

Критерий устойчивости Михайлова

Характеристическое уравнение системы:

$$F(p) = 0.0128T_0 p^4 + (0.0128 + 0.24T_0)p^3 + (0.24 + 21T_0)p^2 + (1 + 49.743T_0)p + 49.743, \text{ где } p = j\omega$$

Вещественная и мнимая функции Михайлова:

$$X(\omega) = \operatorname{Re}(F) = a_0\omega^4 - a_2\omega^2 + a_4 = 0$$

$$Y(\omega) = \operatorname{Im}(F) = -a_1\omega^3 + a_3\omega = 0$$

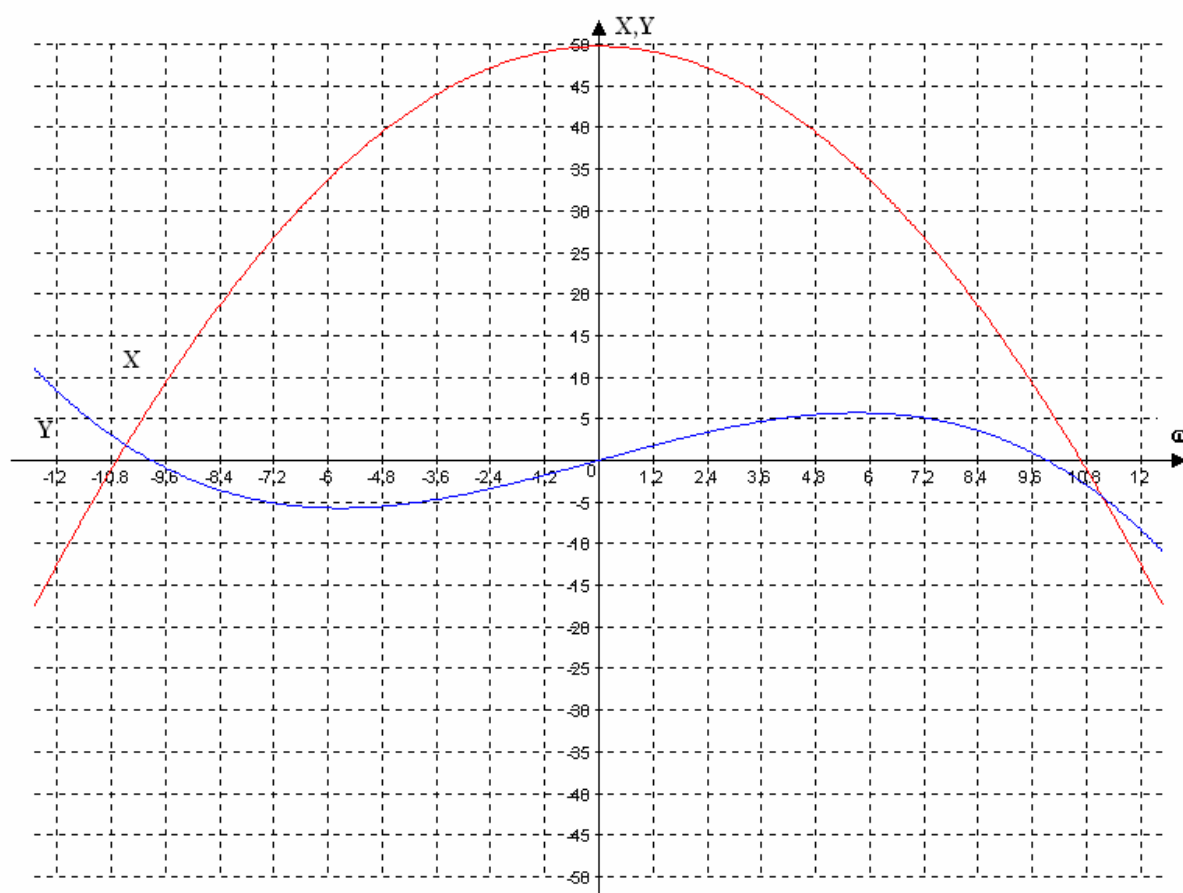
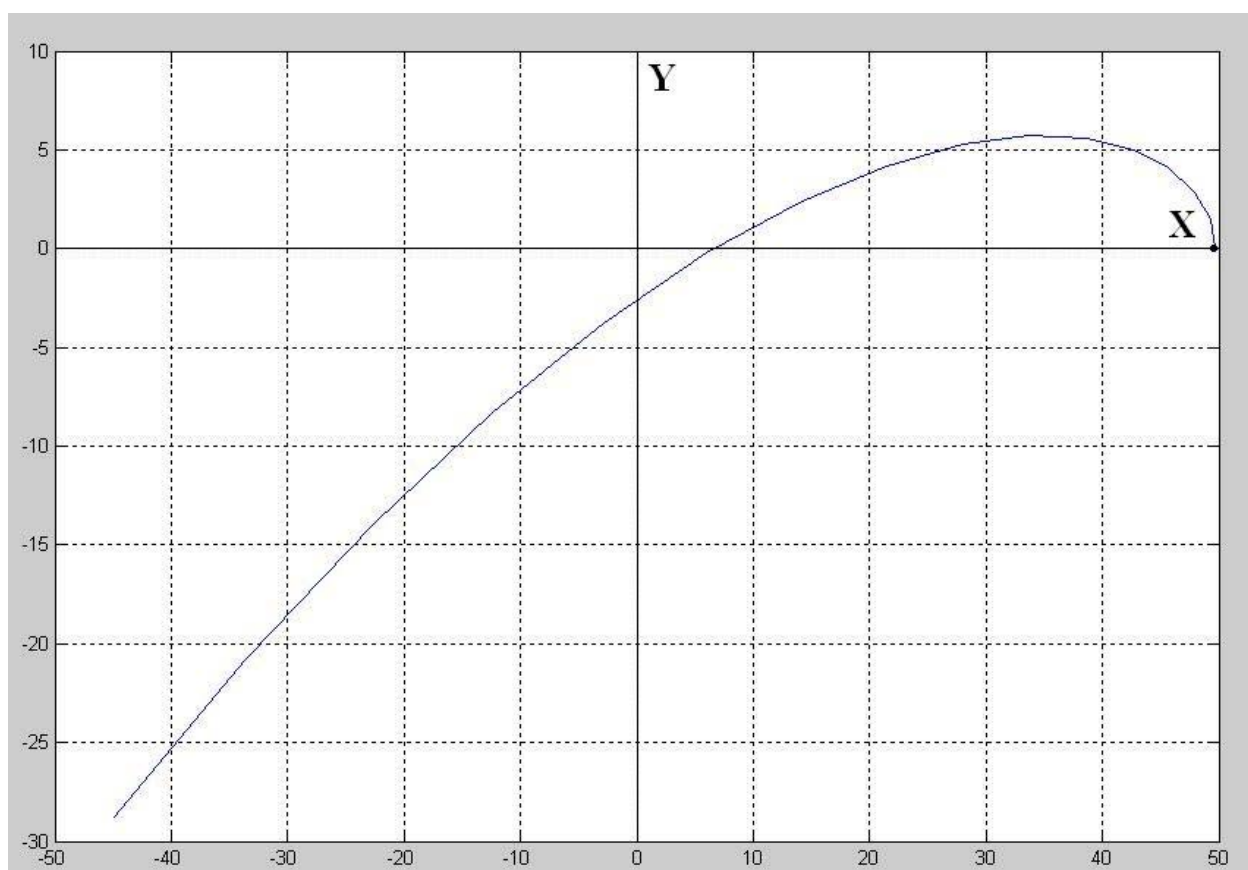
При $T_0 = 0.01$:

$$X = 0.0128 \cdot 0.01\omega^4 - (0.24 + 21 \cdot 0.01)\omega^2 + 49.743$$

$$Y = -(0.0128 + 0.24 \cdot 0.01)\omega^3 + (1 + 49.743 \cdot 0.01)\omega$$

Таблица значений:

ω	X	Y
0.0	49.74	0.00
1.0	49.29	1.48
2.0	47.95	2.87
3.0	45.70	4.08
4.0	42.58	5.02
5.0	38.57	5.59
6.0	33.71	5.70
7.0	28.00	5.27
8.0	21.47	4.20
9.0	14.13	2.40
10.0	6.02	-0.23
11.0	2.83	-3.76
12.0	-12.40	-8.30
13.0	-22.65	-13.93
14.0	-33.54	-20.74
15.0	-45.03	-28.84



Система неустойчива.

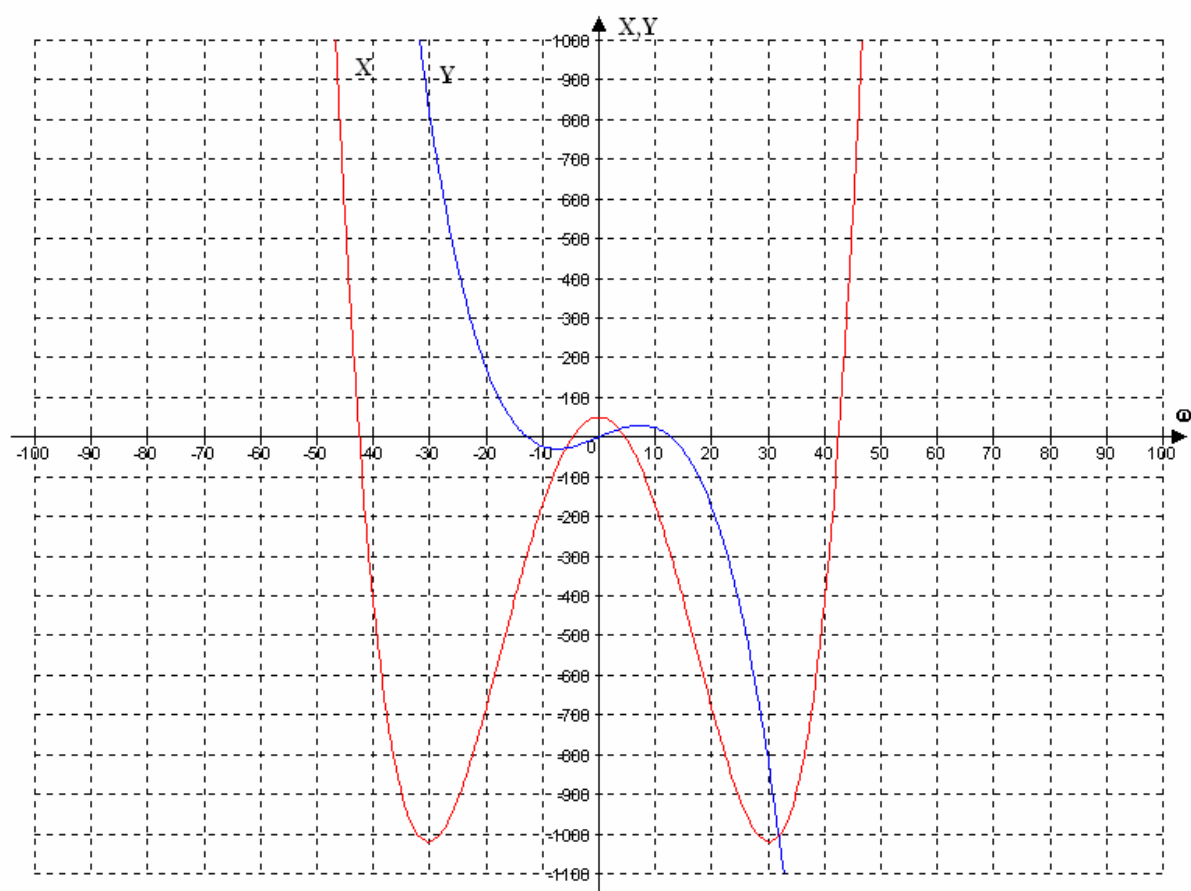
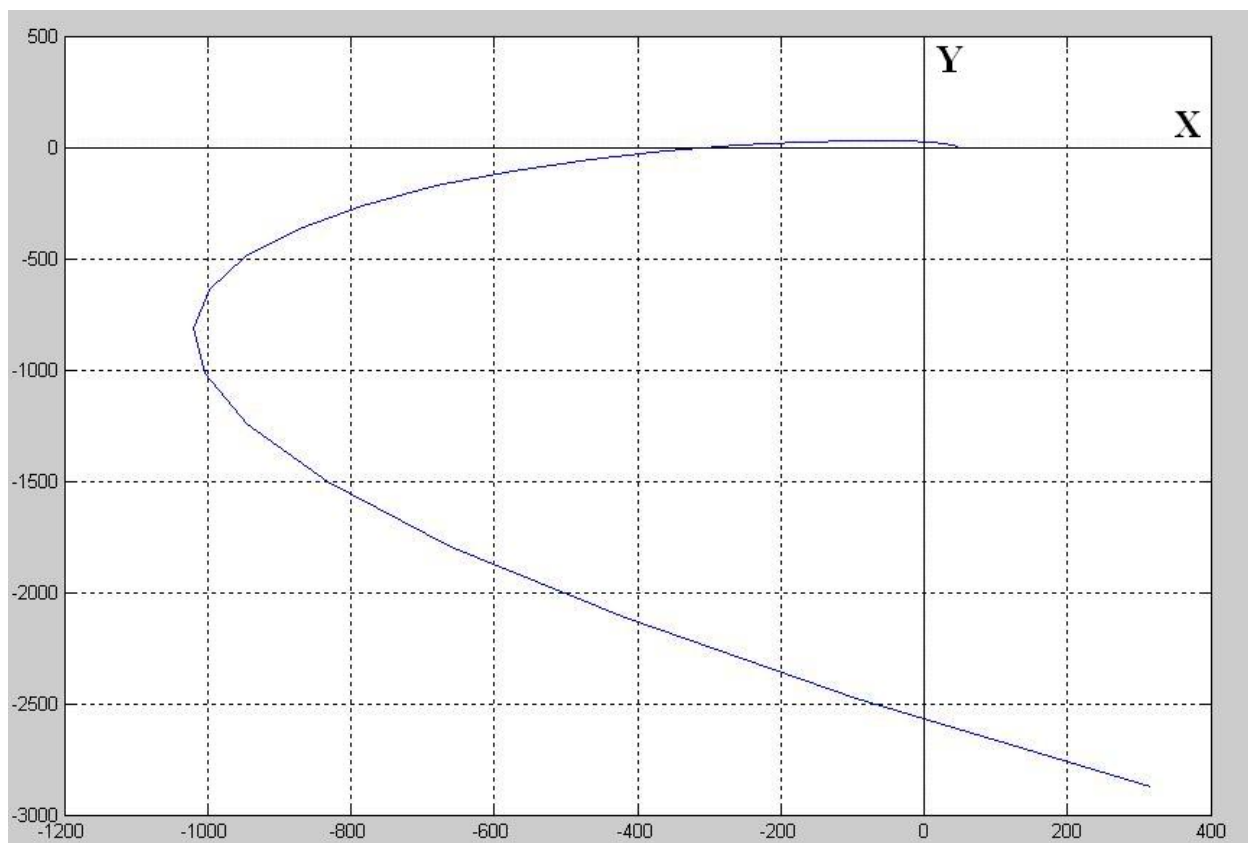
При $T_0 = 0.1$:

$$X = 0.0128 \cdot 0.1 \omega^4 - (0.24 + 21 \cdot 0.1) \omega^2 + 49.743$$

$$Y = -(0.0128 + 0.24 \cdot 0.1) \omega^3 + (1 + 49.743 \cdot 0.1) \omega$$

Таблица значений:

ω	X	Y
0.0	49.74	0.00
2.0	40.40	11.65
4.0	12.63	21.54
6.0	-32.84	27.90
8.0	-94.77	28.95
10.0	-171.46	22.94
12.0	-260.67	8.10
14.0	-359.72	-17.34
16.0	-465.41	-55.14
18.0	-574.05	-107.08
20.0	-681.46	-174.91
22.0	-782.97	-260.41
24.0	-873.42	-365.34
26.0	-947.17	-491.46
28.0	-998.06	-640.55
30.0	-1019.46	-814.37
32.0	-1004.24	-1014.68
34.0	-944.79	-1243.26
36.0	-832.99	-1501.87
38.0	-660.24	-1792.27
40.0	-417.46	-2116.23
42.0	-95.05	-2475.52
44.0	317.07	-2871.90



Система устойчива.

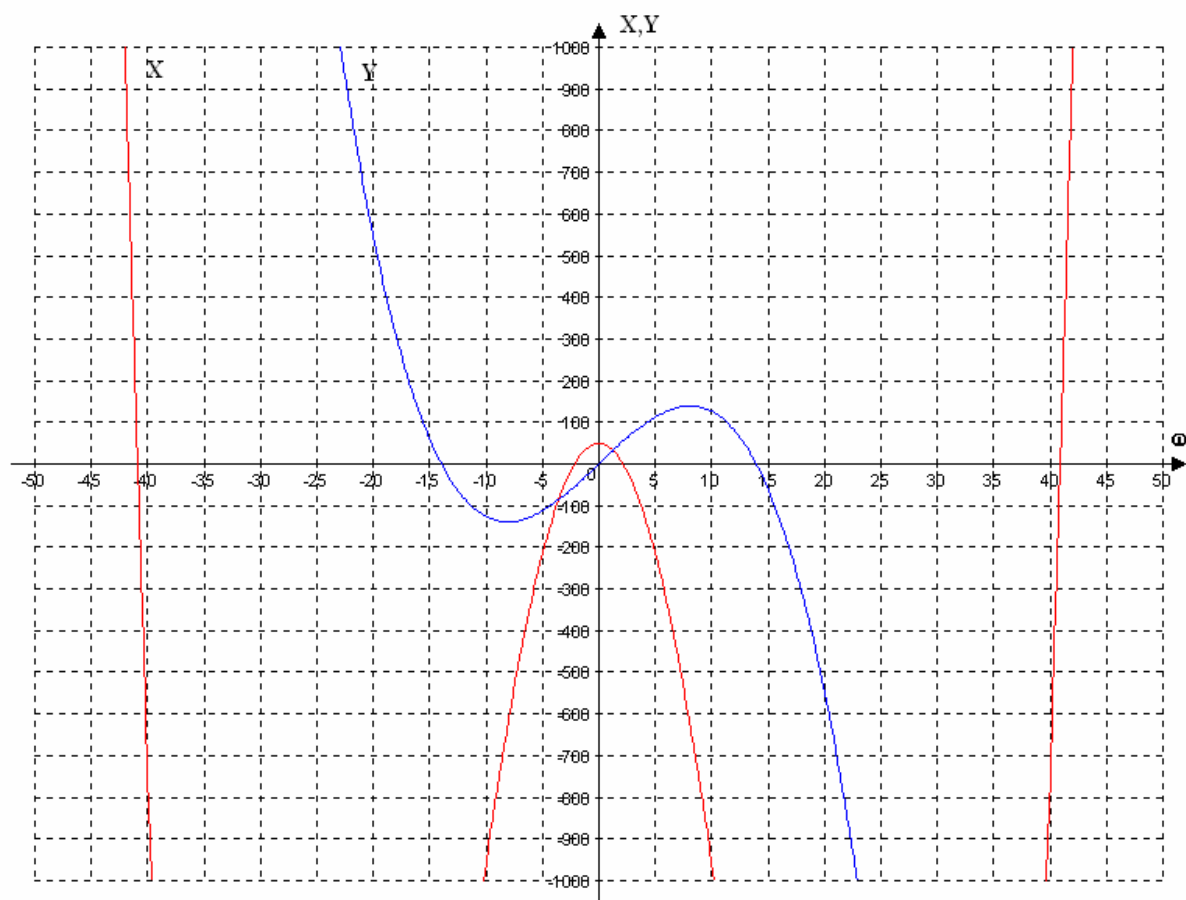
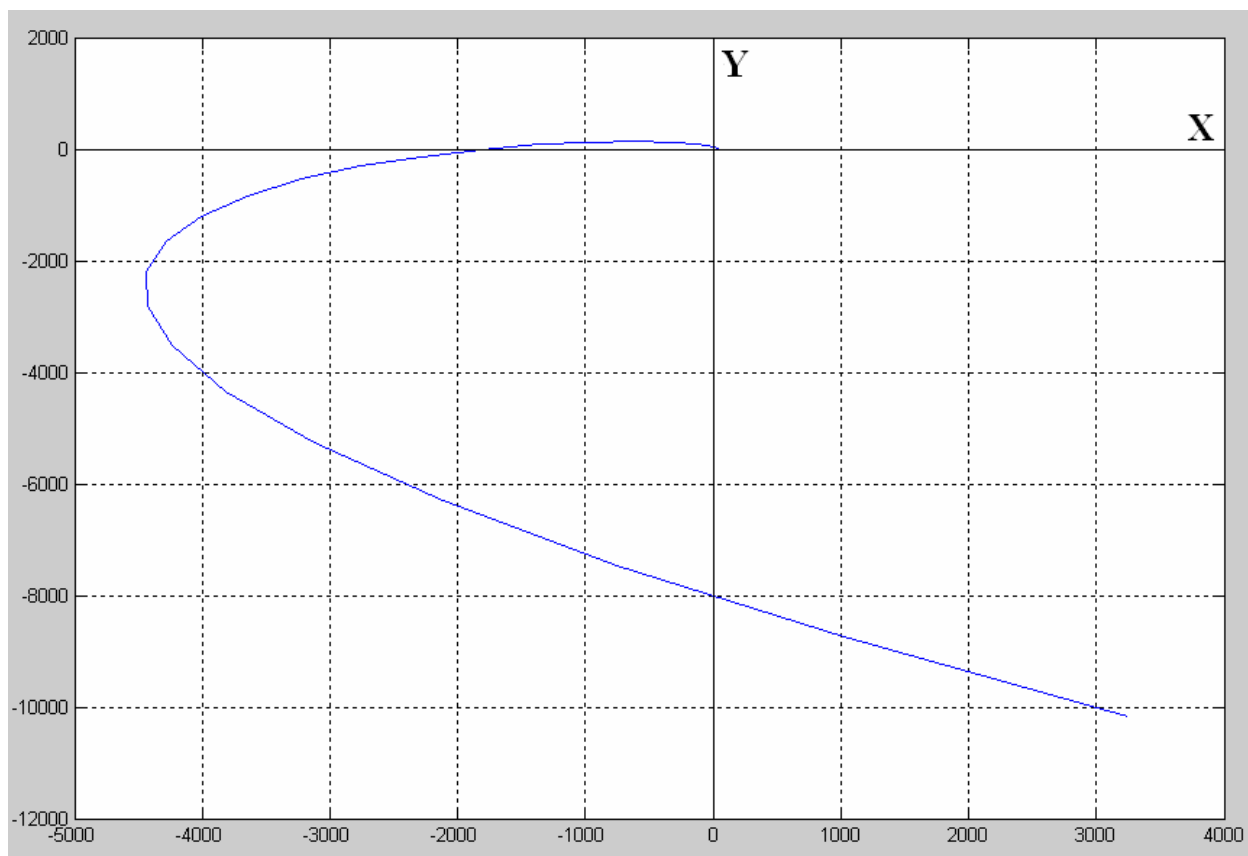
При $T_0 = 0.5$:

$$X = 0.0128 \cdot 0.5 \omega^4 - (0.24 + 21 \cdot 0.5) \omega^2 + 49.743$$

$$Y = -(0.0128 + 0.24 \cdot 0.5) \omega^3 + (1 + 49.743 \cdot 0.5) \omega$$

Таблица значений:

ω	X	Y
0.0	49.74	0.00
2.0	6.89	50.68
4.0	-120.46	94.99
6.0	-328.60	126.54
8.0	-611.40	138.98
10.0	-960.26	125.92
12.0	-1364.11	80.98
14.0	-1809.43	-2.20
16.0	-2280.27	-130.00
18.0	-2758.17	-308.80
20.0	-3222.26	-544.97
22.0	-3649.18	-844.88
24.0	-4013.13	-1214.91
26.0	-4285.85	-1661.43
28.0	-4436.62	-2190.82
30.0	-4432.26	-2809.45
32.0	-4237.13	-3523.70
34.0	-3813.15	-4339.94
36.0	-3119.75	-5264.54
38.0	-2113.95	-6303.88
40.0	-750.26	-7464.34
42.0	1019.24	-8752.28
44.0	3244.92	-10174.09



Система устойчива.