BIFURCATIONS OBSERVED IN BVP OSCILLATOR WITH PERIODICALLY SWITCHED RC CIRCUIT

Takuji Kousaka¹, Ken’ichi Fujimoto², Yue Ma³, Hiroyuki Kitajima⁴, Tetsushi Ueta⁵, Hiroshi Kawakami⁶
¹Department of Mechanical and Energy Systems Engineering
Oita University, Oita, 700 Dannoharu, Oita 870-1192, Japan
²Institute of Health Biosciences
The University of Tokushima, 3-18-15 Kuramoto-cho, Tokushima 770-8509, Japan
³Spatio-temporal Order Project (JST)
Department of Physics, Graduate School of Science,
Kyoto University, Kitashirakawa Oiwake-cho, Kyoto 606-8502, Japan
⁴Department of Reliability-based Information Systems Engineering
Kagawa University, 2217-20 Hayashi-cho, Takamatsu, Kagawa 761-0396, Japan
⁵Center for advanced information technology,
The University of Tokushima, 2-1 Minamijosanjima, Tokushima, 770-8506, Japan
⁶The University of Tokushima, 2-24, Shinkura, Tokushima 770-8501, Japan

Abstract. Many works have been devoted to the study of the behavior of the Bonhoeffer-van der Pol (BVP) oscillator in physiological and biochemical modeling studies. In this paper, bifurcations and chaos in BVP oscillator, which is intermittently connected to a parallel RC load, are investigated. By using the periodicity of switching action we introduce a composite discrete map as the Poincaré map that is useful for the analysis of piecewise nonlinear systems. Adjusting the switching period close to the integral multiple of the period of self-oscillation, we find various synchronizations. In particular, the fundamental synchronization is discussed. Under the appropriate switching ratios, we illustrate that the synchronized state bifurcates to chaotic states by the period doubling cascades or the torus breaking down.

Keywords. nonlinear circuit, periodic switch, composite Poincaré map, chaos, bifurcation.

AMS (MOS) subject classification: 34A36

Notation

\( G_m^k \): Saddle-node bifurcation of period-\( m \) orbit
\( P_m^k \): Period-doubling bifurcation of period-\( m \) orbit
\( N_m^k \): Neimark-Sacker bifurcation of period-\( m \) orbit
where \( k \) is the index.