

Systems of Ordinary Differential Equations > Linear Systems of Three and More Equations

2.
$$x'_t = cy - bz$$
, $y'_t = az - cx$, $z'_t = bx - ay$.

1°. First integrals:

$$ax + by + cz = A, (1)$$

$$x^2 + y^2 + z^2 = B^2, (2)$$

where A and B are arbitrary constants. It follows from these integrals that the integral lines are circles formed by the intersection of the planes (1) and spheres (2).

2°. Solution:

$$x = aC_0 + kC_1 \cos(kt) + (cC_2 - bC_3) \sin(kt),$$

$$y = bC_0 + kC_2 \cos(kt) + (aC_3 - cC_1) \sin(kt),$$

$$z = cC_0 + kC_3 \cos(kt) + (bC_1 - aC_2) \sin(kt),$$

where $k = \sqrt{a^2 + b^2 + c^2}$ and the four constants of integration, C_1, \dots, C_4 , are constrained by a single relation,

$$aC_1 + bC_2 + cC_3 = 0.$$

Reference

Kamke, E., Differentialgleichungen: Lösungsmethoden und Lösungen, I, Gewöhnliche Differentialgleichungen, B. G. Teubner, Leipzig, 1977.

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http://eqworld.ipmnet.ru/en/solutions/sysode/sode0202.pdf