0.81 0.91 0.12 0.91 0.63 0.09 0.28].`
   2. `x=[4 5 0 3].`

7 Two friends `A` and `B` start with initial salaries of 1 unit and 1.25 unit, respectively. At the end of each year, they get a raise of 6% and 2% respectively. Write a MATLAB code that uses either a `for` or `while` loop to calculate annual salaries of the two until the year when A's salary exceeds that of B's. Report the value of the earliest year n when A's salary exceeds B's.

When the program ends, `A` and `B` should be a n-dimensional vectors, containing their salaries in the respective years.

LEVEL: HULK

1. Two friends `A` and `B` start with initial salaries of 1 unit and 1.25 unit, respectively. At the end of each year, they get a raise of 6% and 2% respectively. Write a MATLAB code that uses either a `for` or `while` loop to calculate annual salaries of the two until the year when A's salary exceeds that of B's. Report the value of the earliest year n when A's salary exceeds B's.

   When the program ends, `A` and `B` should be a n-dimensional vectors, containing their salaries in the respective years.

2. Let us now use MATLAB solver `ode45` for the RL circuit model (with some changes):

$$V - IR - L\frac{dI}{dt} = 0, \qquad I(0) = 0$$

Part-1: Solve the above ODE with $L = 2$, $R = 2.5$, but when voltage decreases with time as:

$$V = 5e^{-0.2t}$$

Part–2: Solve the above ODE for the case where R also depends on current I. Thus, inductance is constant at $L = 2$ and:

$$V = 5e^{-0.2t} \quad \text{and} \quad R = 2.5 + 0.5\left(\frac{I}{2}\right)^{0.25}$$

In both the cases, initial value is $I(0) = 0$. **Use `ode45` to obtain $I(5)$**

3 (a) Use MacLaurin series expansion to obtain the approximation of e^a:

$$e^a = 1 + a + \frac{a^2}{2!} + \cdots + \frac{a^n}{n!}$$

Do this for $a = 0.5$, and $n = \{1, 2, 3, 4, 5\}$.

(b) Calculate $f(x, n) = c_0 + c_1 x + \cdots + c_n x^n$. Choose $x = 0.5$, $c_0 = 0$, $c_i = 1/i$.

4. A company produces Transistors, Resistors, and Computer Chips, which are built using materials C, Z and G. Each transistor requires 4 of material–C, 1 of material–Z and 2 of material-G. Likewise the number of materials of each type required in making transistors, resistors and chips is given in the following table:

	C	Z	G
Transistors	4	1	2
Resistors	3	3	1
Computer chips	2	1	3

If the total amount of materials used today are 960 units of C, 510 units of Z, and 610 units of G, find the number of transistors, resisters and computer chips manufactures in this production run.

You will need to set up the system of equations for this production run, and solve it using a method of your choice.

5. Use MATLAB command `fsolve` to solve the following nonlinear equations:

$$D(12 - y) - 100\frac{xy}{K + y} = 0$$

$$(0.75D + 1.4) - 60\frac{y}{K + y} = 0$$

Typical values of parameters are $D = 3.6$ and $K = 60$. Use `fsolve` to find the values of $[x;\ y]$ using initial guess of $x^{(0)} = 5$ and $y^{(0)} = 9$.

3–4. Please report the values of x and y.

6 The model for activated sludge process is given by:

$$\frac{dX}{dt} = -(0.6D + 1.6)X + 60\frac{XS}{K + S}$$

$$\frac{dS}{dt} = D(12 - S) - 100\frac{XS}{K + S}$$

Typical values of parameters are $D = 4.2$ and $K = 45$. The initial conditions are $X(0) = 0.5$ and $S(0) = 12$. Use `ode45` to obtain the values of X and S at time $t = 0.5$.

1. Report the value of X at time $t = 0.5$ using `ode45`.
2. Report the value of S at time $t = 0.5$ using `ode45`.