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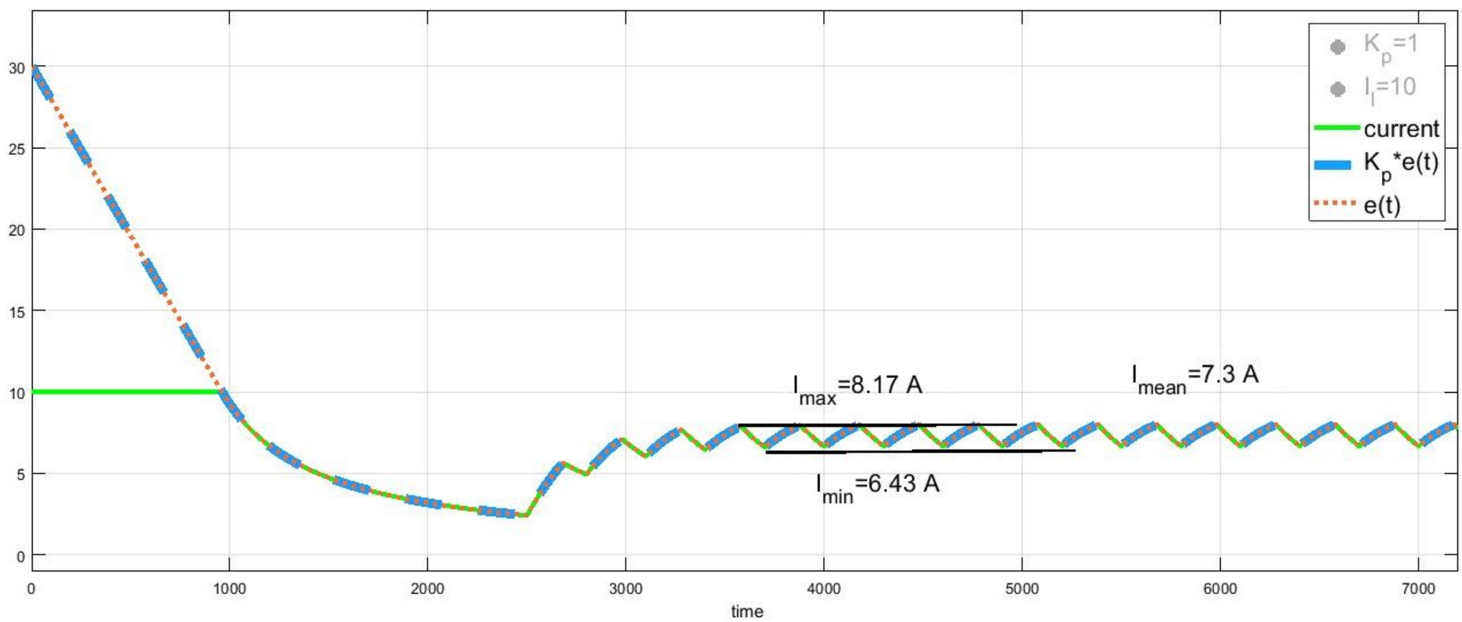
Assignment 5
Water Heater Model using Proportional controller

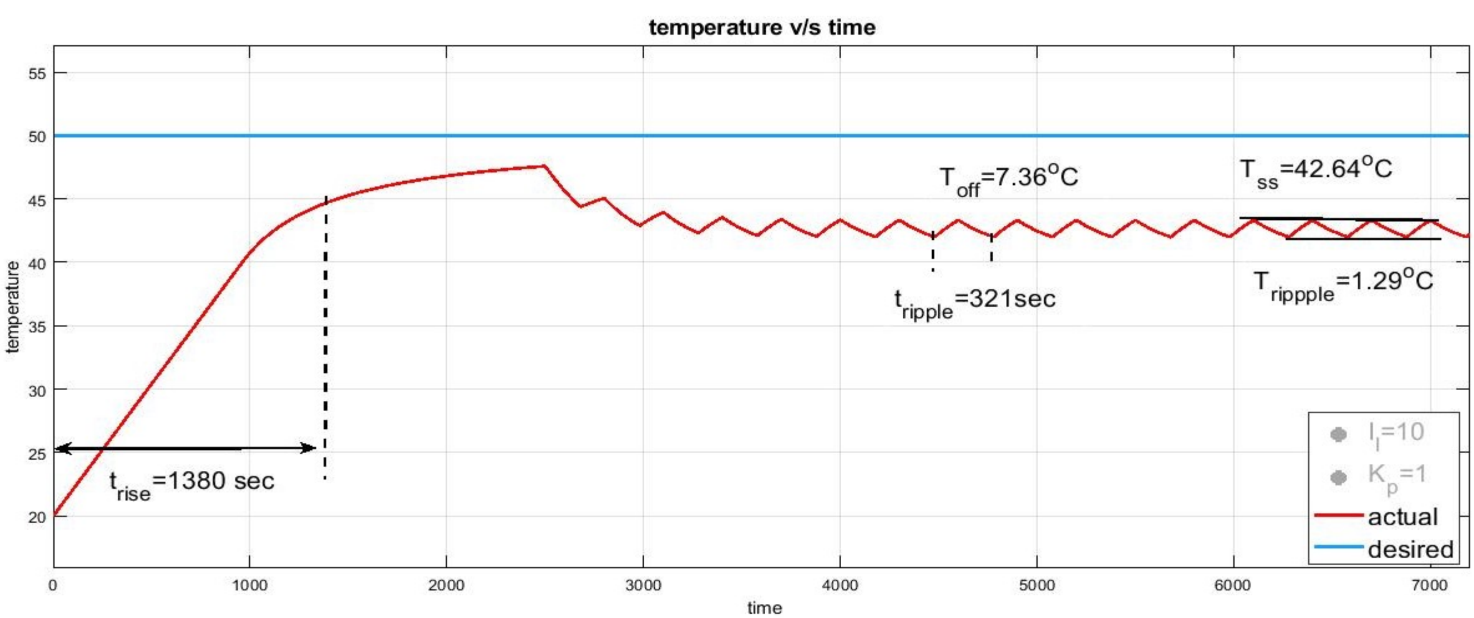
April 17, 2021

1 $I_l = 10A$

1.1 $K_p = 1$

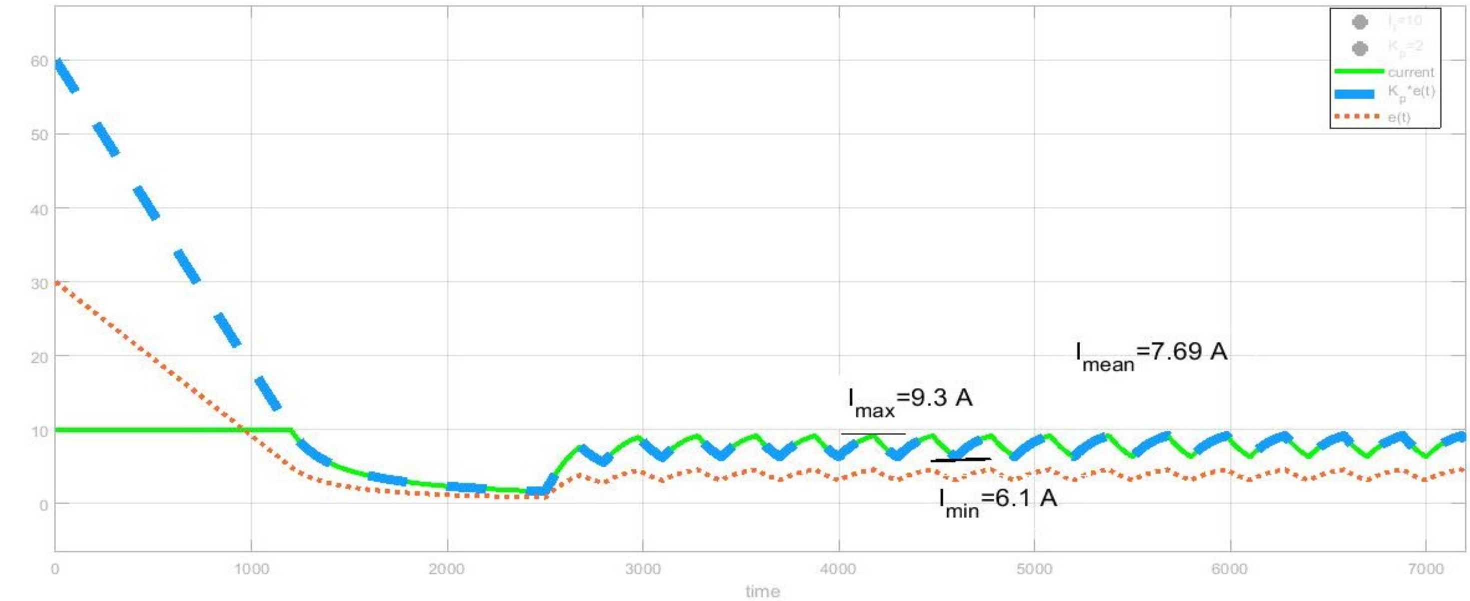


(a) current v/s time

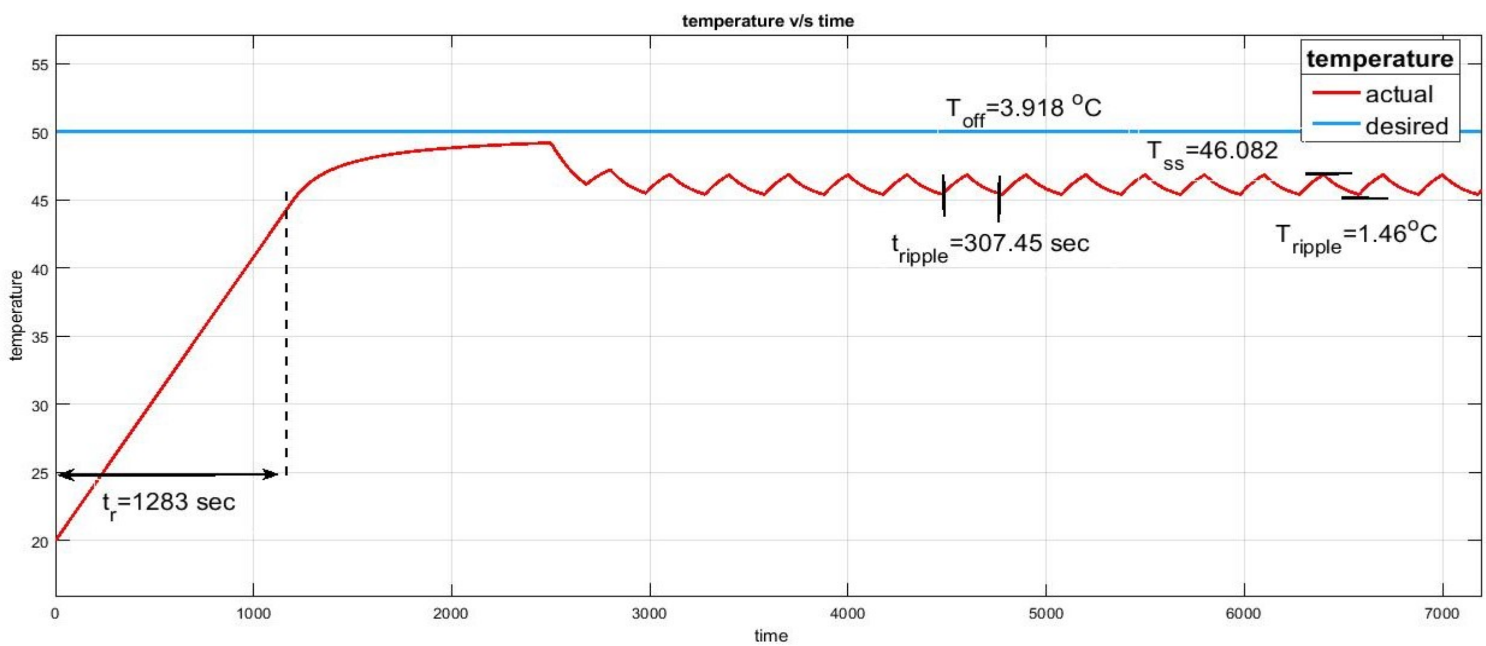


(b) temperature v/s time

1.2 $K_p = 2$

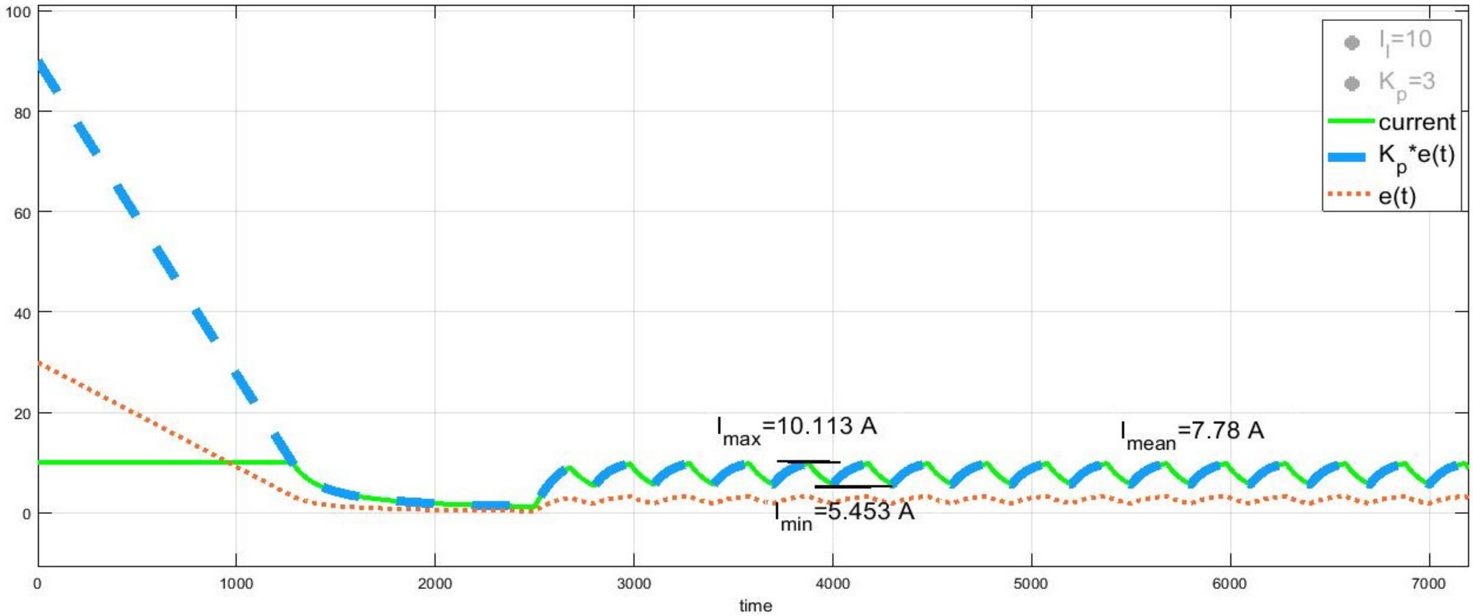


(a) current v/s time

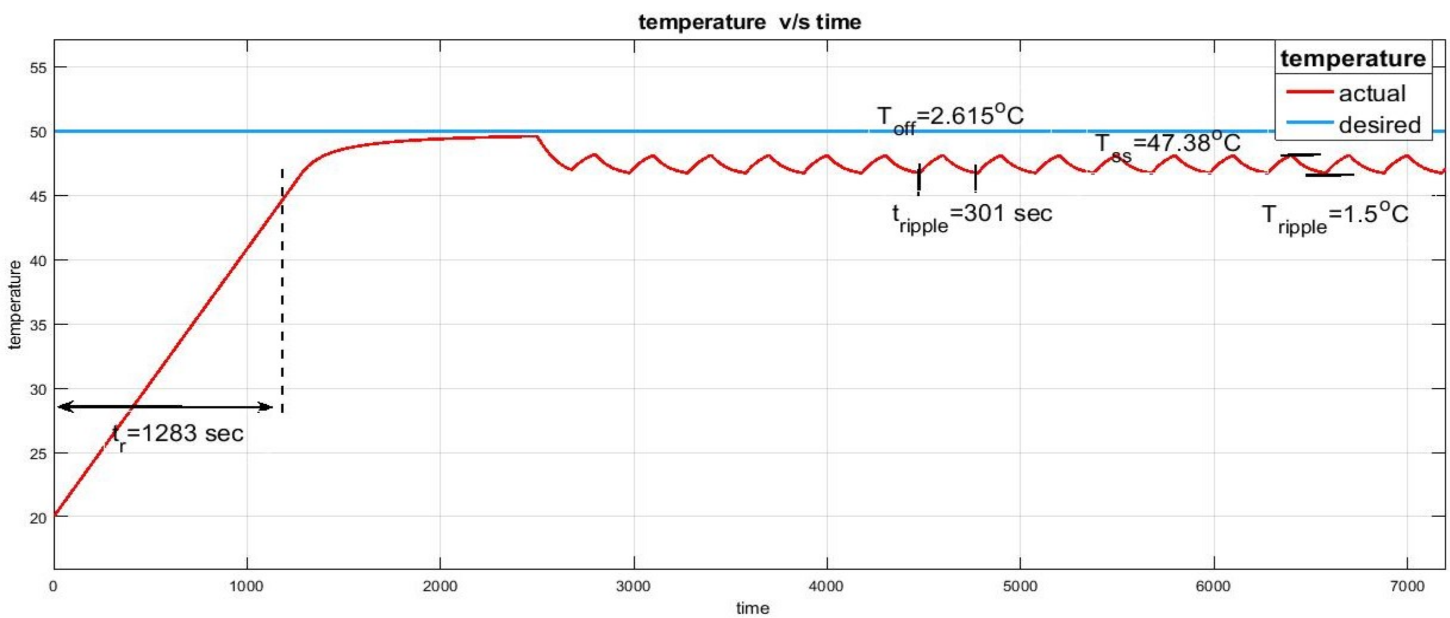


(b) temperature v/s time

1.3 $K_p = 3$

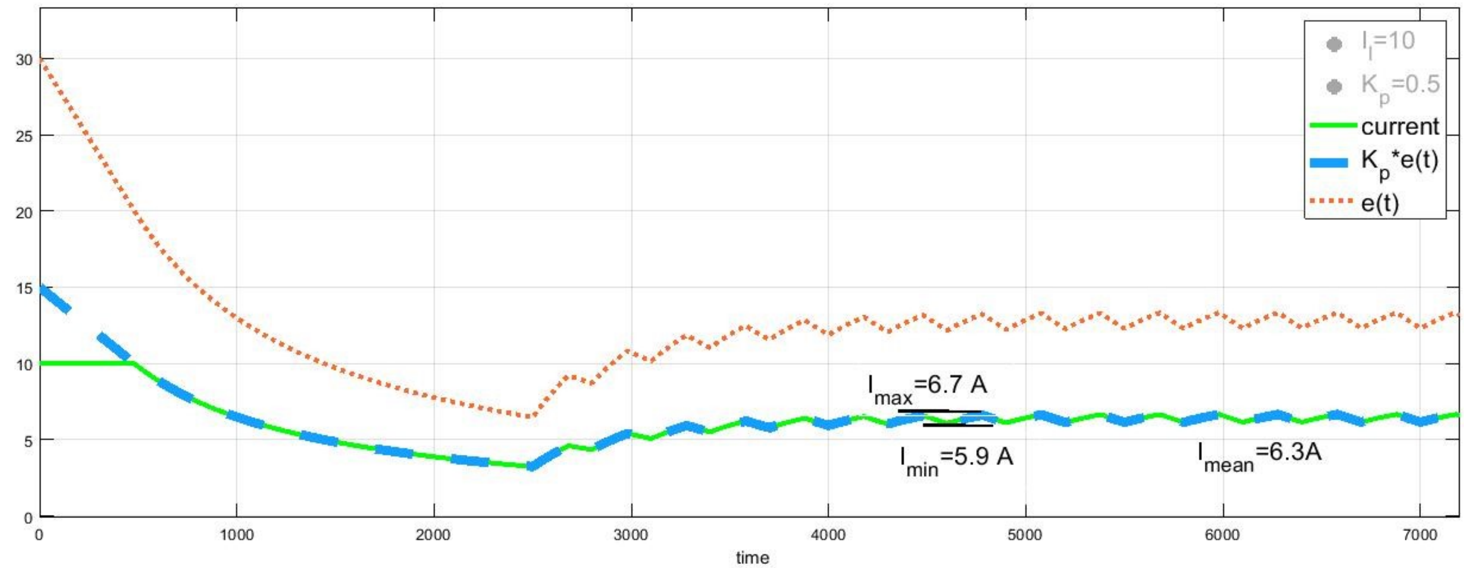


(a) current v/s time

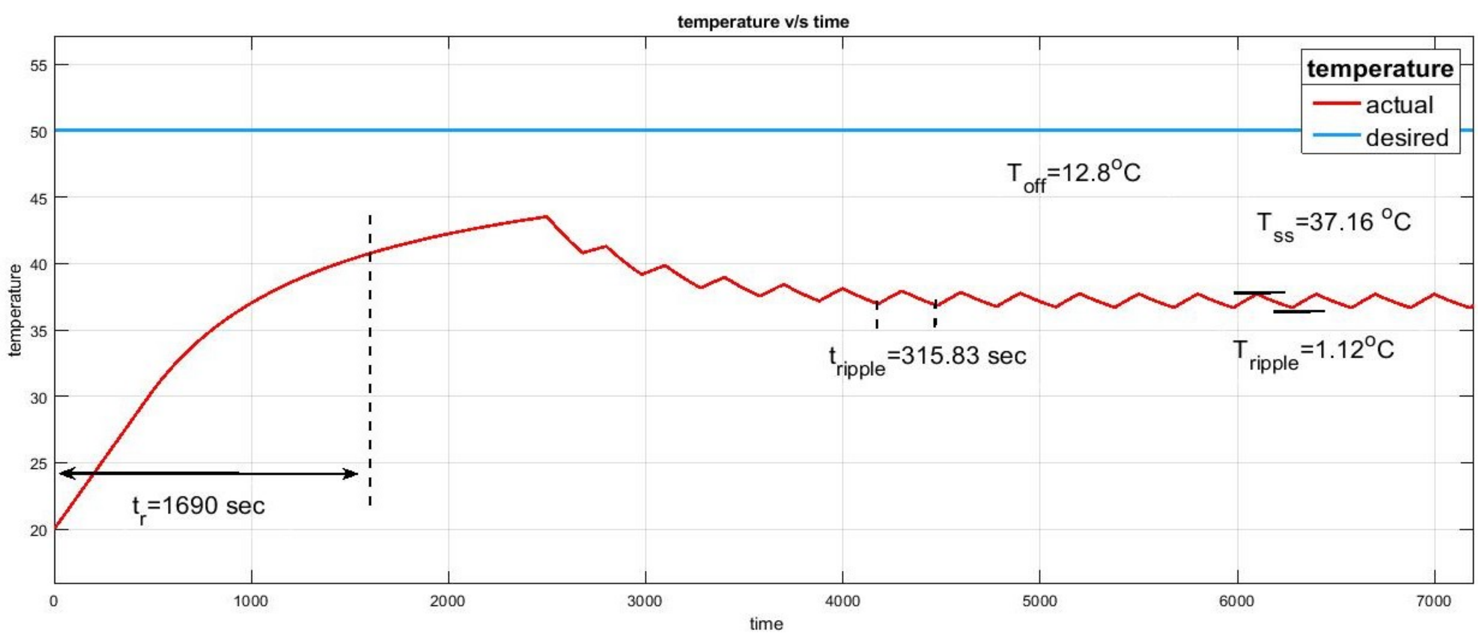


(b) temperature v/s time

1.4 $K_p = 0.5$

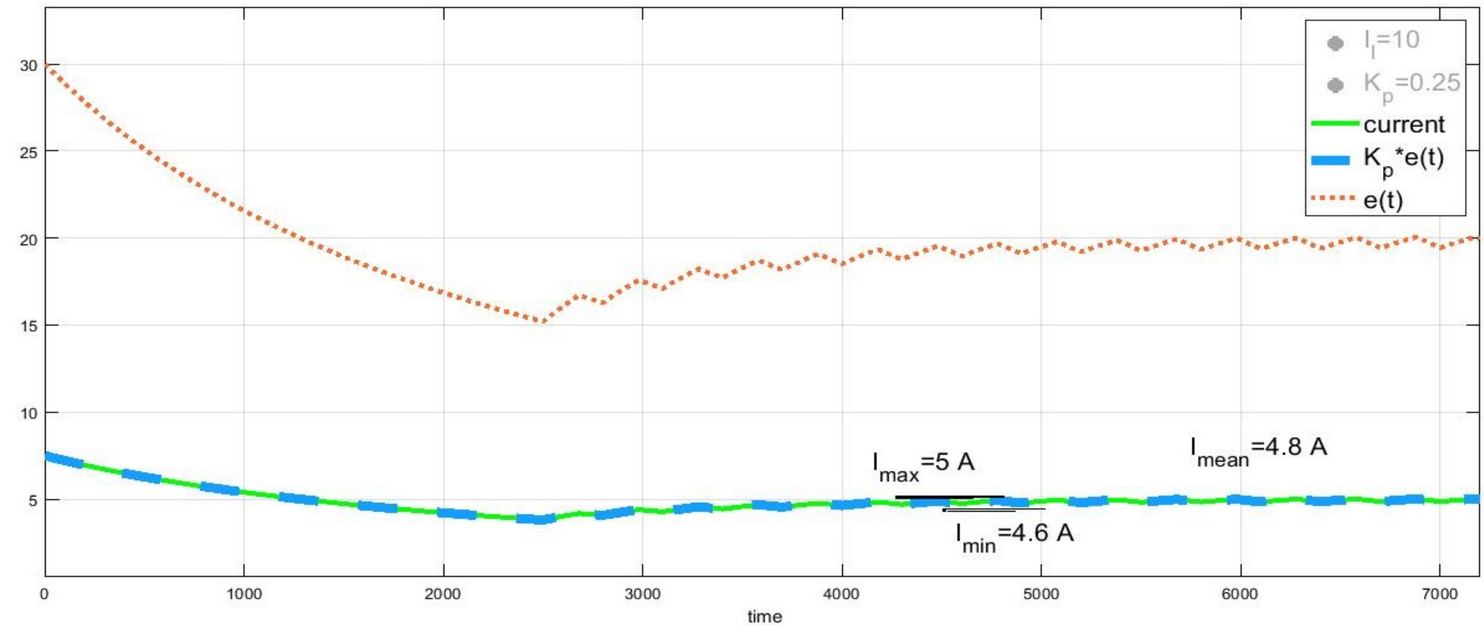


(a) current v/s time

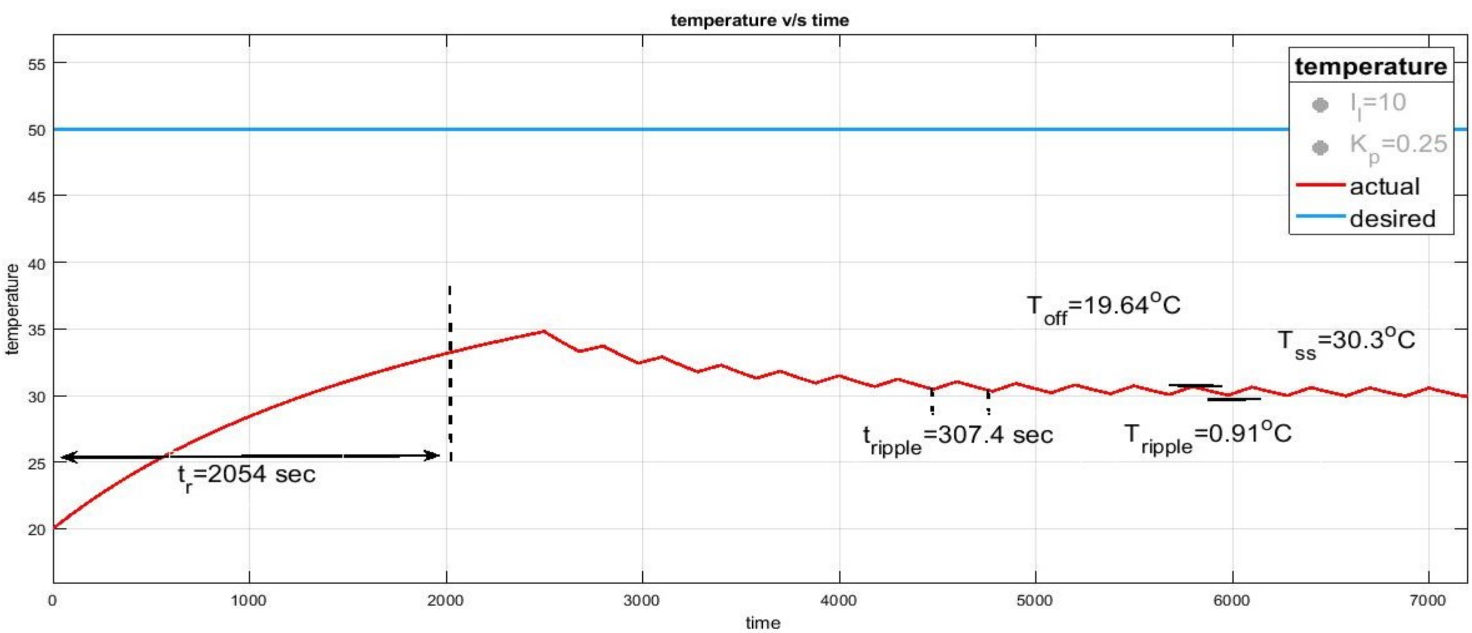


(b) temperature v/s time

1.5 $K_p = 0.25$, $Peakcurrent = 5A$



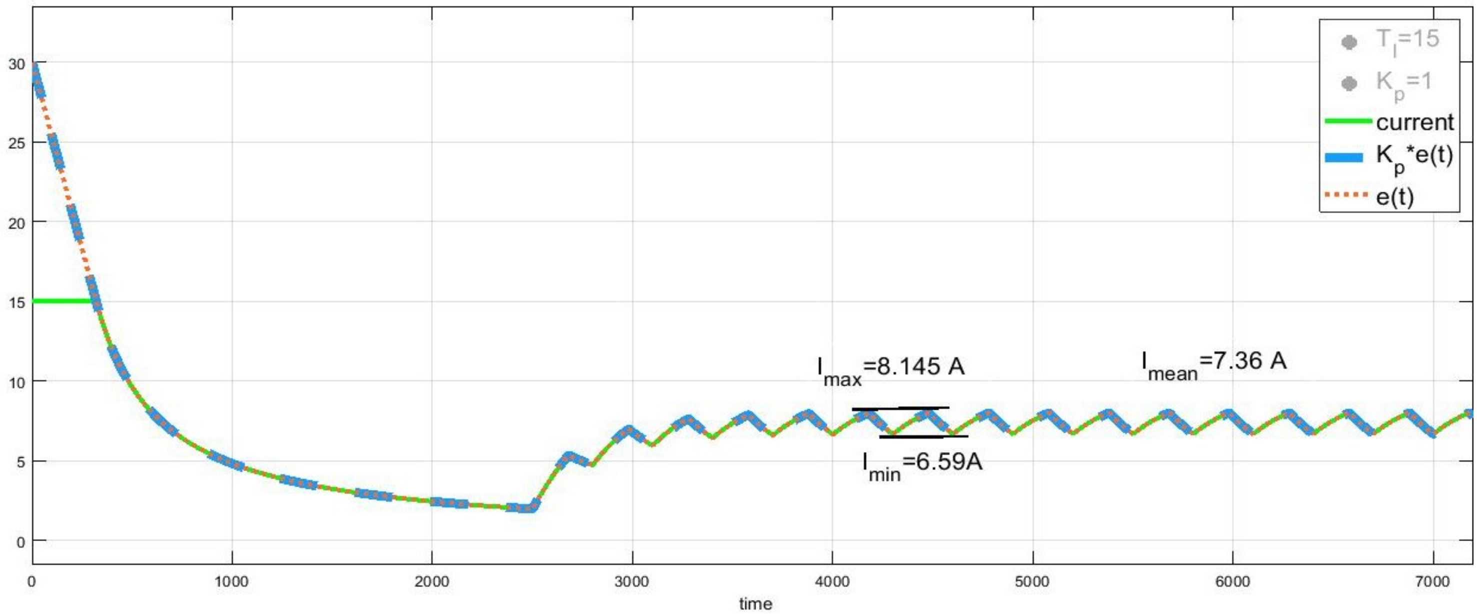
(a) current v/s time



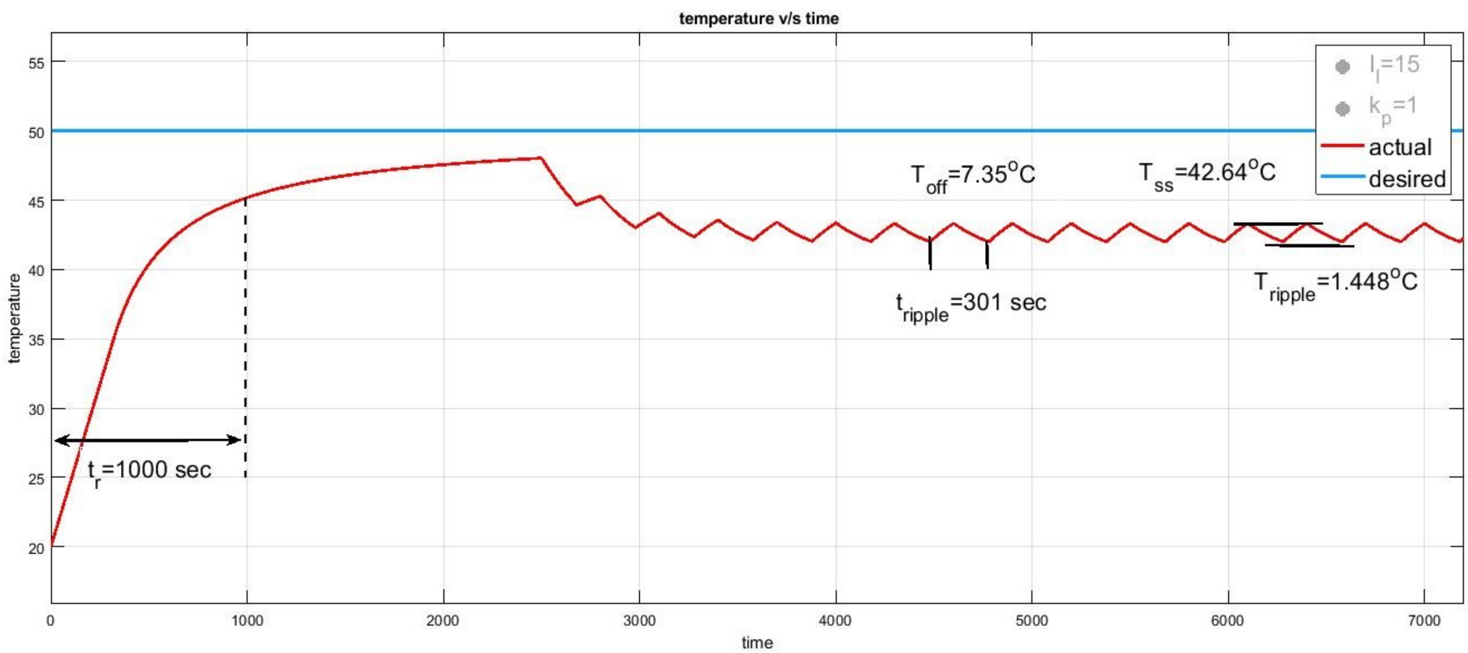
(b) temperature v/s time

2 $I_l = 15A$

2.1 $K_p = 1$

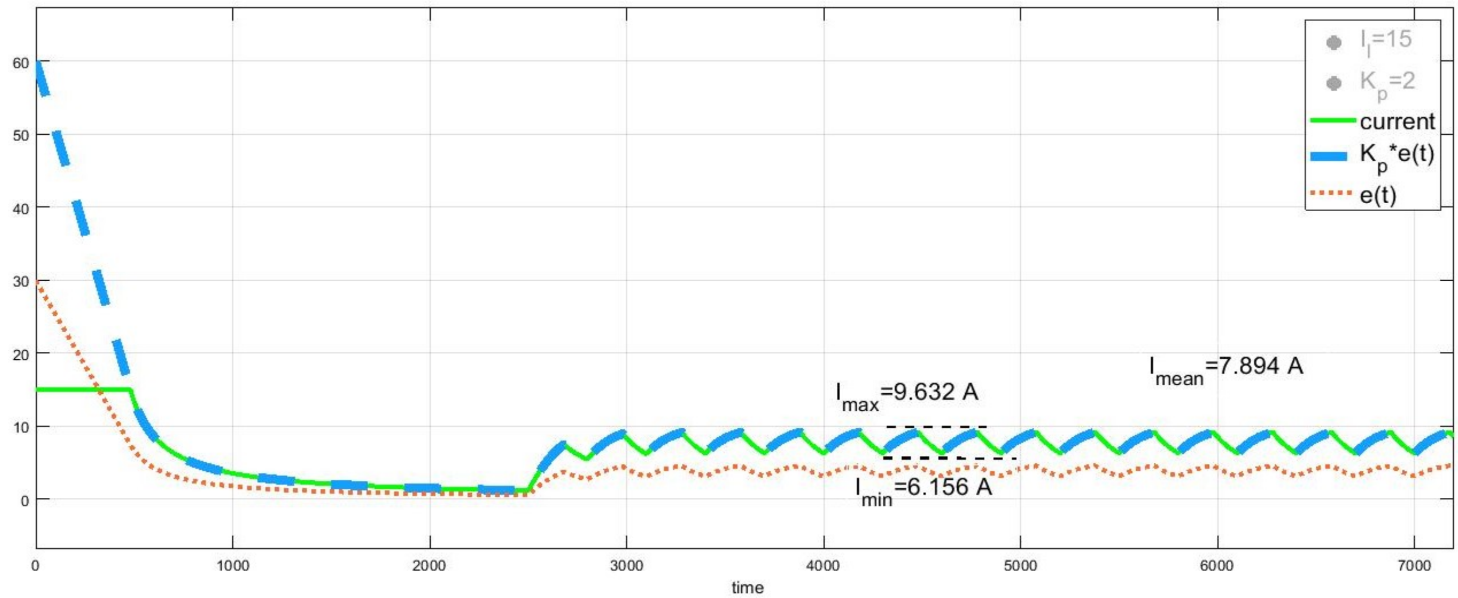


(a) current v/s time

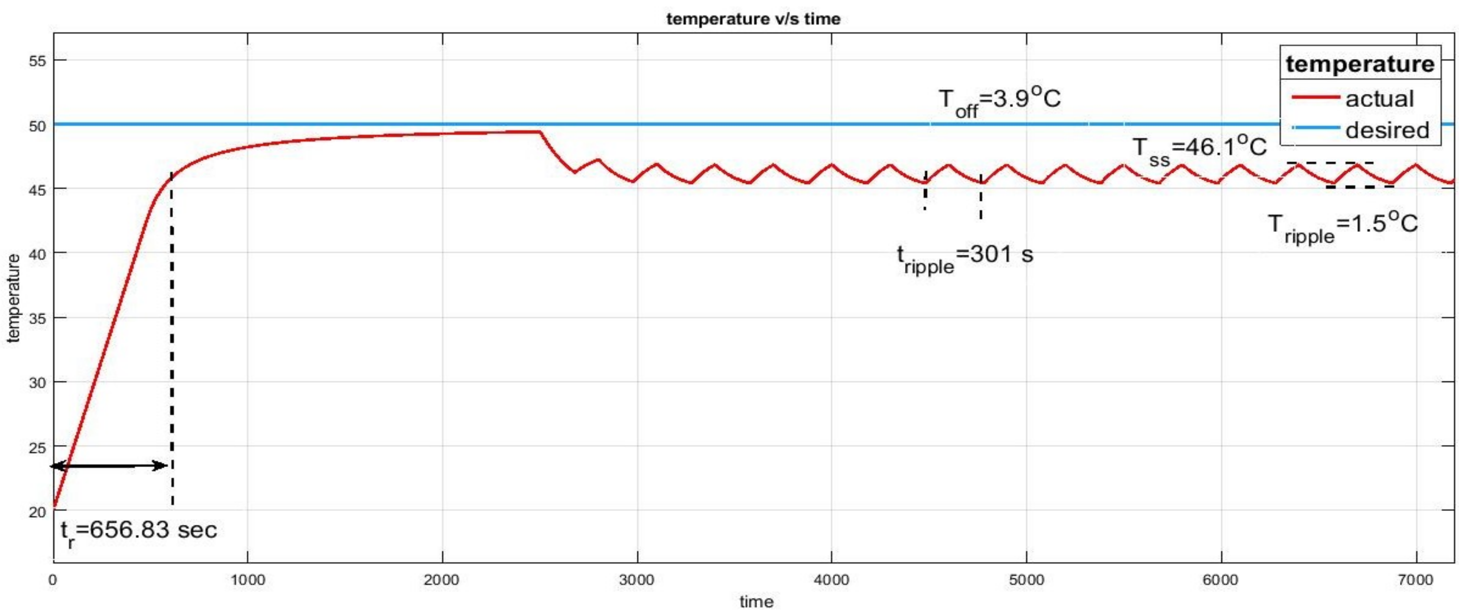


(b) temperature v/s time

2.2 $K_p = 2$

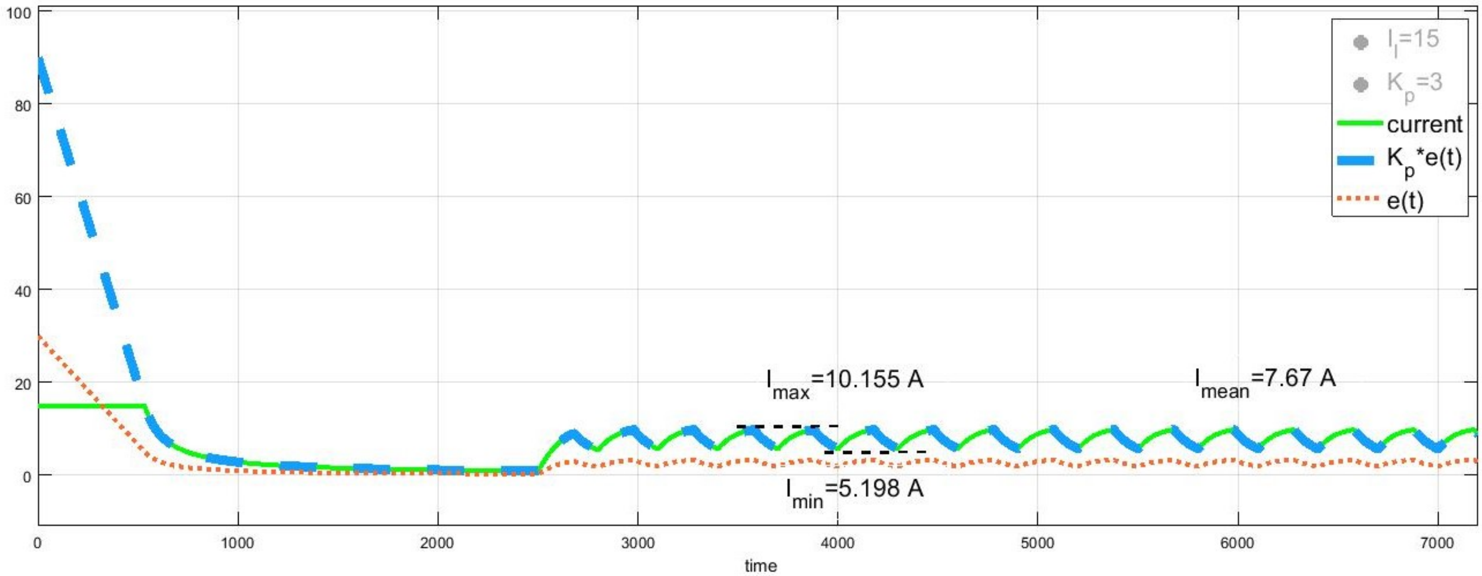


(a) current v/s time

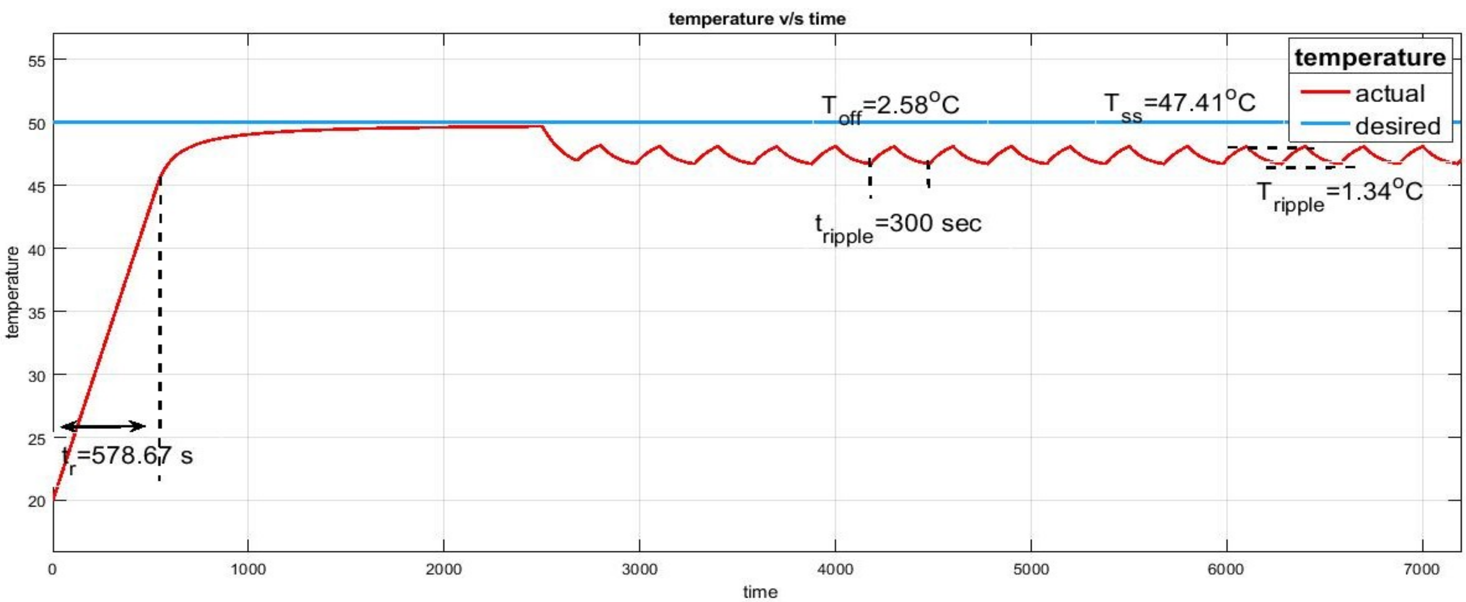


(b) temperature v/s time

2.3 $K_p = 3$

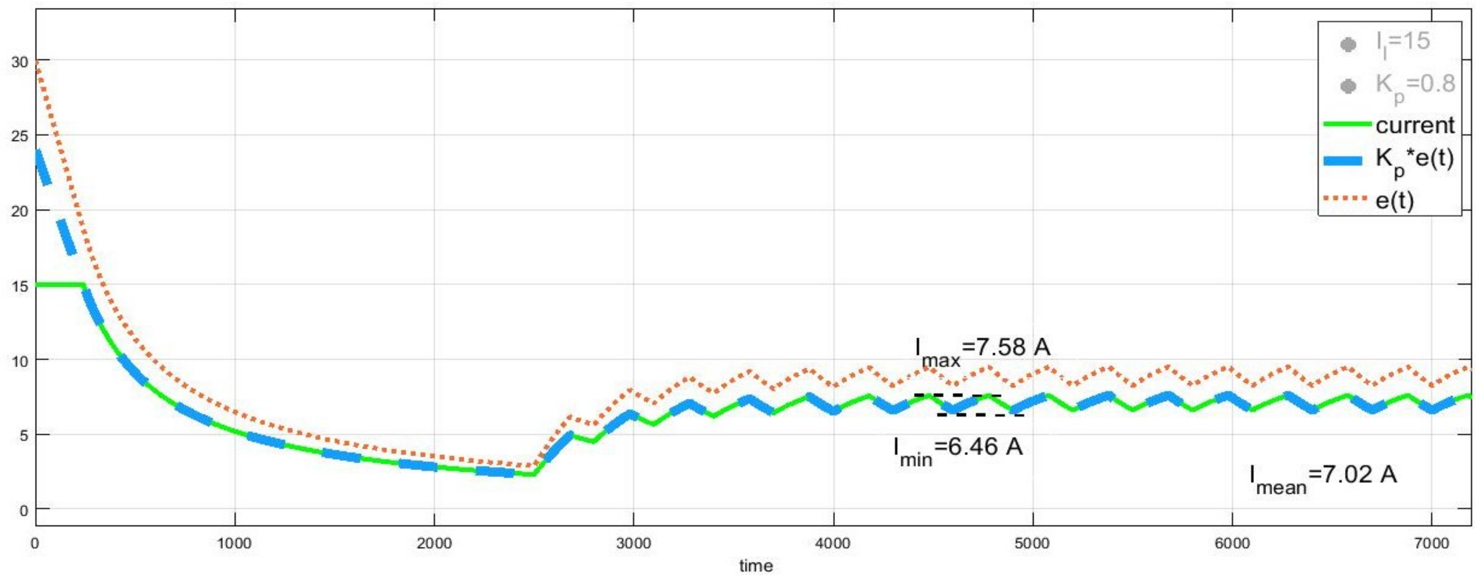


(a) current v/s time

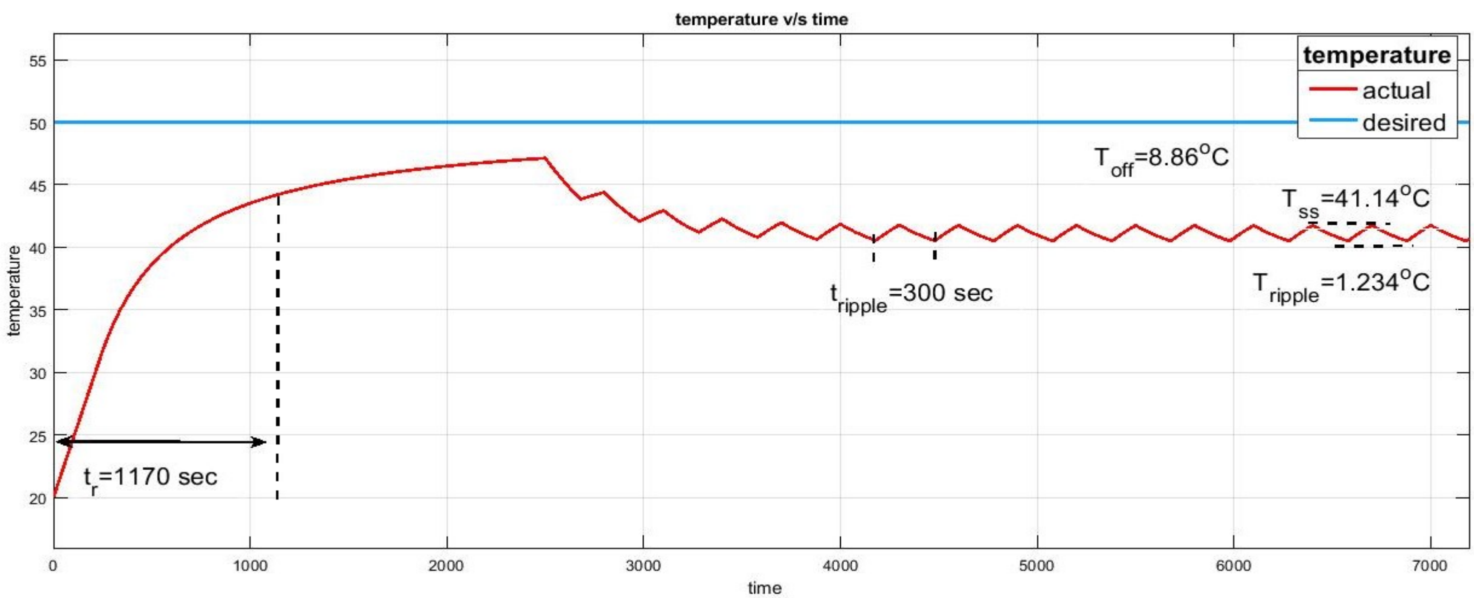


(b) temperature v/s time

2.4 $K_p = 0.8$, $Peakcurrent = 7.5A$



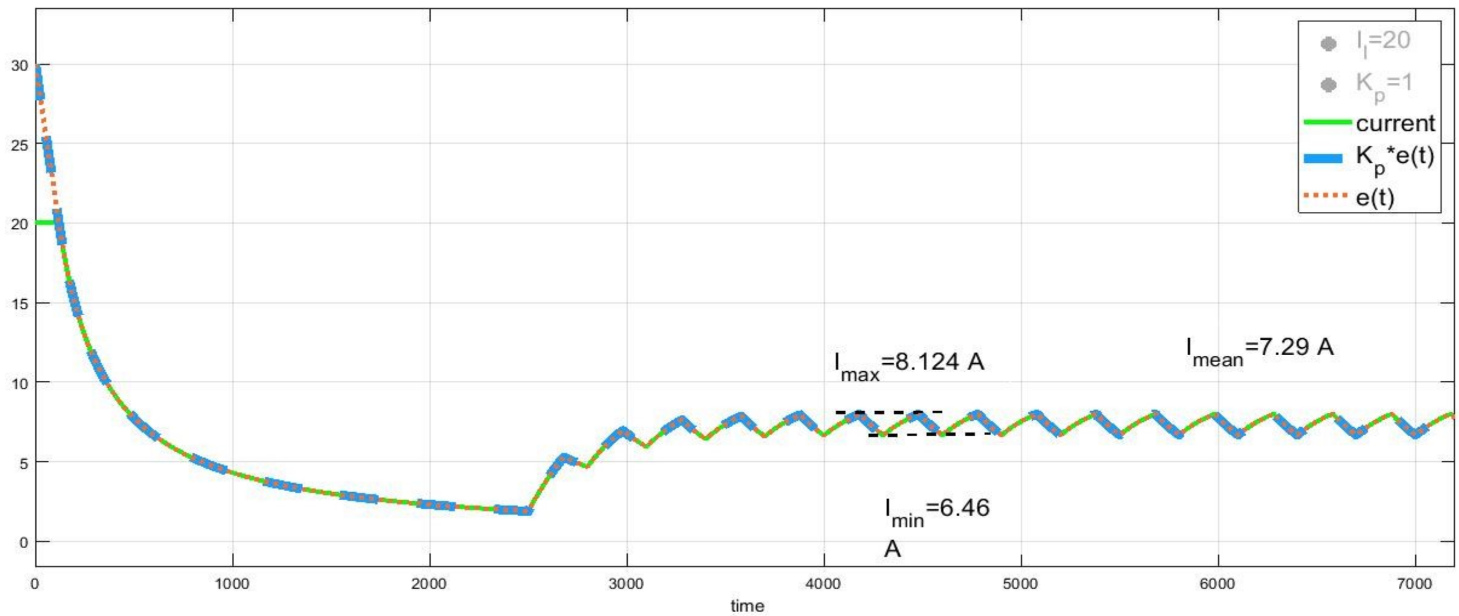
(a) current v/s time



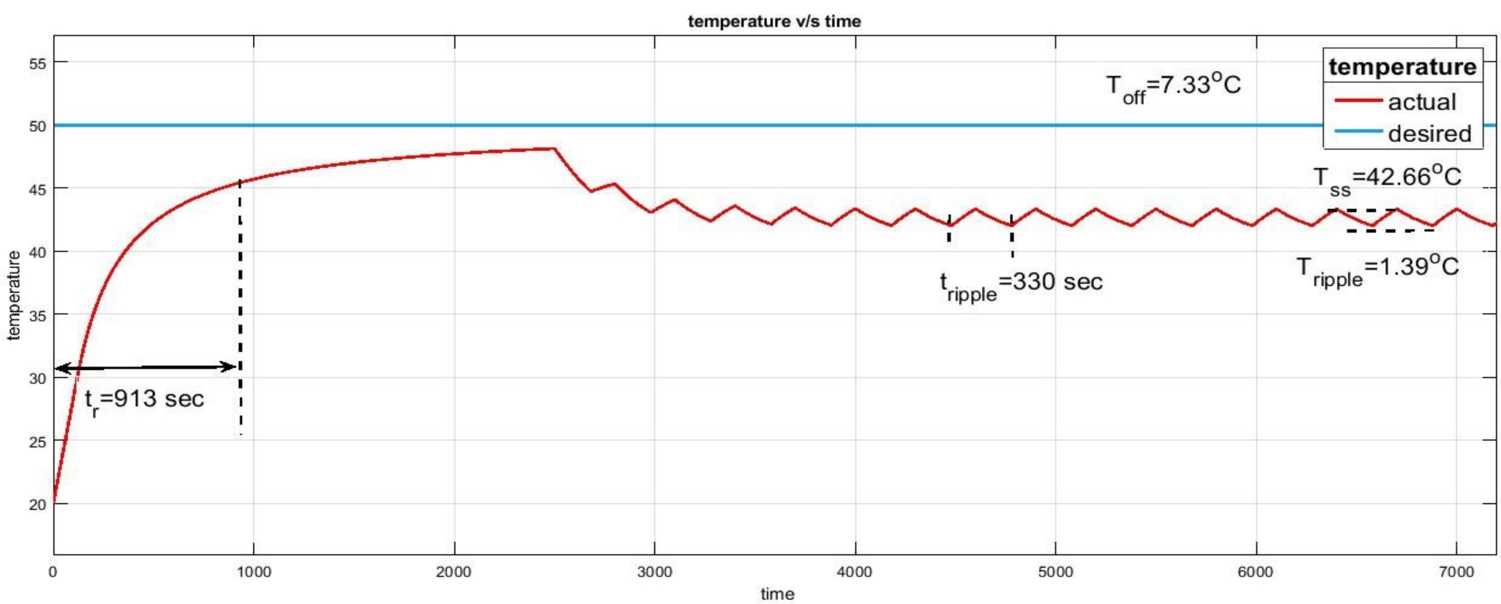
(b) temperature v/s time

3 $I_l = 20A$

3.1 $K_p = 1$

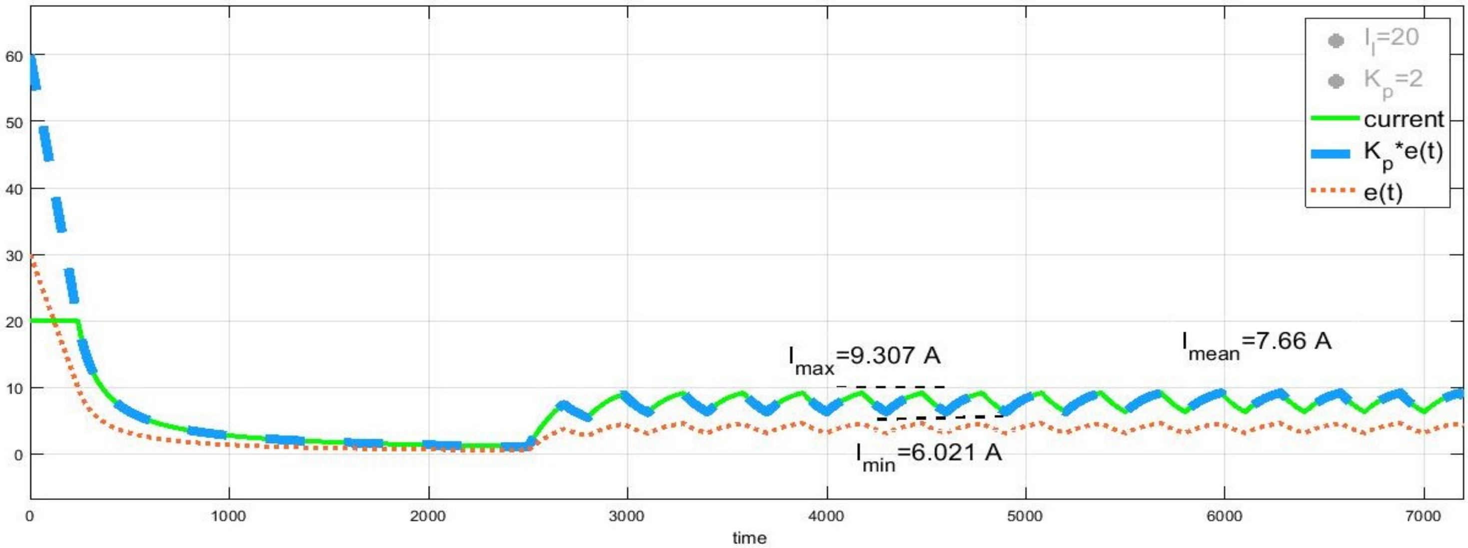


(a) current v/s time

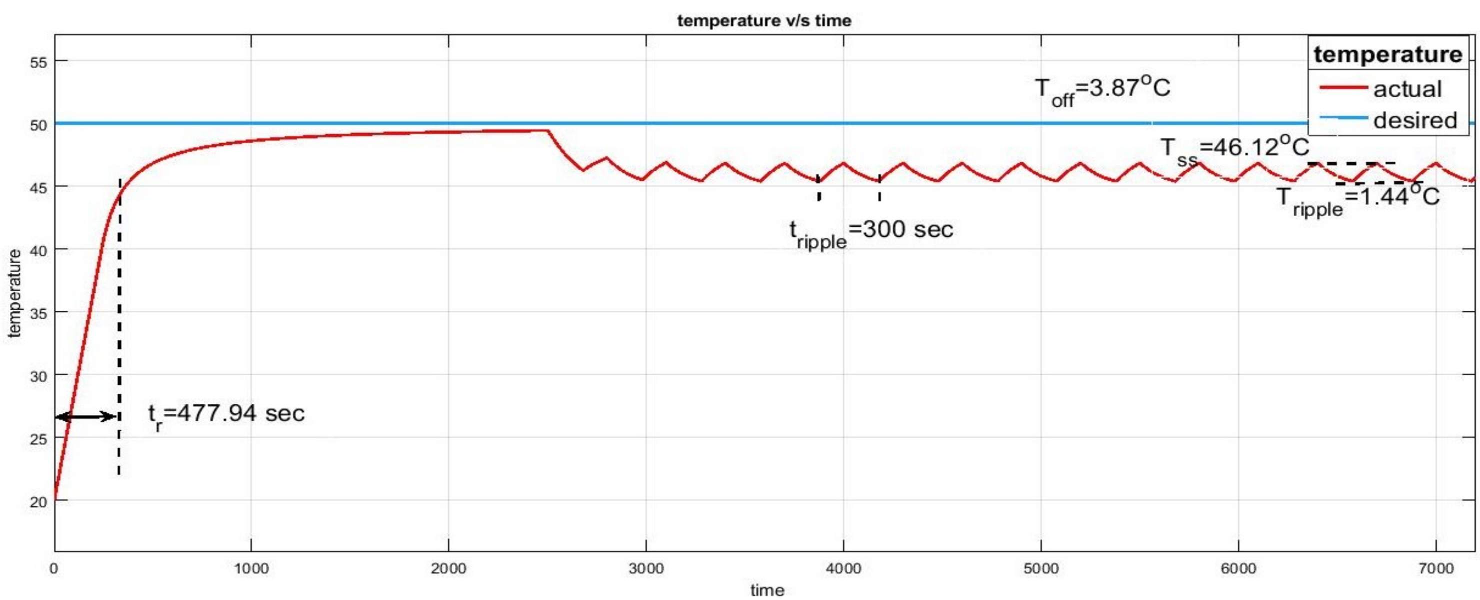


(b) temperature v/s time

3.2 $K_p = 2$

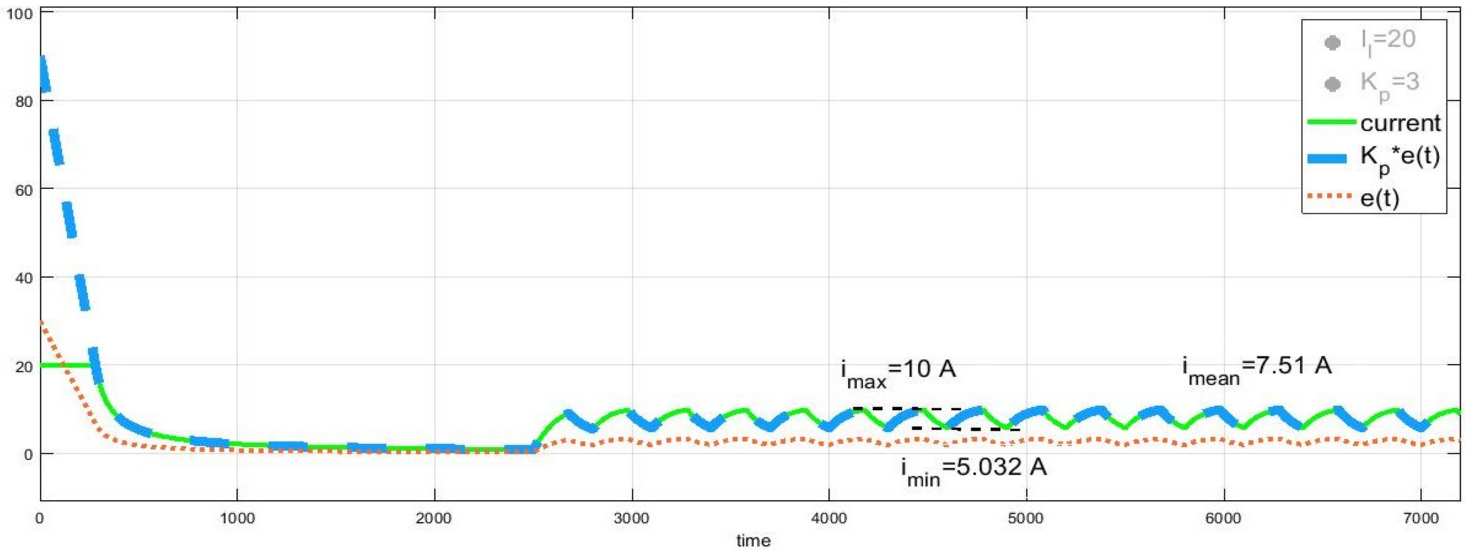


(a) current v/s time

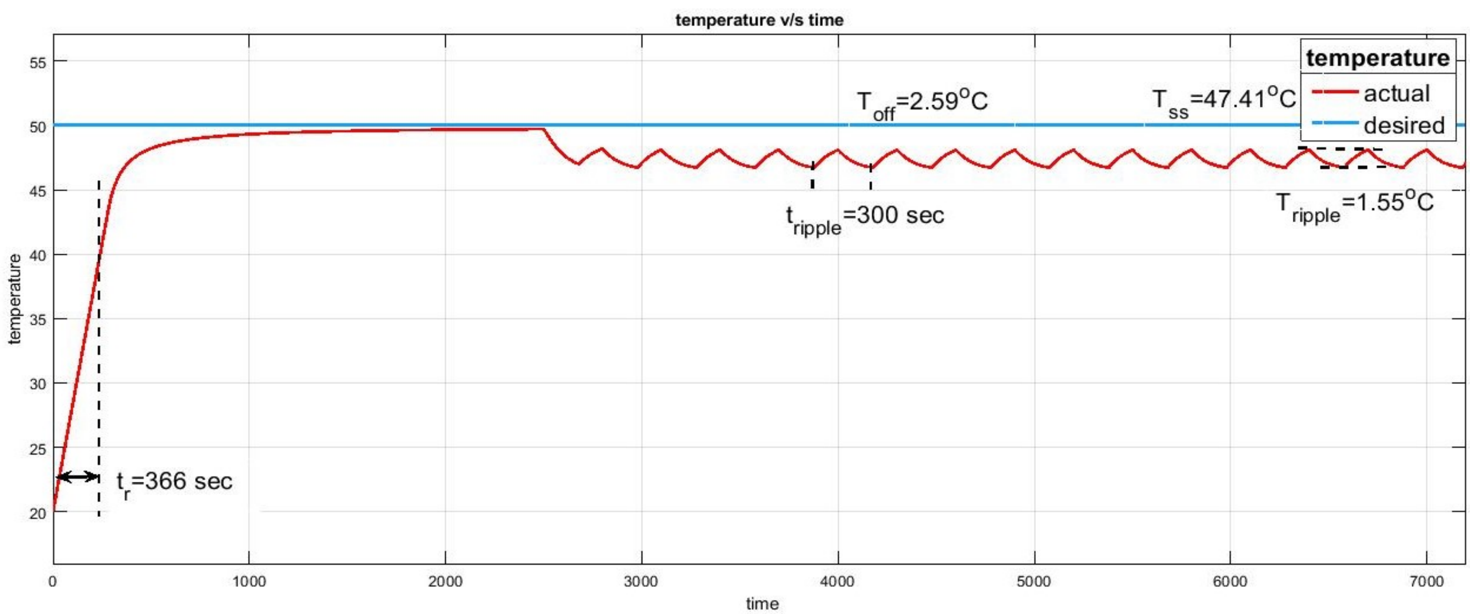


(b) temperature v/s time

3.3 $K_p = 3$, $Peak current = 10A$



(a) current v/s time



(b) temperature v/s time

4 Observations to report

1. **Why is the initial rise curve slope reducing so drastically close to 90% value?**

   The rise in the slope is reducing beyond 90% because the error is reducing due to rise in the actual temperature, since

   $$e(t) = c(t_{desired}) - c(t_{actual}) \tag{1}$$

   and , hence the value of the current reduces as

   $$i(t) = k_p * e(t) \tag{2}$$

   and because the heat is related to current as(see equation 3) the temperature rises slowly as the desired temperature comes closer.

2. **The magnitude of temperature fall and rise in the very first cycle of withdrawal and decrease in temperature in steady state.**

   In the first cycle of the water being withdrawn the hot water is replaced by the cold water at 20^oC , this cold water brings the average temperature of the system down.But later in the same cycle as the heating element was subsequently heating the water the temperature again rises as the water is not withdrawn in the later $120sec(duty\ cycle\ is\ 60\%)$.
   In steady state the temperature decreases because of repeated and periodic credit of the the hot water.

3. **Effect of current on rise time.**

   Effect of current on rise time can be seen if we compare the rise time for different values of current supplied to the system, the following table (see table 1) illustrates the data from graphs:

Current	Rise time
10A	1380 sec
15A	1000 sec
20A	913 sec

Table 1: Data for different values of I when $K_p = 1$

and it is also obvious because the more current we put into the system more the heat supplied per unit time will be because,

$$heat_t = I^2Rt \tag{3}$$

where I is current and R is resistance of heating element and t is time