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Existence and uniqueness of periodic solutions of a certain functional differential equation

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We prove the existence and uniqueness of periodic solutions of a first order differential equation

$$x'(t) = f(x(t)) + x(\lfloor t \rfloor)g(t - \lfloor t \rfloor), \quad t \geq 0$$

that contains a piecewise constant term. Such equations admit periodic solutions and hence they can be used for numerical modelling of temperature changes in a space surrounded by environment with different temperature. For some types of functional equations, it is possible to use the comparison principle method of differential equations to obtain existence, uniqueness, and asymptotic stability results.

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