

## Assignment 5: Water Heater System with Proportional Control

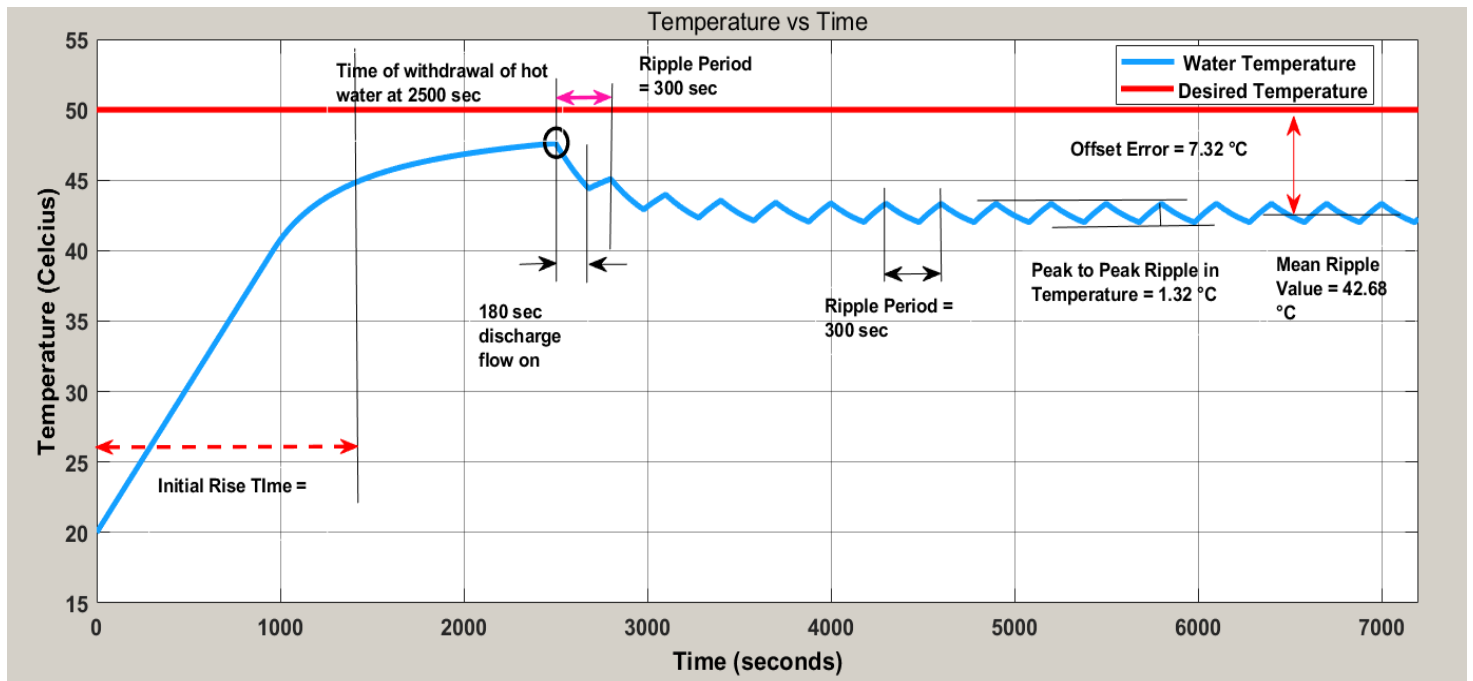
Submit by: 18-04-2021 (Sunday) 1700 Hours

Submit on: [dt.shahani2020@gmail.com](mailto:dt.shahani2020@gmail.com)

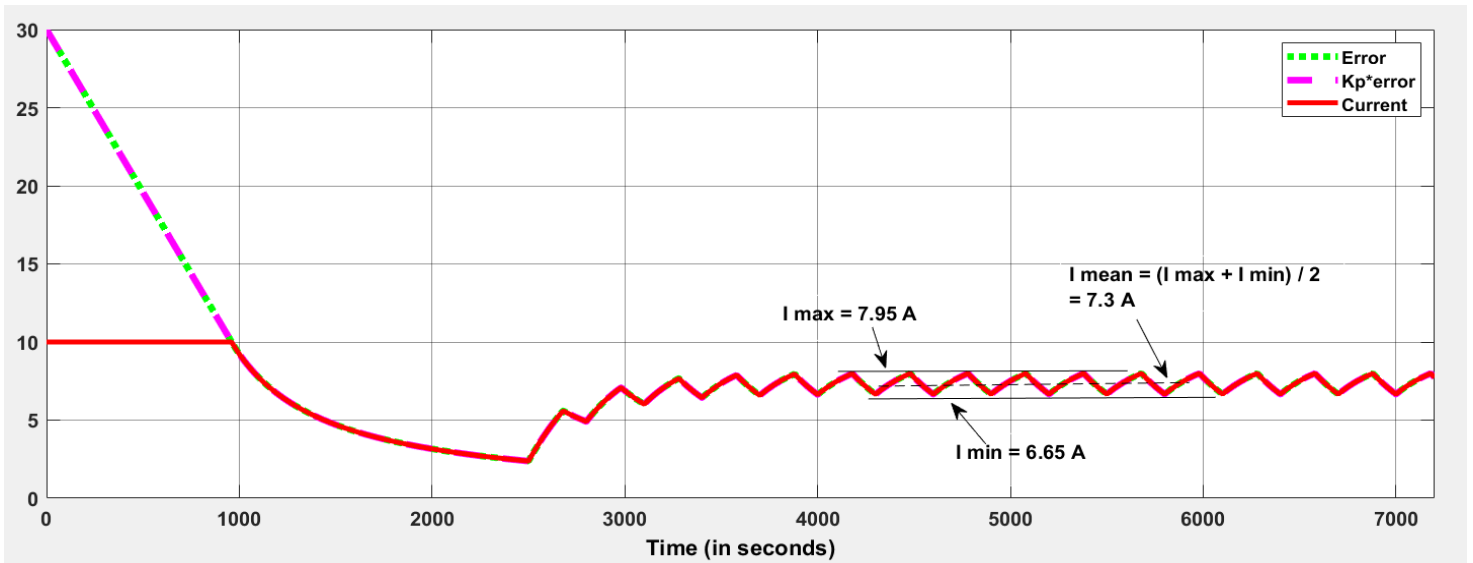
[iitdsl2020@gmail.com](mailto:iitdsl2020@gmail.com)

1. Make a water heater model which has a proportional controller in which the desired temperature of water is 50°C. No water is withdrawn for first 2500 seconds. Thereafter, the water is withdrawn at the rate of  $f = 1$  litre/min with a duty cycle of 60 %. In the withdrawal period, the amount of water that is withdrawn is instantly replaced from the water which is at 20°C. The overall simulation is from 0 to 7200 seconds. Take the initial temperature of water at 20°C.
2. Simulate for the following cases:
  - a) Proportional Controller with maximum current limit as:
    - i. 10 A ( $K_p = 1, 2, 3, 0.5$ , and that value of  $K_p$  for which Peak Current in Steady state = 5 A) (*Total 5 cases*)
    - ii. 15 A ( $K_p = 1, 2, 3$ , and that value of  $K_p$  for which Peak Current in Steady State = 7.5 A) (*Total 4 cases*)
    - iii. 20 A ( $K_p = 1, 2, 3$ , and that value of  $K_p$  for which Peak Current in Steady State = 10 A) (*Total 4 cases*)
3. Plot vs time the following graphs for each  $K_p$  and current value. Keep the simulation time for 7200 seconds.
  - GRAPH1:  
Temperature of Water v/s Time (take the temperature axis from 15 to 55°C)
  - GRAPH2:  
Error,  $e(t)$ ;  
 $K_p \cdot e(t)$ ;  
Current

*This is just a sample graph*



*This is just a sample graph*



4. Calculate the following parameters from the temperature vs time plot:
  - a) Initial rise time
  - b) Peak-to-peak ripple of temperature in steady state
  - c) Steady state temperature
  - d) Offset error in temperature
  - e) Ripple period in steady state
5. Calculate the Mean current from the current vs time plot in the steady state.
6. Explain the following on your observations from above graph:
  - a) Why is the initial rise curve slope reducing so drastically close to 90% value?
  - b) The magnitude of temperature fall and rise in the very first cycle of withdrawal and decrease in temperature in steady state.
  - c) Effect of current on rise time.