P11412 UV Water Treatment Team

Feasibility Analysis

Ergonomic Analysis

Sensitivity of General 1st Order System Response

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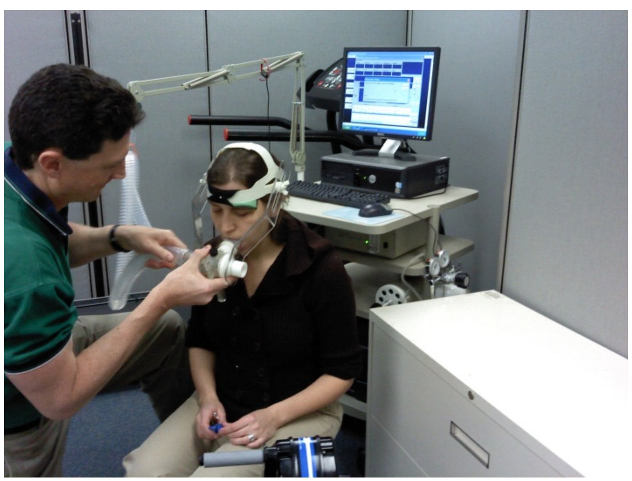
P11412-Ergonomic Analysis

When the team started work on the redesign of the manual powered device from B9, one of the first issues to arise was that the current model was very difficult to use. It immediately because one of our goals to decrease the effort to use the device but we also wanted to see if there were other ways we could improve the users comfort. To figure out these questions, we first had to do a usability test on the device to get a basis of how much work is required to get a just a half gallon of water.

To accomplish this task we decided to do a VO_2 test on a user to see how much oxygen was required to get a ½ gallon of water. This data could then be extrapolated to find the users respiratory exchange ratio (RER), calorie usage, and overall ability to make water with the device. The test consists of being hooked up to a breathing tube that captures all of your oxygen and CO_2 needs. The user's nose is plugged and they are wearing a heart rate monitor which is feeding date directly into a computer. The data below was collected during this test.

Person	Time Cranking (Min:Sec)	Clean water made (gallons)	VO2 (L/min)	**RER**	Kcal used	Extra Comments
Sarah	4:52	.42	1.27	**1.21**	32	Hand abrasions due to rubbing
Seann	7:35	.5	2.33	**.96**	104	Awkward on lower back



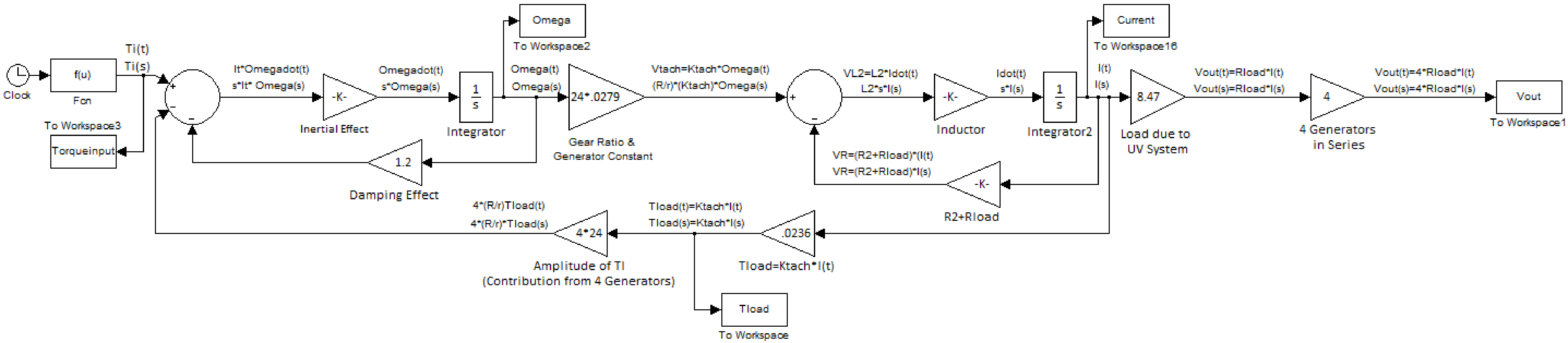
The data was very helpful in showing ecaxtly how difficult the process of turning the crank was. Sarah did a great job at capturing our target user. She is a younger female of average height and weight and recently gave birth to a child. Because she was a female she made sure to sit with her legs to the side of the crank because it would culturally unacceptable for her to stradle the crank. As she started cranking, it was clear that the work needed was very high. During the roughly 5 minutes Sarah was cranking she had to take a break in the middle to catch her breath. At the end of the 5 minutes Sarah was fatigued and only cranked .43 gallons of water, just under her target. After looking at the data collected it was easy to see why. Sarah's RER was 1.21 which is a high anaerobic rating. Anaerobic refers to a task that causes fatigue and cannot be down for long periods of time. Any RER over 1 is classified as anaerobic, which 1.21 being fairly high. Though her VO2 and Kcal seem rather normal, the breaks she took and the relativly short period she could used the device skew these numbers torward a normal curve. The important number collected was the RER. Also while Sarah was trying to crank and keep the nessasary speed requires to keep the pump un, she didn't realize the handles we giving her small abrasive injuries. This is something that could definatly we corrected on a redesigned device.

Figure 1: Hand Abrasions from vigorous crank use with current system design

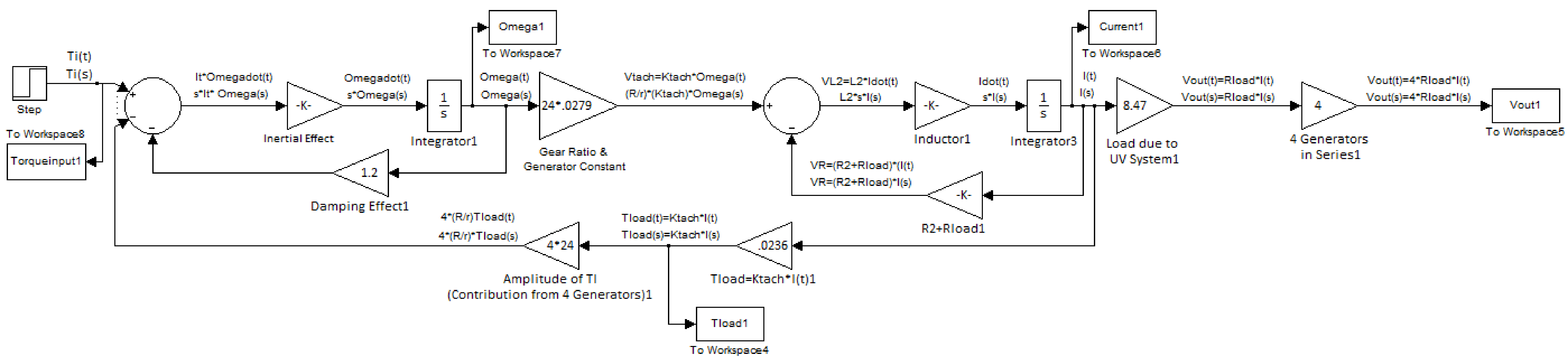
Seann was the second conterstent and he represented the peak performer using the device. Seann is a very fit males who sat over the device my strattling it. He started out very strong and kept a good pace through his trial. The main issue was at the higher speeds there was a lot of motion as he could not get confortable while cranking at such a vigorious pace. Because of his fitness level Seann VO2 and Kcal were fairly high . He was performing at a high level and stopped at the .5 gallon marker. Seann RER also supported the theory that process was very difficult but his RER was under 1.00. This can be accredited to his fitness level and would be very rare in most cases. Even with his fitness level he would not have been able to maintain that pace for an extended period of time, though he assured me 5 gallons of water seemed within his range.

After collecting the data from both users it was very clear that a newly designed system by help the system function more efficently. This could be done several ways, many of which the team is trying to implement. One way would be to use the flywheel to keep stored energy that could be used for the small but scrucial seconds when the user gets tired. Another goal would be to have the flywheel move the task from anaerobic to aerobic. This would increase the amount of time a user could use the device significantly. A person can maintain an activity with an RER of .80 for hours which minimal calorie loss. Overall the team learned a lot for the expeience and plan to test the final product the same way to show comparisons. This will provide a basis for improvments and hopefully after the prototype is finished, it will meet our anticipated marks.

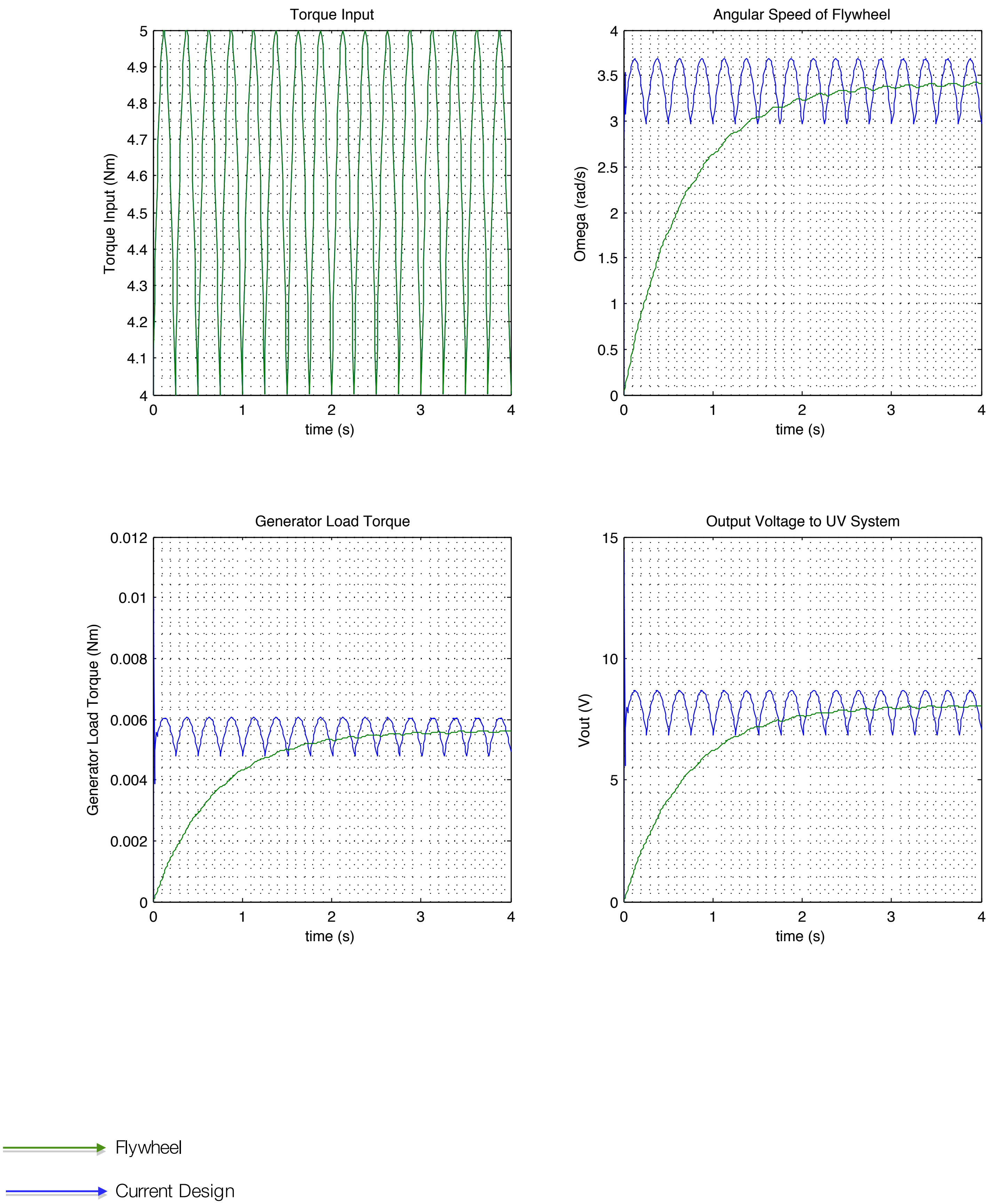
Simulink Block Diagram for Rise Time of Power Generation System: Rectified Sine Input of Torque Input



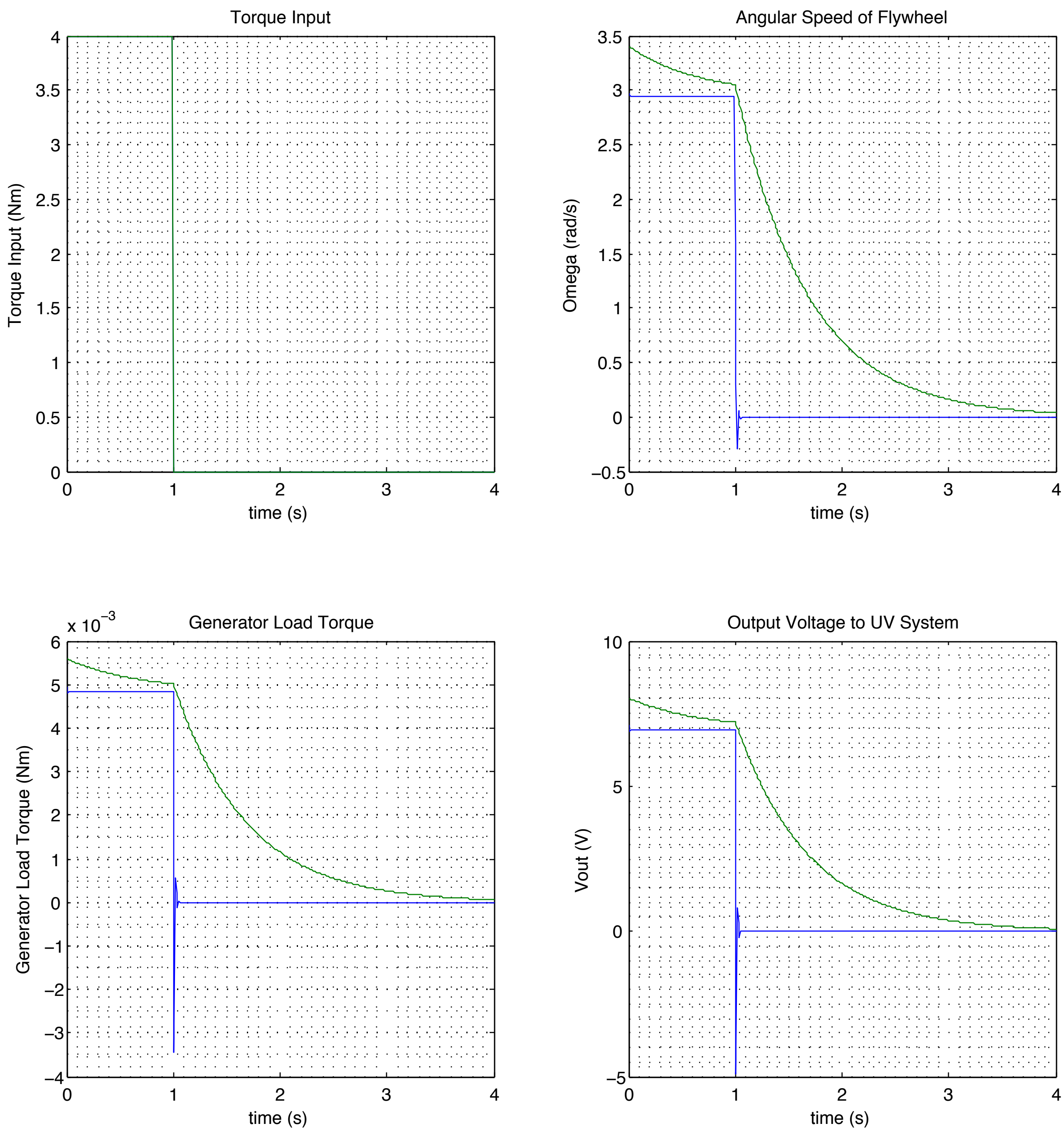
Simulink Block Diagram for Decay Time of Power Generation System: Step Input from Initial Conditions of Rise Time Analysis



B-9 Manual Power Generation System Response with Rectified Sine Wave Torque Input: Rise Time



B-9 Manual Power Generation System Response with Rectified Sine Wave Torque Input: Decay Time



Flywheel

Current Design