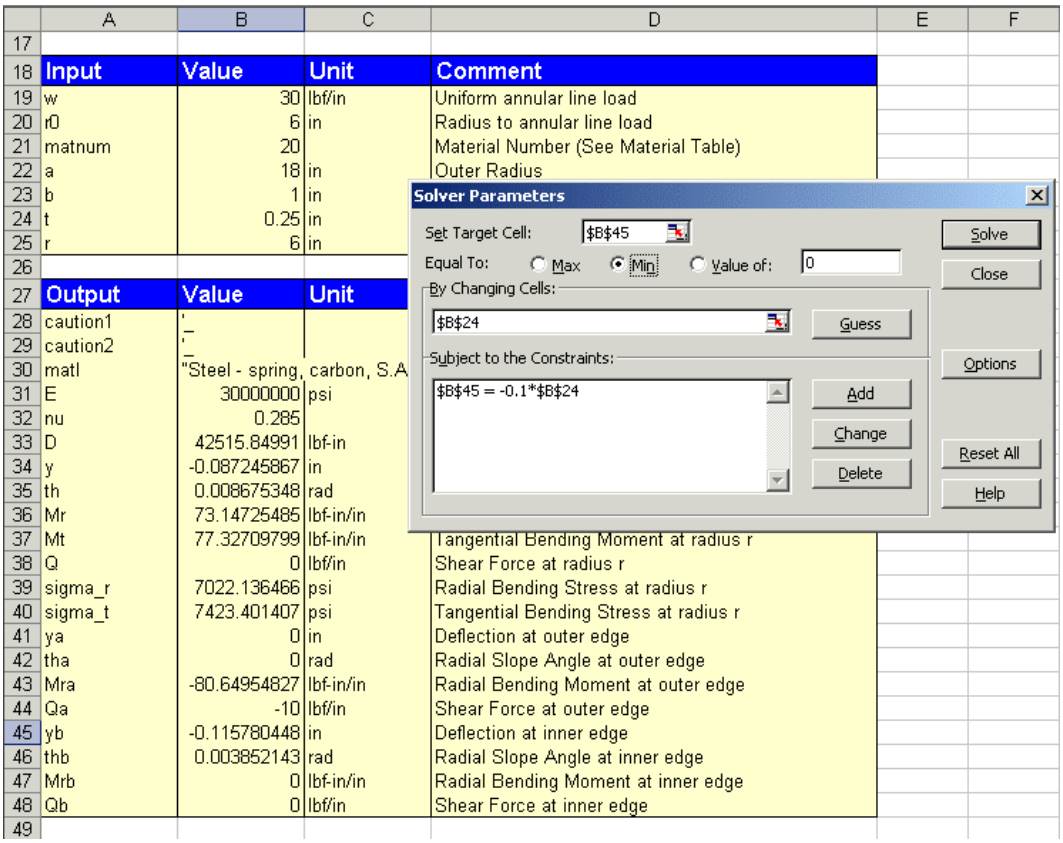
Tutorial—Five Quick Problems

Problem 5

Continue with the annular plate from problem 4. To optimize the design, you would like to specify that the maximum deflection in the center be at most 10% of the plate thickness.

You can use the Excel Solver to solve this problem. Specify the deflection output as the "Target" cell and use either the minimize or maximize option. Use the thickness cell as the "Changing" cell. Add a constraint that the deflection at the inner edge must equal -0.1 times the thickness and click Solve.



	A	B	C	D
17				
18	**Input**	**Value**	**Unit**	**Comment**
19	w	30	lbf/in	Uniform annular line load
20	r0	6	in	Radius to annular line load
21	matnum	20		Material Number (See Material Table)
22	a	18	in	Outer Radius
23	b	1	in	
24	t	0.25	in	
25	r	6	in	
26				
27	**Output**	**Value**	**Unit**	
28	caution1	'		
29	caution2	'		
30	matl	"Steel - spring, carbon, S.A		
31	E	30000000	psi	
32	nu	0.285		
33	D	42515.84991	lbf-in	
34	y	-0.087245867	in	
35	th	0.008675348	rad	
36	Mr	73.14725485	lbf-in/in	
37	Mt	77.32709799	lbf-in/in	Tangential Bending Moment at radius r
38	Q	0	lbf/in	Shear Force at radius r
39	sigma_r	7022.136466	psi	Radial Bending Stress at radius r
40	sigma_t	7423.401407	psi	Tangential Bending Stress at radius r
41	ya	0	in	Deflection at outer edge
42	tha	0	rad	Radial Slope Angle at outer edge
43	Mra	-80.64954827	lbf-in/in	Radial Bending Moment at outer edge
44	Qa	-10	lbf/in	Shear Force at outer edge
45	yb	-0.115780448	in	Deflection at inner edge
46	thb	0.003852143	rad	Radial Slope Angle at inner edge
47	Mrb	0	lbf-in/in	Radial Bending Moment at inner edge
48	Qb	0	lbf/in	Shear Force at inner edge
49				

After a few iterations, success! If you make the plate at least .367 inches thick, the deflection will be OK.

	A	B	C	D
17				
18	**Input**	**Value**	**Unit**	**Comment**
19	w	30	lbf/in	Uniform annular line load
20	r0	6	in	Radius to annular line load
21	matnum	20		Material Number (See Material Table)
22	a	18	in	Outer Radius
23	b	1	in	Inner Radius
24	t	0.366745016	in	Plate Thickness
25	r	6	in	Sample radius, r
26				
27	**Output**	**Value**	**Unit**	**Comment**
28	caution1	'		Dimension Check
29	caution2	'		Thickness Check
30	matl	"Steel - spring, carbon, S.A.E.		Material name
31	E	30000000	psi	Young's Modulus
32	nu	0.285		Poisson's ratio
33	D	134221.9362	lbf-in	Plate Constant
34	y	-0.027635812	in	Deflection at radius r
35	th	0.002747984	rad	Radial Slope Angle at radius r
36	Mr	73.14725485	lbf-in/in	Radial Bending Moment at radius r
37	Mt	77.32709799	lbf-in/in	Tangential Bending Moment at radius r
38	Q	0	lbf/in	Shear Force at radius r
39	sigma_r	3263.028314	psi	Radial Bending Stress at radius r
40	sigma_t	3449.487075	psi	Tangential Bending Stress at radius r
41	ya	0	in	Deflection at outer edge
42	tha	0	rad	Radial Slope Angle at outer edge
43	Mra	-80.64954827	lbf-in/in	Radial Bending Moment at outer edge
44	Qa	-10	lbf/in	Shear Force at outer edge
45	yb	-0.036674364	in	Deflection at inner edge
46	thb	0.001220197	rad	Radial Slope Angle at inner edge
47	Mrb	0	lbf-in/in	Radial Bending Moment at inner edge
48	Qb	0	lbf/in	Shear Force at inner edge
49				