Assignment 11: STRESS

Question 1

Create a Matlab function to implement STRESS (Berns p97, Eqs. 5.20 and 5.21 - note that 5.21 is slightly cut off, missing the bottom part of the Summation operator and part of the small i indices. It should be clear enough...).

```
function st = CalcSTRESS(delE,delV)
    F = sum(delE.^2)./sum(delE.*delV);
    st = 100*(sum((delE-(F.*delV)).^2)./sum((F.^2).*(delV.^2))).^(1/2);
end
```

- The above function to calculate STRESS takes **ΔE** and **ΔV** as input arguments
- STRESS Computed using the following formula

$$STRESS = 100\left(\frac{\sum_i (\Delta E_i - F\Delta V_i)^2}{\sum_i F^2 \Delta V_i^2}\right)^{1/2} \qquad (5.20)$$

$$F = \frac{\sum_i \Delta E_i^2}{\sum_i \Delta E_i \Delta V_i} \qquad (5.21)$$

Question 2

*Create a Matlab function to implement ΔE*94 (Berns p101-102, Eqs. 5.30 - 5.34). For 5.34, please just use the second option (geometric mean of the C*ab of the standard and trial).*

```
function De94 = deltaE94(lab_bat,lab_ref)


    %Chroma
    C_star_ref = C_star(lab_ref(2,:),lab_ref(3,:));
    C_star_bat = C_star(lab_bat(2,:),lab_bat(3,:));
    C_Star_ab = sqrt(C_star_bat.*C_star_ref);
```

```
    %Delta Values
    dL = deltaL(lab_bat(1,:),lab_ref(1,:));
    dC = deltaC(C_star_bat,C_star_ref);
    dh = deltah(lab_bat,lab_ref);
    dH = deltaH(C_star_bat,C_star_ref,dh);

    %Weighting Functions
    SL = 1;
    SC = 1+(0.045.*C_Star_ab);
    SH = 1+(0.015.*C_Star_ab);

    %Parametric factors
    kL = 1;
    kC = 1;
    kH = 1;

    De94 = ((dL./ (kL.*SL)).^2+(dC./ (kC.*SC)).^2+(dH./ (kH.*SH)).^2).^(1/2);

end
```

- The above function to calculate ΔE*94 takes **LAB values of batch and reference** as input arguments
- ΔE*94 is calculated using the below formula

$$\Delta E^*_{94} = \sqrt{\left(\frac{\Delta L^*}{k_L S_L}\right)^2 + \left(\frac{\Delta C^*_{ab}}{k_C S_C}\right)^2 + \left(\frac{\Delta H^*_{ab}}{k_H S_H}\right)^2} \quad (5.30)$$

$$S_L = 1 \quad (5.31)$$

$$S_C = 1 + 0.045 C^*_{ab} \quad (5.32)$$

$$S_H = 1 + 0.015 C^*_{ab} \quad (5.33)$$

$$C^*_{ab} = \left\{ \frac{C^*_{ab,\mathrm{Std}}}{\sqrt{C^*_{ab,1} C^*_{ab,2}}} \right\} \quad (5.34)$$

- It includes other functions for calculations such as ΔL, ΔC, ΔH, C*ab

```
%Function to calculate Delta L
function DL = deltaL(L_bat,L_std)
    DL = L_bat - L_std;
end
```

```
%Function to calculate Delta C*
function DC = deltaC(C_bat,C_std)
    DC = C_bat - C_std;
end

%Function to calculate Delta H
function DH = deltaH(C_bat,C_std,deltah)
    DH = 2*(C_bat.*C_std).^(1/2).*sinDeg(deltah./2);


function C = C_star(a_star,b_star)
    C = sqrt((a_star).^2 + (b_star).^2);
end


%Function to calculate Delta h
function Dh = deltah(bat,std)
    Dh = hueAngle(bat(2,:),bat(3,:)) - hueAngle(std(2,:),std(3,:));
end


%Function to calculate hue angle
function h = hueAngle(a,b)
      h = atan2(b,a).*180./pi;
      h = h+(h<0).*360;
end
```

Question 3

*Compute ΔE*ab, ΔE*94, and ΔE*00 color difference metrics for all pairs in the data set, and create a table of min, mean, and max values over the data set for each metric.*

- Computation is done using the following code in which each of the functions to calculate *ΔE*ab, ΔE*94, and ΔE*00* takes **LAB values of batch and reference** as input arguments.
- Functions of *ΔE*94* can be referred from question 2. Function of *ΔE*ab, ΔE*94* is used from previous assignments and included in the Matlab file.

```
deltaEab_colDiff = deltaEab(lab_trl,lab_std);

deltaE94_colDiff = deltaE94(lab_trl,lab_std);

deltaE00_colDiff = deltaE00(lab_trl,lab_std);
```

ΔEab	ΔE94	ΔE00
0.96514	0.95765	0.80986
1.3746	0.97557	1.1267
1.5545	0.76765	0.94128
1.0114	0.57732	0.80721
3.2235	1.6478	1.0772
1.0644	0.71173	0.91221
1.183	0.94945	0.76386
0.8755	0.67397	0.732
1.5291	1.0535	0.81185
0.78083	0.7805	0.77774
1.6164	1.0446	1.189
1.6192	1.034	0.99188
1.5253	0.81932	0.90269
1.4776	1.1417	1.1255
1.24	0.82189	0.86959
:	:	:
4.1715	1.5041	1.4634
2.8134	1.7276	1.9796
18.404	4.82	3.5251
4.1805	2.413	2.4004
11.514	3.2575	2.3564
4.5855	2.5658	2.6545
17.609	4.6028	4.2787
4.615	2.5451	2.7427
15.518	4.0822	4.0229
3.9521	2.2174	2.4909
12.034	2.8369	2.8135
3.7476	2.1554	2.5319
8.8309	2.2347	2.2159
3.4803	2.0378	2.434
7.284	1.9285	1.9251

Note: All values of *ΔE*ab, ΔE*94, and ΔE*00* will be found in the attached **.xlsx** file

	Min	Mean	Max
*ΔE*ab*	0.77827	2.3416	18.404
*ΔE*94*	0.57732	1.2576	4.82
*ΔE*00*	0.65033	1.2531	4.2787

Question 4

*Compute and report STRESS for each of the three color difference formulas using the whole data set. Note that to check your work, you can compare your STRESS values for the 156 RIT-DuPont pairs to the values in the book: 33.42 for ΔE*ab and 19.79 for ΔE*00. The STRESS values for the whole data set may be slightly different.*

- Computation is done using the following code in which the functions to calculate *STRESS* takes **respective ΔE and given ΔV** values as arguments. The function to calculate STRESS is used from question 1.

```
STRESS_colDiff_Eab = CalcSTRESS(deltaEab_colDiff,deltaV_colDiff);

STRESS_colDiff_E94 = CalcSTRESS(deltaE94_colDiff,deltaV_colDiff);

STRESS_colDiff_E00 = CalcSTRESS(deltaE00_colDiff,deltaV_colDiff);
```

	All Pairs	DuPont Dataset (For Reference)
*ΔE*ab*	59.412	33.426
*ΔE*94*	28.471	20.488
*ΔE*00*	23.817	19.772

The performance of each listed total color-difference formula