TABLA DE POSICIONES DE LA LINEA NEUTRA (Centroid) Y MOMENTOS DE INERCIA DE FLEXION

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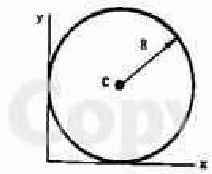
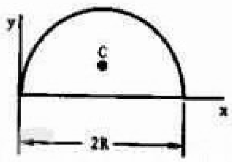
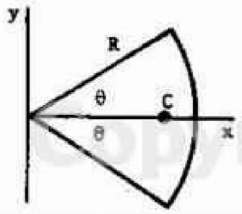
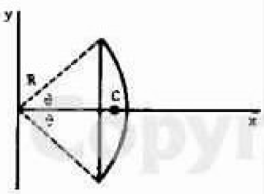
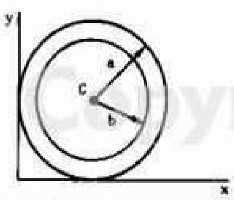
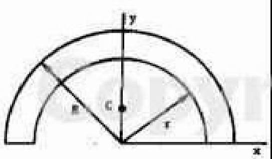
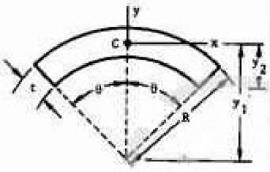
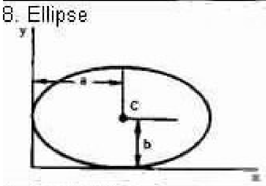
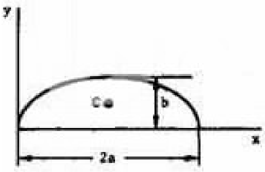
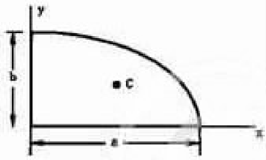
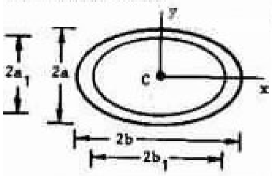
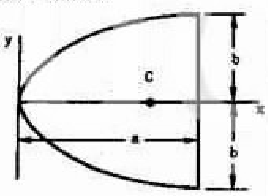
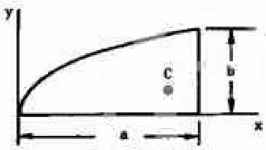
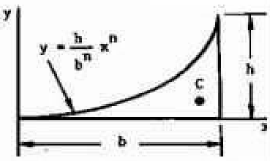
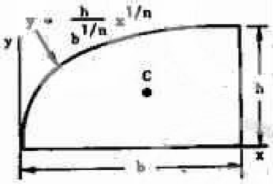
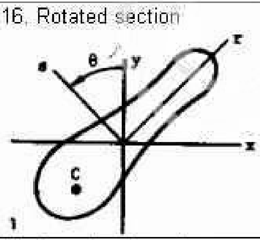
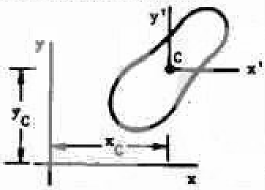
Referencia:
http://www.structures.ucsd.edu/casl/data_analysis/section_properties.htm

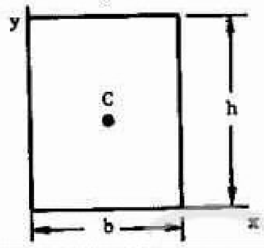
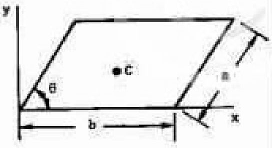
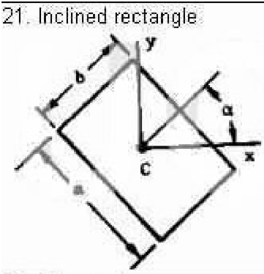
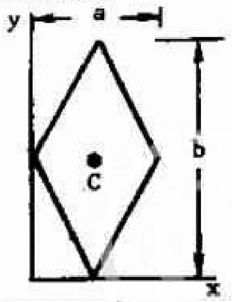
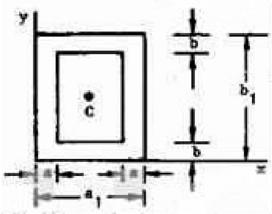
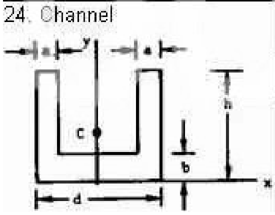
$$A=\iint_S dx\,dy \qquad 0=\iint_S (x-x_c)\,dx\,dy \qquad 0=\iint_S (y-y_c)\,dx\,dy \qquad I_{y_c}=\iint_S (x-x_c)^2\,dx\,dy \qquad I_{x_c}=\iint_S (y-y_c)^2\,dx\,dy$$

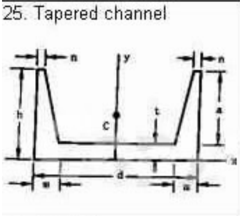
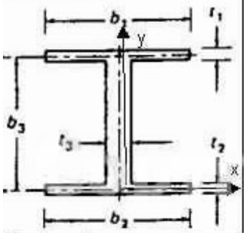
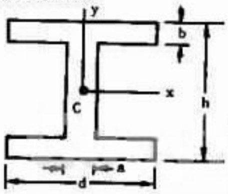
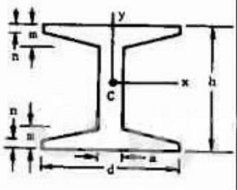
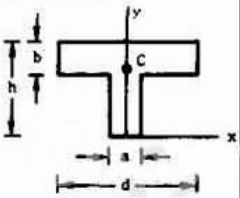
$$I_y=\iint_S x^2\,dx\,dy \quad I_x=\iint_S y^2\,dx\,dy$$

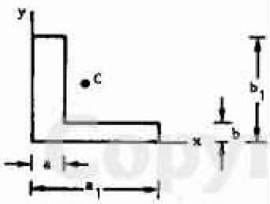
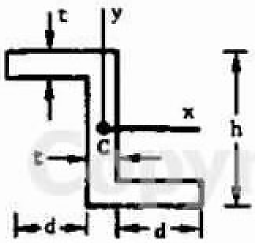
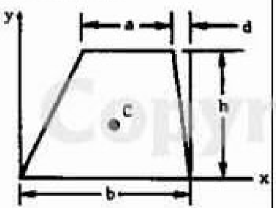
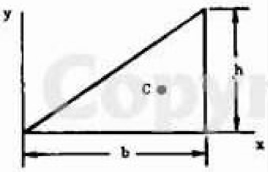
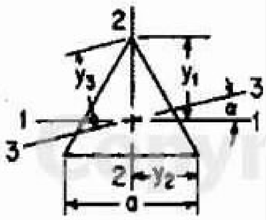
Cross section	Area	Centroid	Inertia	Torsional Constant
1. Circle 	$A=\pi R^2$	$x_c=R$ $y_c=R$	$I_{x_c}=I_{y_c}=\frac{1}{4}\pi R^4$ $I_x=I_y=\frac{5}{4}\pi R^4$	$J=\frac{\pi R^4}{2}$
2. Semicircle 	$A=\frac{1}{2}\pi R^2$	$x_c=R$ $y_c=\frac{4R}{3\pi}$	$I_{x_c}=\frac{R^4(9\pi^2-64)}{72\pi}$ $I_{y_c}=\frac{1}{8}\pi R^4$ $I_x=\frac{1}{8}\pi R^4$ $I_y=\frac{5}{8}\pi R^4$	$J=0.296R^4$
3. Circular sector 	$A=R^2\theta$	$x_c=\frac{2R}{3}\frac{\sin\theta}{\theta}$ $y_c=0$	$I_{x_c}=\frac{1}{4}R^4(\theta-\sin\theta\cos\theta)$ $I_{y_c}=\frac{1}{4}R^4(\theta+\sin\theta\cos\theta)$	$J=CR^4$ 2θ: 45°, 60°, 90° C: 0.0181, 0.0349, 0.0825 2θ: 120°, 180°, 270° C: 0.148, 0.296, 0.528 2θ: 300°, 360° C: 0.686, 0.878
4. Circular segment 	$A=R^2\left(\theta-\frac{1}{2}\sin 2\theta\right)$	$x_c=\frac{2R}{3}\left(\frac{\sin^3\theta}{\theta-\sin\theta\cos\theta}\right)$ $y_c=0$	$I_x=\frac{AR^2}{4}\left[1-\frac{2\sin^3\theta\cos\theta}{3(\theta-\sin\theta\cos\theta)}\right]$ $I_y=\frac{AR^2}{4}\left[1+\frac{2\sin^3\theta\cos\theta}{\theta-\sin\theta\cos\theta}\right]$	--
5. Annulus 	$A=\pi(a^2-b^2)$	$x_c=a$ $y_c=a$	$I_{x_c}=I_{y_c}=\frac{\pi}{4}(a^4-b^4)$ $I_x=I_y=\frac{5}{4}\pi a^4-\pi a^2b^2-\frac{\pi}{4}b^4$	$J=\frac{\pi(a^4-b^4)}{2}$
6. Semi annulus 	$A=\frac{\pi}{2}(R^2-r^2)$	$x_c=0$ $y_c=\frac{4R}{3\pi}\left(\frac{r}{R}+\frac{R}{R+r}\right)$	$I_x=\frac{\pi}{8}(R^4-r^4)$ $I_y=I_x$	--

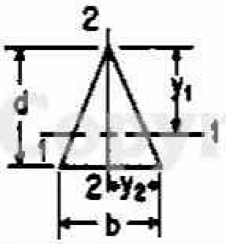
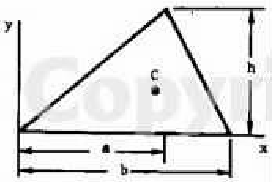
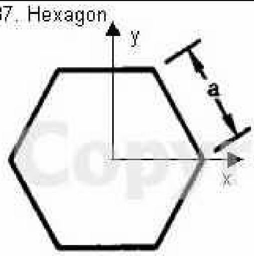
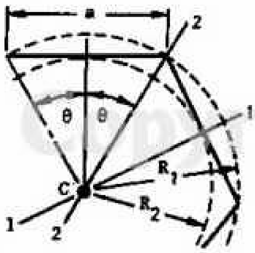
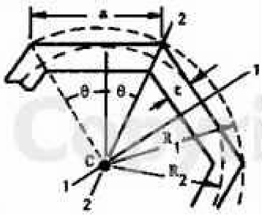
Cross section	Area	Centroid	Inertia	Torsional Constant
7. Annulus sector 	$A=\theta t(2R-t)$	$x_C=0$ $y_C=0$ $y_1=\frac{2R\sin\theta}{3\theta}\left(1-\frac{t}{R}+\frac{1}{2-t/R}\right)$ $y_2=R\left[\frac{2\sin\theta}{3\theta(2-t/R)}+\left(1-\frac{t}{R}\right)\frac{2\sin\theta-3\theta\cos\theta}{3\theta}\right]$	$I_x=R^3t\left[\left(1-\frac{3t}{2R}+\frac{t^2}{R^2}-\frac{t^3}{4R^3}\right)\cdot\left(\theta+\sin\theta\cos\theta-\frac{2\sin^2\theta}{\theta}\right)+\frac{t^2\sin^2\theta}{3R^2\theta(2-t/R)}\left(1-\frac{t}{R}+\frac{t^2}{6R^2}\right)\right]$ $I_y=R^3t\left(1-\frac{3t}{2R}+\frac{t^2}{R^2}-\frac{t^3}{4R^3}\right)\cdot(\theta-\sin\theta\cos\theta)$	– –
8. Ellipse 	$A=\pi ab$	$x_C=a$ $y_C=b$	$I_{x_C}=\frac{\pi}{4}ab^3$ $I_{y_C}=\frac{\pi}{4}a^3b$ $I_x=\frac{5}{4}\pi ab^3$ $I_y=\frac{5}{4}\pi a^3b$	$J=\frac{\pi a^3b^3}{a^2+b^2}$
9. Semi-ellipse 	$A=\frac{1}{2}\pi ab$	$x_C=a$ $y_C=\frac{4b}{3\pi}$	$I_{x_C}=\frac{ab^3}{72\pi}(9\pi^2-64)$ $I_{y_C}=\frac{\pi}{8}a^3b$ $I_x=\frac{\pi}{8}ab^3$ $I_y=\frac{5}{8}\pi a^3b$	– –
10. Quarter-ellipse 	$A=\frac{1}{4}\pi ab$	$x_C=\frac{4}{3\pi}a$ $y_C=\frac{4}{3\pi}b$	$I_{x_C}=ab^3\left(\frac{\pi}{16}-\frac{4}{9\pi}\right)$ $I_{y_C}=a^3b\left(\frac{\pi}{16}-\frac{4}{9\pi}\right)$ $I_x=\frac{\pi ab^3}{16}$ $I_x=\frac{\pi a^3b}{16}$	– –
11. Hollow ellipse 	$A=\pi(ab-a_1b_1)$	$x_C=0$ $y_C=0$	$I_x=\frac{\pi}{4}(ba^3-b_1a_1^3)$ $I_y=\frac{\pi}{4}(ab^3-a_1b_1^3)$	$J=\frac{\pi a^3b^3}{a^2+b^2}(1-q^4)$ where $q=\frac{b_1}{b}=\frac{a_1}{a}$
12. Parabola 	$A=\frac{4}{3}ab$	$x_C=\frac{3}{5}a$ $y_C=0$	$I_{x_C}=I_x=\frac{4}{15}ab^3$ $I_{y_C}=\frac{16}{175}a^3b$ $I_y=\frac{4}{7}a^3b$	– –

Cross section	Area	Centroid	Inertia	Torsional Constant
13. Semi-parabola 	$A=\frac{2}{3}ab$	$x_C=\frac{3}{5}a$ $y_C=\frac{3}{8}b$	$I_x=\frac{2}{15}ab^3$ $I_y=\frac{2}{7}a^3b$	--
14. n[th] degree parabola 	$A=\frac{bh}{n+1}$	$x_C=\frac{n+1}{n+2}b$ $y_C=\frac{h}{2}\left(\frac{n+1}{2n+1}\right)$	$I_x=\frac{bh^3}{3(3n+1)}$ $I_y=\frac{hb^3}{n+3}$	--
15. n[th] degree parabola 	$A=\frac{n}{n+1}bh$	$x_C=\frac{n+1}{2n+1}b$ $y_C=\frac{n+1}{2(n+2)}h$	$I_x=\frac{n}{3(n+3)}bh^3$ $I_y=\frac{n}{3n+1}hb^3$	--
16. Rotated section 	--	--	$I_x=I_r\cos^2\theta+I_s\sin^2\theta+I_{rs}\sin 2\theta$ $I_y=I_r\sin^2\theta+I_s\cos^2\theta-I_{rs}\sin 2\theta$	--
17. Translated section 	A	--	$I_x=I_{x_C}+y_C^2A$ $I_y=I_{y_C}+x_C^2A$	--

Cross section	Area	Centroid	Inertia	Torsional Constant
19. Rectangle 	$A = bh$	$x_C = \frac{1}{2}b$ $y_C = \frac{1}{2}h$	$I_{x_C} = \frac{bh^3}{12}$ $I_{y_C} = \frac{b^3h}{12}$ $I_x = \frac{bh^3}{3}$ $I_y = \frac{b^3h}{3}$	$J = bh^3\left[\frac{1}{3} - 0.21\frac{h}{b}\left(1 - \frac{h^4}{12b^4}\right)\right]$
20. Parallelogram 	$A = ab\sin\theta$ $A = bh$	$x_C = \frac{1}{2}(b + a\cos\theta)$ $y_C = \frac{1}{2}(a\sin\theta)$	$I_{x_C} = \frac{a^3b}{12}\sin^3\theta$ $I_{y_C} = \frac{ab}{12}\sin\theta\left(b^2 + a^2\cos^2\theta\right)$ $I_x = \frac{a^3b}{3}\sin^3\theta$ $I_y = \frac{ab}{3}\sin\theta(b + a\cos\theta)^2 - \frac{a^2b^2}{6}\sin\theta\cos\theta$	--
21. Inclined rectangle 	$A = ab$	$x_C = 0$ $y_C = 0$	$I_x = \frac{ab}{12}\left(a^2\cos^2\alpha + b^2\sin^2\alpha\right)$ $I_y = \frac{ab}{12}\left(a^2\sin^2\alpha + b^2\cos^2\alpha\right)$	--
22. Diamond 	$A = \frac{ab}{2}$	$x_C = \frac{a}{2}$ $y_C = \frac{b}{2}$	$I_{x_C} = \frac{ab^3}{48}$ $I_{y_C} = \frac{a^3b}{48}$	--
23. Hollow rectangle 	$A = 2a_1b + 2ab_1 - 4ab$	$x_C = \frac{a_1}{2}$ $y_C = \frac{b_1}{2}$	$I_{x_C} = \frac{a_1b_1^3 - (a_1 - 2a)(b_1 - 2b)^3}{12}$ $I_{y_C} = \frac{a_1^3b_1 - (a_1 - 2a)^3(b_1 - 2b)}{12}$	$J = \frac{2ab(a_1 - a)^2(b_1 - b)^2}{a_1a + b_1b - a^2 - b^2}$
24. Channel 	$A = 2ah + db - 2ab$	$x_C = 0$ $y_C = \frac{2ah^2 + db^2 - 2ab^2}{2A}$	$I_x = \frac{2}{3}ah^3 + \frac{1}{3}(d - 2a)b^3$ $I_{y_C} = I_y = \frac{d^3h - (h - b)(d - 2a)^3}{12}$	--

Cross section	Area	Centroid	Inertia	Torsional Constant
25. Tapered channel 	$A = td + a(m+n)$	$x_C = 0$ $y_C = \frac{6h^2n + 3ct^2 + 2a(m-n)(h+2t)}{6A}$ $(c = d - 2n)$	$I_x = \frac{2nh^3 + et^3 + \frac{m-n}{2a}(h^4 - t^4)}{3}$ $I_y = \frac{hd^3 - \frac{a}{8(m-n)}(c^4 - e^4)}{12}$ $(c = d - 2n, e = d - 2m)$	– –
26. I section 	$A = t_1b_1 + t_2b_2 + t_3\left(b_3 - \frac{t_1}{2} - \frac{t_2}{2}\right)$	$x_C = 0$ $yc = \frac{\left(b_2t_2^2 + b_1t_1\left(b_3 + \frac{t_2}{2}\right) + \left(b_3 - \frac{t_1}{2} - \frac{t_2}{2}\right)(t_3)\left(\frac{b_3}{2} + \frac{t_2}{2}\right)\right)}{2A}$	– –	$J = \frac{b_1t_1^3 + b_2t_2^3 + b_1t_1^3}{3}$
27. I section 	$A = 2db + ah - 2ab$	$x_C = 0$ $y_C = 0$	$I_x = \frac{dh^3 - (d-a)(h-2b)^3}{12}$ $I_y = \frac{2hd^3 + (h-2b)a^3}{12}$	$J = \frac{2}{3}db^3 + \frac{1}{3}(h-2b)^3a$
28. Tapered I section 	$A = ha + (d-a)(m+n)$	$x_C = 0$ $y_C = 0$	$I_x = \frac{dh^3 - \frac{(d-a)}{8(m-n)}(c^4 - e^4)}{12}$ $I_y = \frac{2nd^3 + ea^3 + \frac{(m-n)}{2(d-a)}(d^4 - a^4)}{12}$ $(c = h - 2n, e = h - 2m)$	– –
29. T section 	$A = db + ah - ab$	$x_C = 0$ $y_C = h - \frac{ah^2 + db^2 - ab^2}{2A}$	$I_{x_C} = \frac{1}{3}\left[\begin{matrix} d(h-y_C)^3 \\ -(d-a)(h-b-y_C)^3 - ay_C^3 \end{matrix}\right]$ $I_{y_C} = I_y = \frac{d^3b + (h-b)a^3}{12}$ $I_x = \frac{1}{3}dh^3 - \frac{1}{3}(d-a)(h-b)^3$	– –

Cross section	Area	Centroid	Inertia	Torsional Constant
30. L section 	$A = a_1 b + a b_1 - ab$	$x_c = \dfrac{a b_1^2 + a_1 b^2 - ab^2}{2A}$ $y_c = \dfrac{a_1^2 b + a^2 b_1 - a^2 b}{2A}$	$I_{x_c} = \dfrac{1}{3}\left[\begin{matrix} a_1 y_c^3 - (a_1 - a)(y_c - b)^3 \\ + a(b_1 - y_c)^3 \end{matrix}\right]$ $I_{y_c} = \dfrac{1}{3}\left[\begin{matrix} b_1 x_c^3 - (b_1 - b)(x_c - a)^3 \\ + b(a_1 - x_c)^3 \end{matrix}\right]$ $I_x = \dfrac{1}{3} a b^3 + \dfrac{1}{3}(a_1 - a) b^3$ $I_y = \dfrac{1}{3} b a^3 + \dfrac{1}{3}(b_1 - b) a^3$	$J = \dfrac{a_1 b^3 + b_1 a^3}{3}$
31. Z section 	$A = t(h + 2d)$	$x_c = 0$ $y_c = 0$	$I_x = \dfrac{(d+t)h^3 - d(h - 2t)^3}{12}$ $I_y = \dfrac{h(2d+t)^3 - 2d^3(h-t)}{12} - \dfrac{6d(d+t)^2(h-t)}{12}$	$J = \dfrac{1}{3}(h + 2d)t^3$
32. Trapazoid 	$A = \dfrac{1}{2} h (a + b)$	$x_c = \dfrac{2b^2 + 2ba - bd - 2ad - a^2}{3(a+b)}$ $y_c = \dfrac{1}{3} h \left(\dfrac{2a + b}{a + b}\right)$	$I_{x_c} = \dfrac{h^3(a^2 + 4ab + b^2)}{36(a+b)}$ $I_{y_c} = \dfrac{h}{36(a+b)}\left[\begin{matrix} b^4 + a^4 + 2ab(a^2 + b^2) \\ - d(b^3 + 3b^2 a - 3ba^2 - a^3) \\ + d^2(b^2 + 4ab + a^2) \end{matrix}\right]$ $I_x = \dfrac{h^3}{12}(3a + b)$	– –
33. Right triangle 	$A = \dfrac{1}{2} bh$	$x_c = \dfrac{2}{3} b$ $y_c = \dfrac{1}{3} h$	$I_{x_c} = \dfrac{bh^3}{36}$ $I_{y_c} = \dfrac{b^3 h}{36}$ $I_x = \dfrac{bh^3}{12}$ $I_y = \dfrac{b^3 h}{4}$	– –
34. Equilateral triangle 	$A = 0.4330 a^2$	$y_1 = 0.5774 a$ $y_2 = 0.5000 a$ $y_3 = 0.5774 a \cos\alpha$	$I_1 = I_2 = I_3 = 0.01804 a^4$	$J = \dfrac{a^4 \sqrt{3}}{80}$

Cross section	Area	Centroid	Inertia	Torsional Constant
35. Isosceles triangle 	$A = \frac{bd}{2}$	$y_1 = \frac{2}{3}d$ $y_2 = \frac{b}{2}$	$I_1 = \frac{1}{36}bd^3$ $I_2 = \frac{1}{48}db^3$	- -
36. Triangle 	$A = \frac{1}{2}bh$	$x_C = \frac{1}{3}(a+b)$ $y_C = \frac{1}{3}h$	$I_{x_C} = \frac{bh^3}{36}$ $I_{y_C} = \frac{bh}{36}(b^2 - ab + a^2)$ $I_x = \frac{bh^3}{12}$ $I_y = \frac{bh}{12}(b^2 + ab + a^2)$	- -
37. Hexagon 	$A = \frac{3}{2}\sqrt{3}a^2$	$x_C = 0$ $y_C = 0$	- -	$J = 1.03a^4$
38. Regular polygon with n sides 	$(R_1 = \frac{a}{2\sin\theta}$ $R_2 = \frac{a}{2\tan\theta})$ $A = \frac{1}{4}a^2 n \cot\theta$	$x_C = 0$ $y_C = 0$	$I_1 = \frac{A(6R_1^2 - 2a^2)}{24}$ $I_2 = \frac{A(12R_2^2 + a^2)}{48}$	- -
39. Hollow regular polygon with n sides 	$(R_1 = \frac{a}{2\sin\theta}$ $R_2 = \frac{a}{2\tan\theta})$ $A = nat\left(1 - \frac{t\tan\theta}{a}\right)$	$x_C = 0$ $y_C = 0$	$I_1 = \frac{na^3t}{8}\left(\frac{1}{3} + \frac{1}{\tan^2\theta}\right)\cdot$ $\left[1 - 3\frac{t\tan\theta}{a} + 4\left(\frac{t\tan\theta}{a}\right)^2 - 2\left(\frac{t\tan\theta}{a}\right)^3\right]$ $I_2 = I_1$	$J = 4nat^3$