

Lab 9 (Cascade Control with PD Controller – Ball and Beam):

Pre-Lab: Read section 2 of the Ball and Beam Workbook and answer the questions in section 3 before coming to the lab. The specifications needed for the questions can be found in the tables at the end of this document.

Lab Experiment:

1. Connect the SRV02, VoltPaq, and Q2_USB data acquisition board with the following changes.
 - a. Use the black RCA to RCA connector instead of the 2xRCA to 2xRCA cable.
 - b. Instead of using the white and yellow RCA connectors, connect the red (S3) connector to analogue input #0 and the black (S4) connector to analogue input #1.
 - c. The S1 & S2 connections on the motor SRV02 will not be used. Instead use the 6-pin-mini-DIN to 6-pin-mini-DIN cables to connect the BB01 position sensor to S3 on the amplifier.
2. In matlab, browse to the folder “C:\Users\Students\Documents\BALL AND BEAM \Controllers”
3. Open the file “s_bb01_pos_outer_loop.mdl and follow the setup instructions detailed in section 5.2 of the Ball and Beam Workbook.
4. Read through section 4.1 of the workbook and run through the cascade control with ideal PD controller experiment.
 - a. The root locus can be plotted using the rlocus(sys) command in Matlab.
5. Read through section 4.2 of the workbook and run through the cascade control with practical PD controller experiment. Do not do section 4.2.3.

Important: Before closing the model, select “QUARC → Clean all ...” and click “Yes” on the prompt to delete all generated code.

Post-Lab: Write a lab report detailing the procedure and results of the experiments run. Guidelines for writing the lab report can be found in section 6 of the Ball and Beam Workbook.

3 SPECIFICATIONS

Table 3.1 lists and characterizes the main parameters associated with the BB01. See Figure 3.1 for an illustration of the Ball and Beam dimensions and the variables α , θ , and x that are associated with the system. Some of the parameters listed in Table 3.1 are used in the mathematical model.

Symbol	Description	Matlab Variable	Value
	Mass of ball beam module		0.65 kg
	Calibration base length		50 cm
	Calibration base depth		22.5 cm
L_{beam}	Beam length	L_beam	42.55 cm
	Lever arm length		12.0 cm
r_{arm}	Distance between SRV02 output gear shaft and coupled joint	r_arm	2.54 cm
	Support arm length		16.0 cm
r_b	Radius of ball	r_ball	1.27 cm
m_b	Mass of ball	m_ball	0.064 kg
K_{bs}	Ball position sensor sensitivity	K_BS	-4.25 cm/V
V_{bias}	Ball position sensor bias power		± 12 V
V_{range}	Ball position sensor measurement range		± 5 V

Table 3.1: Ball and Beam specifications

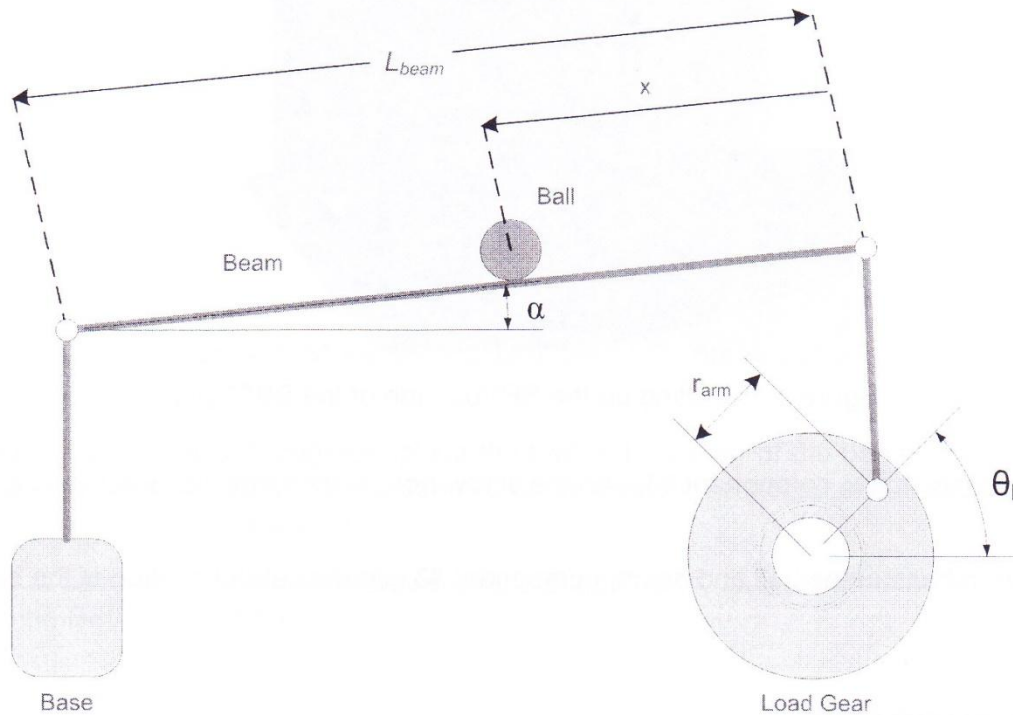


Figure 3.1: Ball and beam lengths and variables