



FIG. 2 Results of the reactivation case. Solid lines are the response values, dashed lines are the thresholds for viral load (3.5 Copies/ μL -blood) and serum creatinine concentration (1.2 mg/dL) and a dotted dashed line is the desired value of $E_K(t)$. Left graphs show the concentrations of susceptible cells, viruses and allospecific CD8^+ T cells that target kidney, respectively (from top to bottom). Right graphs represent the concentrations of infected cells, HCMV-specific CD8^+ T cells and serum creatinine for the reactivation case, respectively, from top to bottom.

cases with a 30% reduction of δ_{EK} and crossed the threshold (3.5 Copies/ μL -blood) in three different periods of the treatment that could cause deleterious repercussions for the human health. Furthermore, the control signal undergoes some changes in its magnitude in which the 30% reduction of δ_{EK} in the reactivation case makes the control signal to start from the value of 1.1. This is in contrast with the assumption of normalized control input that should be between 0 and 1. Thus, the precise calculation of δ_{EK} should be considered as a priority of the HCMV modeling.

Figs. 7 and 8 present the response sensitivity by 10% variation in λ_C . Based on Eq. (9), it is reasonable that a small change in the magnitude of λ_C will result in noticeable changes in the system's response, as seen in Fig. 7 and Fig. 8. Susceptible cells had approximately small variations in this sensitivity analysis on λ_{EK} and δ_{EK} as shown in Figs. 5 and 6. While the final concentration

of these cells experienced a 40% reduction for 10% increment in λ_C but a negligible 8% change by 10% reduction in λ_C for both primary and reactivation infections compared to the original condition (Fig. 7). As observed in Fig. 7, infected cells and virions also experienced a wide range of changes such that the maximum values they reached in 10% increment analysis were about five times more than their maximum values obtained in a 30% increment and 30% reduction analysis in Figs. 5 and 6 for λ_{EK} and δ_{EK} , respectively. Moreover, a 10% decrease in λ_C resulted in very small variations in the concentration of infected cells and virions. In Fig. 8, small changes are seen in the tracking error (with the order of 10^{-3}) and about 25%–30% changes in the final value of the control signal compared to the result obtained in the original condition. Other important variables (the concentrations of serum creatinine (C) and kidney allospecific CD8^+ T cells (E_K)) did