CROSS-SECTION PROPERTIES

Name of program: ***polygon84*** **V 1.03**

This program determines for a polygonal section the center of gravity, area, moments of inertia and main moments of inertia including the angle of rotation of the main axes.
Furthermore the stresses of all input points may be calculated for any combination of N (**positive**, if acting as **tension** force), Mx and My (figure **2**). N may be entered as acting in the center of gravity or any point of the section.

Select **POLYGON** and start the program. For a new section, select **1:** NEW CONTOUR, if you have already calculated a system and want to change the loads, select **2:** NEW LOADS. Then key in the NUMBER of points. The display now indicates the number of the point to be entered. Key in xi, yi of all points counterclockwise (points 7 – 10 in fig. **2**), missing areas have to be input clockwise (pts. 2 – 6). Make sure that the dimensions of the coordinates are consistent with the loads (e.g. **cm** and kN**cm** !). If all n points are entered, the program prompts for the change of point #i, to offer the opportunity to change points, otherwise enter ***0***. The result is indicated as Area **A**, **xs**, **ys** as center point of gravity, moments of inertia **Ixs**, **Iys**, **Ixy** (referred to **xs**, **ys**) and main moments of inertia **I1**, **I2** with angle ϕ of the main axis. After the display of three results the output is halted by ***Pause***, so press **enter** to continue. These section quantities are stored in the list variable $L_4(1)$ - $L_4(9)$!
To end the program here if there are no loads to be examined, enter ***0*** on the prompt ***Calculateσi?***.

Following now is the input of N, Mx, My, which results in the display of a plot of the contour including the main axis for I1 and I2 in lightblue as well as the neutral axis, where $\sigma_i=0$ (magenta). Press **stat** ,then **1:Edit…** You will find the x-coordinates in list L_1, yi in L_2, stresses σ_i in L_3 and the section properties in L_6. L_4 and L_5 contain the coordinates x_0 and y_0, where the neutral axis intersects the contour.

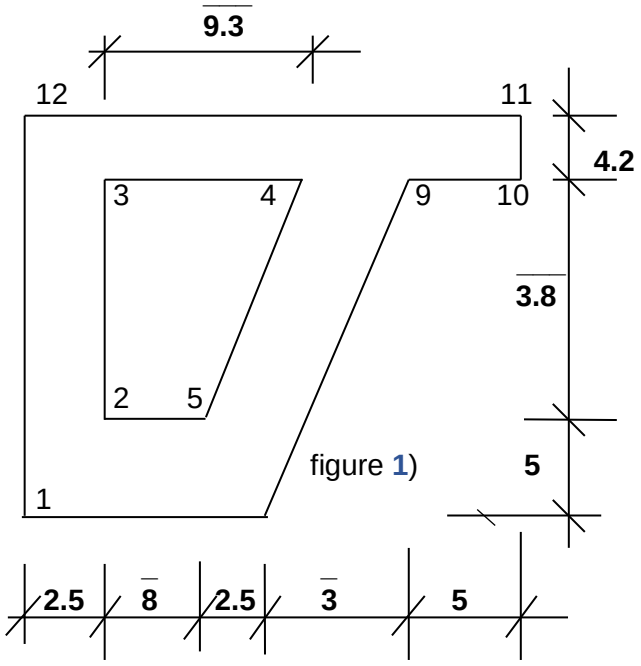


figure **1**)

figure **2**)

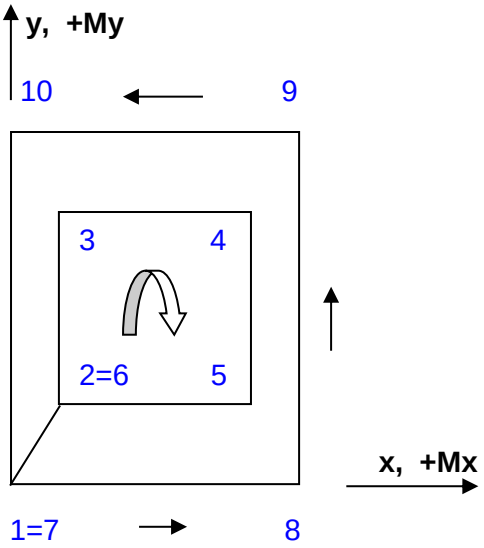


TABLE of COORDINATES ([cm]):

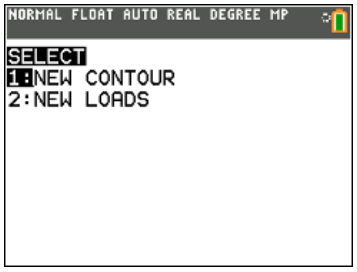
i	x_i	y_i	i	x_i	y_i
1	0	0	**7**	0	0
2	2.5	5	**8**	13	0
3	2.5	8.8	**9**	16	8.8
4	11.8	8.8	**10**	21	8.8
5	10.5	5	**11**	21	13
6	2.5	5	**12**	0	13

EXAMPLE

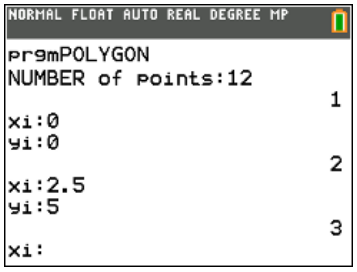
Being given the section of figure 1) and the loads N = **- 50 kN** acting in the centre of the section; Mx = **-700 kNcm**, and My = **+200 kNcm**, calculate the stresses $\sigma_{,i}$ (1 <= i <=12).

Select "**POLYGON",** press **enter** and again **enter** . Select **1:** NEW CONTOUR, then key in **12** for **NUMBER of points** (fig. 3, fig. 4)

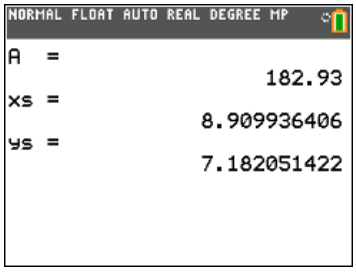
Now enter the points as indicated in the table. After the 12th pair of x_i, y_i the program offers the opportunity to correct inputs. If you entered a wrong value for point **i**, enter now the number **i** in the "**CHANGE point #i :** "-field and key in the correct value, otherwise or to exit enter ***0***.



3)

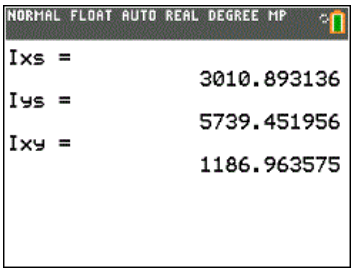


4)

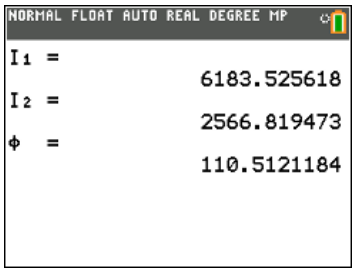


5)

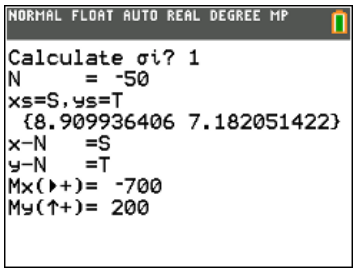
Now the section properties A, y_S, z_S, I_{xs}, I_{ys}, I_{yz} , I_1, I_2, ϕ are displayed (fig. 5 – fig. 7):



6)

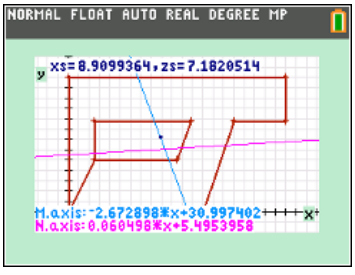


7)

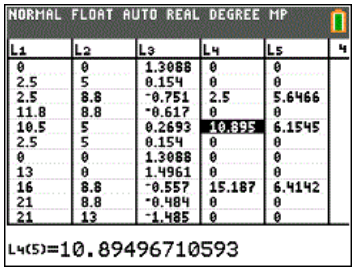


8)

A = 182.93 **xs** = 8.9099 **ys** = 7.182 . Press **enter** : **Ixs** = 3010.89 **Iys** = 5739.45 **Ixy** = 1186.96. Again press **enter**: **I1** = 6183.526 **I2** = 2566.819 ϕ = 110.51. The next **enter** depicts the contour. After the plot of the contour press **enter**. Program prompts: ***Calculateσi?*** Key in ***1*** (fig 8.), then enter **N =** -50. If N <> 0, the input of point ($x_{,N}$, $y_{,N}$), where N is acting in, is requested additionally and the program prompts to enter the position of N on the contour offering xs and ys, stored in **S** and **T**. So key in alpha ln (=**S**) for x-N and alpha **4** (=**T**) for y-N. Afterwards key in the values of **Mx =** -700 and **My** = 200. The following graph displays the contour and the equations of the main axis line M.axis: -2.6728*x +30.997, the neutral axis N.axis: .0060498*x+5.49539 and the location and quantities of xs=8.9099, ys=7.18205 (fig. 9).



9)



10)

Press 2nd quit, then stat and **1: Edit**… You will see numerical results stored in L_1 – L_6 (fig. 10): L_1: x_i of section points, L_2: y_i of section, L_3: stresses σ_i , L_4 and L_5: x_0, and y_0, where neutral axis meets contour (otherwise ***0***). Fig. 10) displays the values x_0=10.895 and y_0=6.1545 between point P_4 and P_5 for σ_i = ***0***. Finally, L_6 (10) contains the inclination angle γ of the neutral axis (= 3.46°). If stress calculation is omitted, this cell contains ***0***.

For new loads, start **POLYGON** again, select **2:** NEW LOADS and enter N, Mx and/or My. In that case **be sure that you have not changed or deleted any variable meanwhile** !

HINTS and WARNINGS

- Pay attention to the applied units! If you enter the coordinates in [**cm**] and moments in [**kNcm**], stresses are output in [**kN/cm²**] !
- If all stresses have the same sign, the neutral axis is described by:
"N.axis: .tan(γ)*x+-…,beyond contour!" instead by an equation .

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