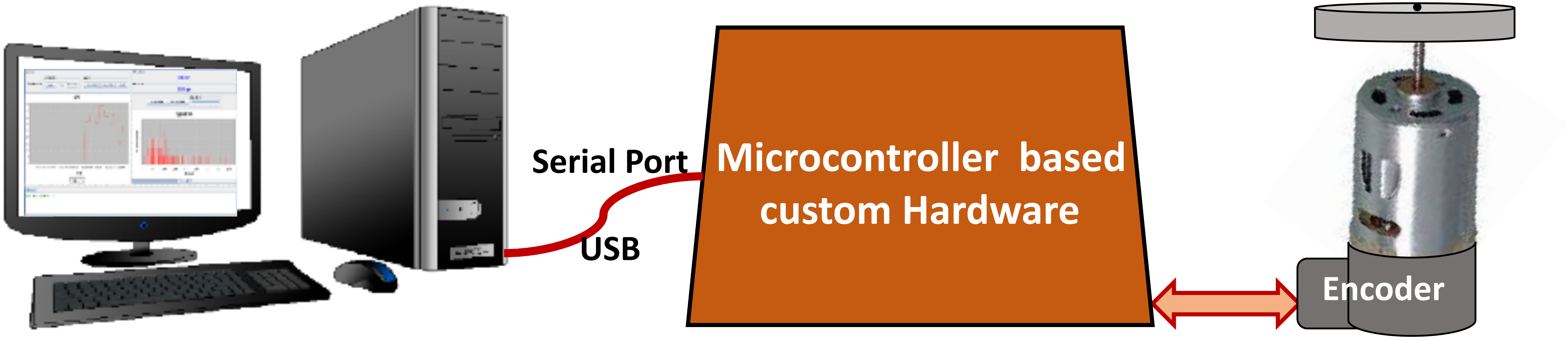
Indian Institute of Technology Bombay

Hardware Interfacing & Control

Prof. P. S. V. Nataraj

PC Based Interface

Using Custom Hardware interface

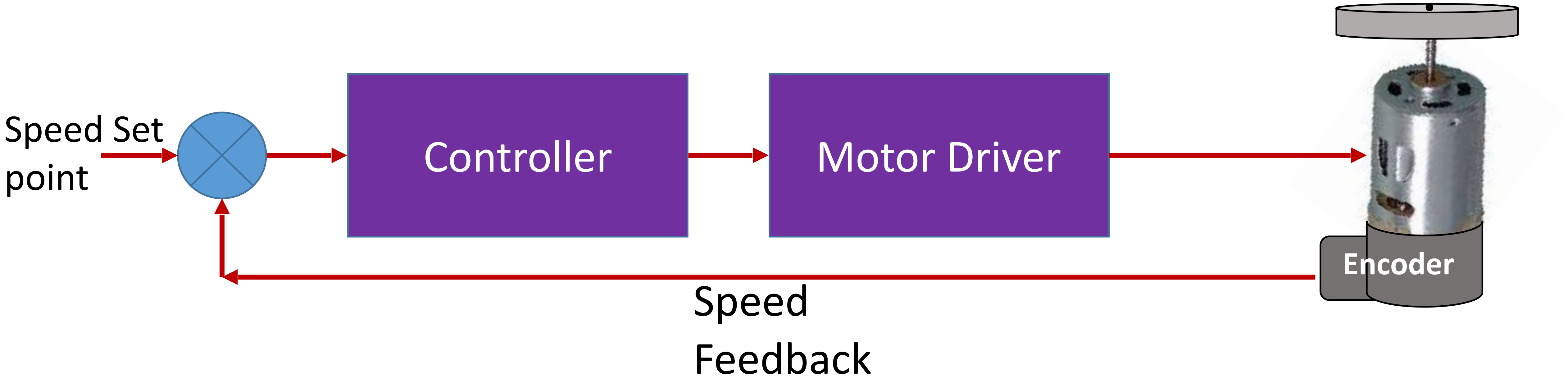


DC motor Control Kit

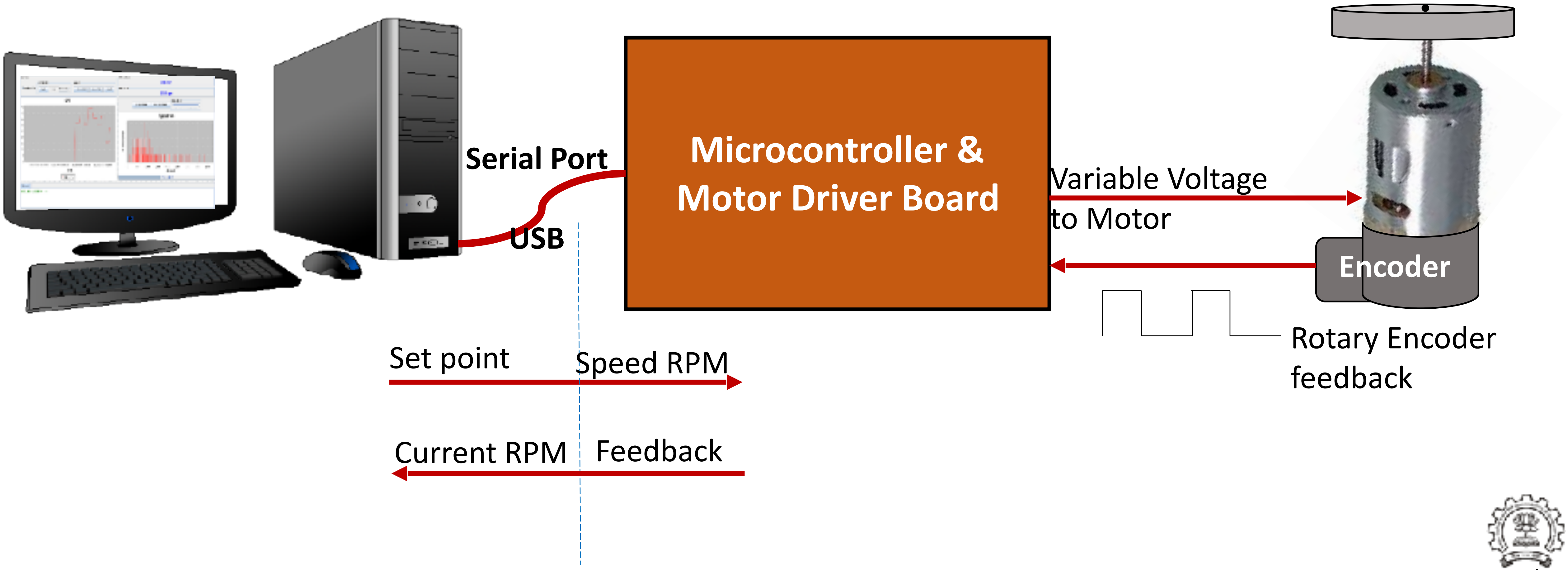
Developed By

IIT Bombay

DC Motor Control



DC motor Control Kit



DC motor Control Kit

Training Modules

Modules for Speed & Position control

System Identification

Traditional Control using P PI PID

Neural Networks

Deep Learning

MPC

Robust Control

IIT Bombay

DC motor Control Kit

USB Connectivity – Plug & Play

Creates real world plant experience on your desktop

Interactive frontend Software modules

Complete Lab Development Package for Academics

Used for class room teaching over 4 years in IIT

Open communication command set

Low Cost

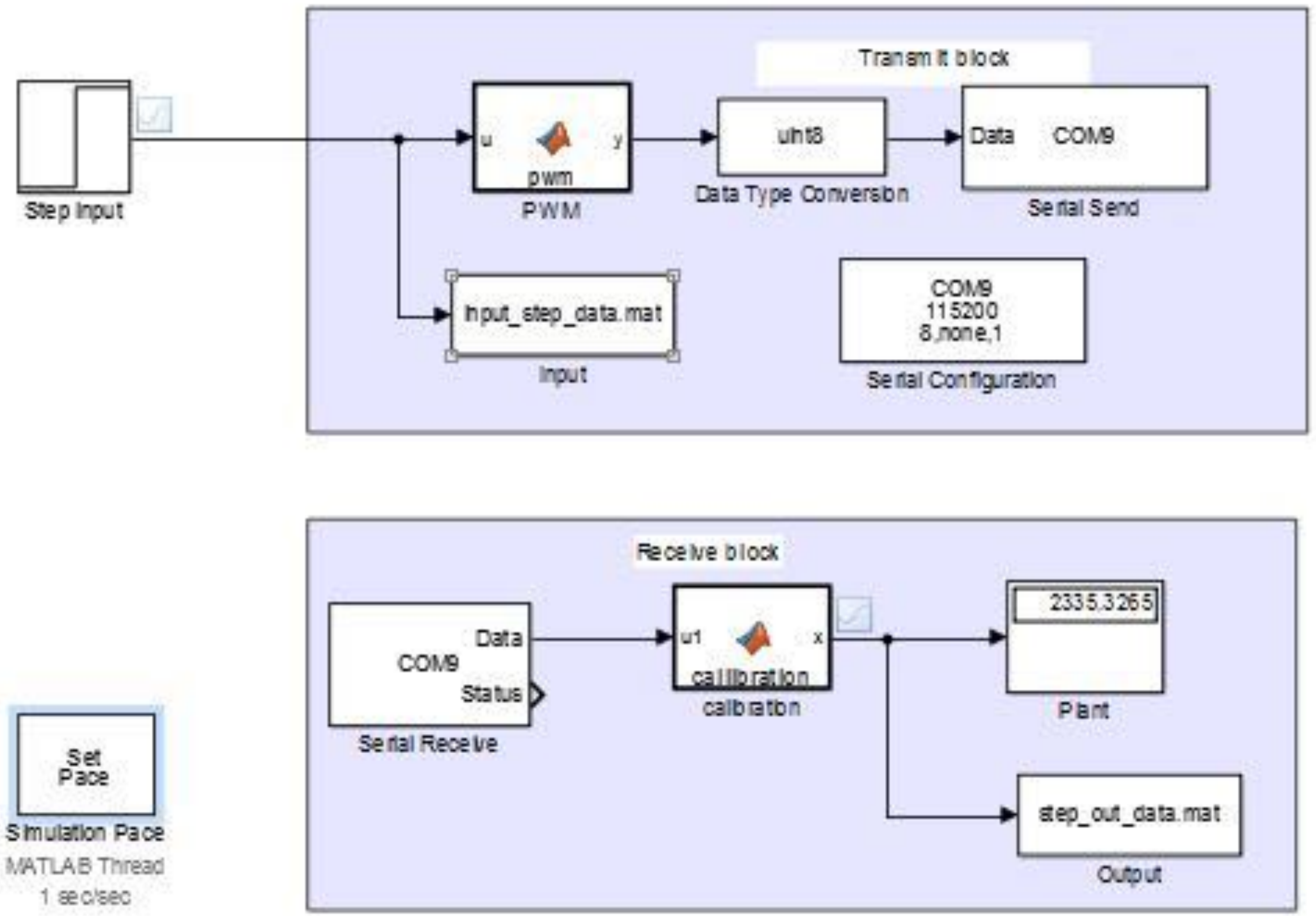
Indian Institute of Technology Bombay

DC Motor control using MATLAB/SIMULINK

Outline

- Experiment No- 1
  - Validation of motor model for speed control
- Experiment No-2
  - PI Control Gains for Motor speed control

Experiment No-1
Validation of motor model for speed control



IIT Bombay

Procedure

- Set ts=0.015
- Run the matlab simulink model
- To stop the motor press the reset button on the DC motor kit .

FOPTD

- The First-order Plus Time Delay (FOPTD) model is given by

$$G(s) = \frac{\Delta Y(S)}{\Delta U(s)} = \frac{K\, e^{-td\,S}}{\tau s+1}$$

gain K ,time constant τ and dead time t_d

Apply two-point method for system

- $t_{63.2}$ = Time required for the output to reach 63.2 % of the steady-state value
- $t_{28.3}$ = Time required for the output to reach 28.3 % of the steady-state value.
- $K = \frac{Difference\ in\ two\ steady\ states\ of\ output}{Difference\ in\ two\ steady\ states\ of\ input}$
- $\tau = 1.5(t_{63.2} - t_{28.3})$
- $t_d = t_{63.2} - \tau$

Sample values

- $t_{63.2}$ = 0.45 sec
- $t_{28.3}$ = 0.33 sec
- $\Delta u(t)$ = 20 PWM units
- $\Delta y(t) = 359\ RPM$
- Using the two-point method

K= 17.95

τ= 0.18 sec

L= 0.12sec

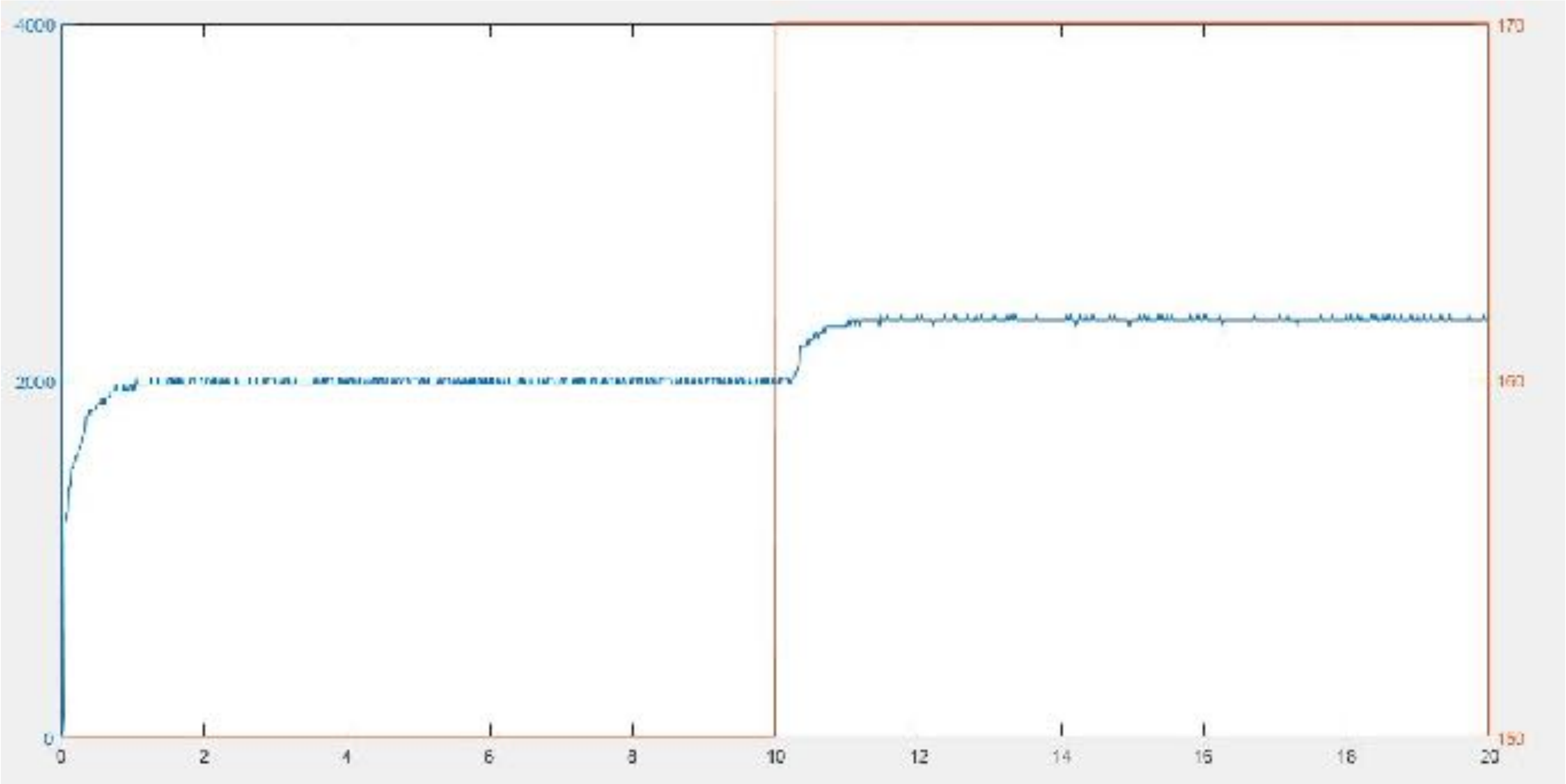
Transfer function

- $G(s) = \frac{\Delta Y(S)}{\Delta U(s)} = \frac{17.95\ e^{-0.12s}}{0.18s+1}$

Output response

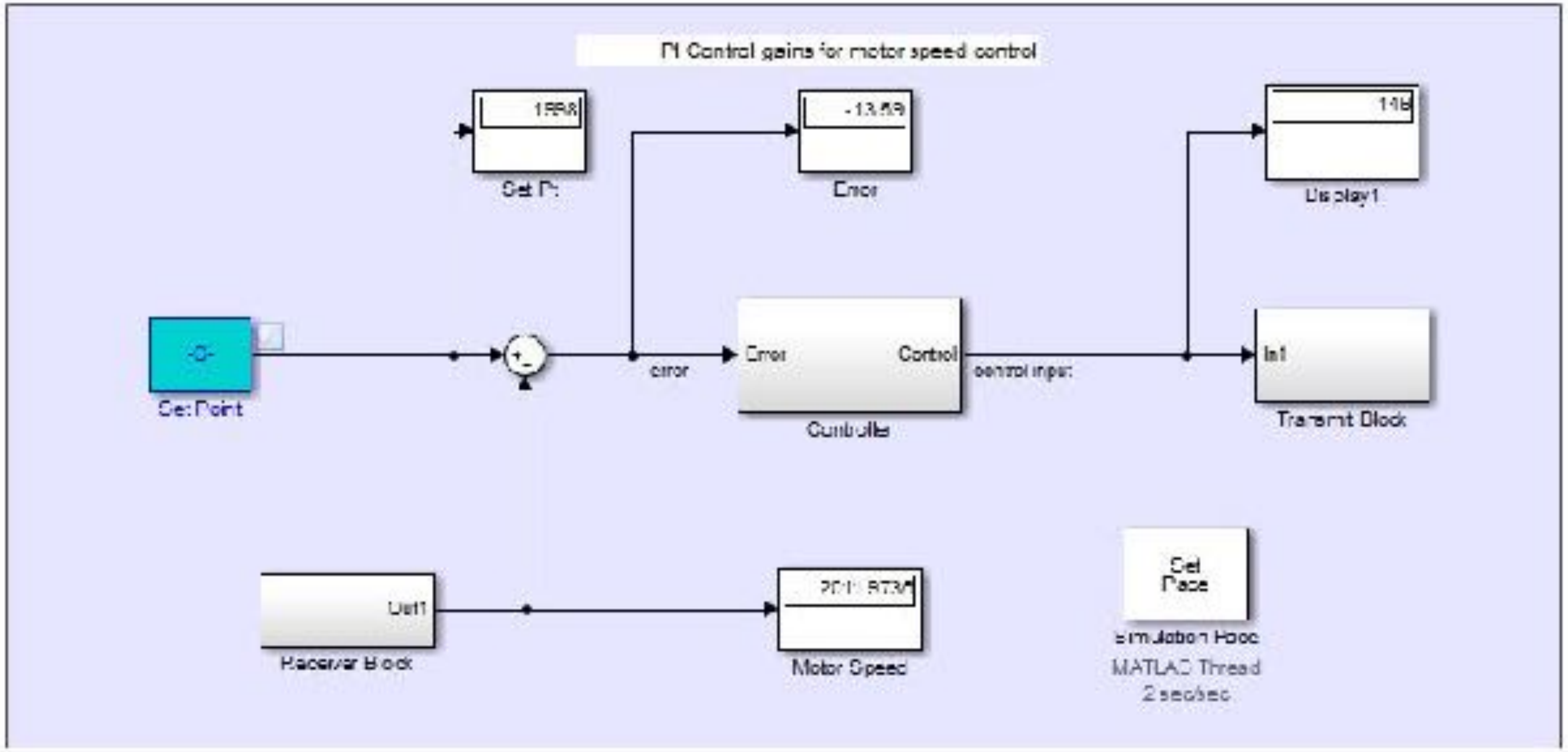
- In the open loop, the plant is brought to equilibrium by applying a step of 150 PWM units.
- The corresponding speed is around 2000 RPM
- After the motor speed settles, the PWM input is instantaneously changed to 170.
- As a result, the speed increases to around 2400 RPM.

Output vs Input



IIT Bombay

Experiment No-2
PI Control Gains for Motor speed control



Ziegler-Nichols Rule for Tuning PID Controllers

Type of controller	K_c	T_i	T_d
P	1/RL	∞	0
PI	0.9/RL	3L	0
PID	1.2/RL	2L	0.5L

Calculations

- Compute the controller parameters as follows:

$$K_c = \frac{0.9}{RL}$$

$$T_i = 3L$$

$$R = k/\tau$$

Sample values

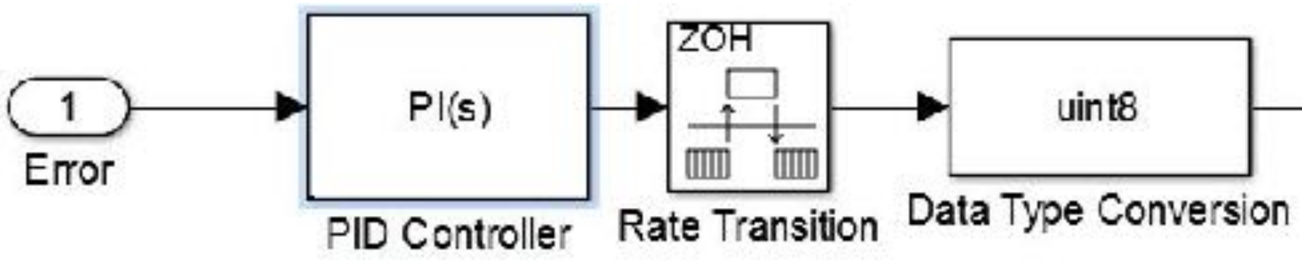
$$K_c = 0.04102$$

$$T_i = 0.825 \text{ sec}$$

Procedure

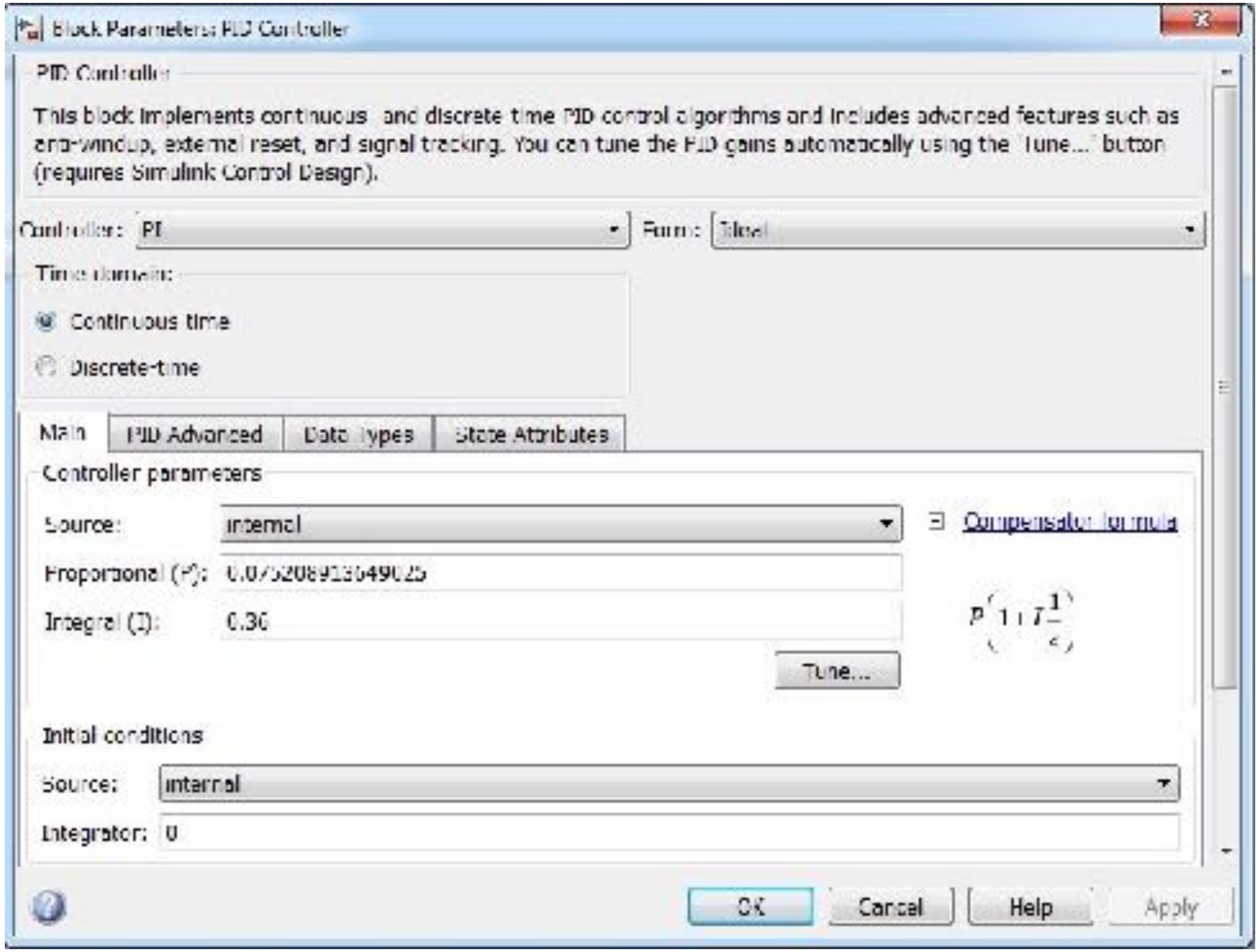
- Double click on the controller block .
- Double click on PID Controller block.
- Enter the P and I values calculated using the **Ziegler-Nichols Rule** .

PID Block



1
Error
PI(s)
PID Controller
ZOH
Rate Transition
uint8
Data Type Conversion
1
Control

PID block configuration

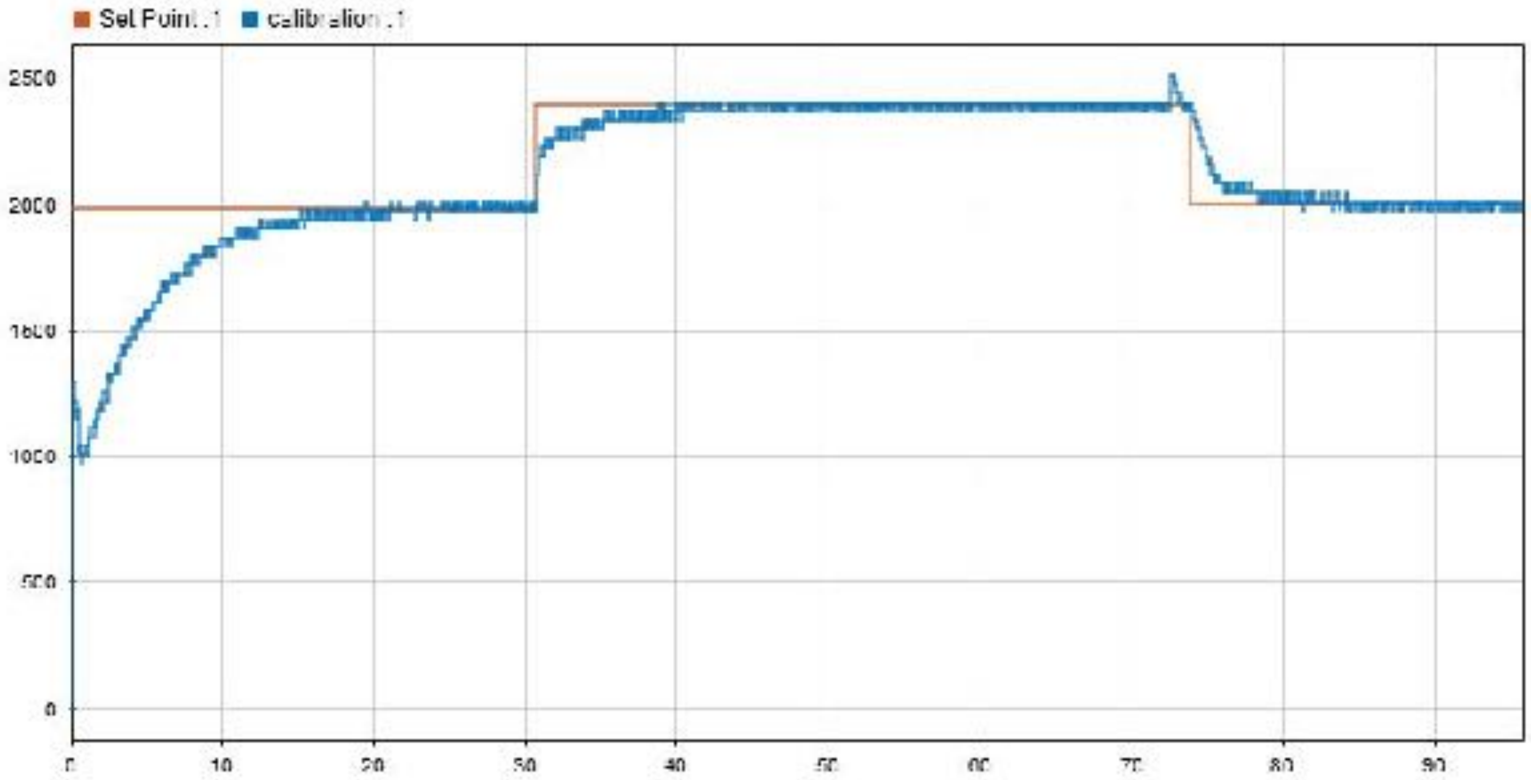


IIT Bombay

Output

- Kc = 0.075 and Ti = 0.36 sec.
- After the speed settles at 2000 RPM, a step of 400 RPM is applied.
- It is seen that the output follows the set point and the speed settles at 2400 RPM.
- Next, a negative step of 400 RPM is applied.
- It is clearly observed that motor speed decreases and settles at 2000 RPM.

Output response



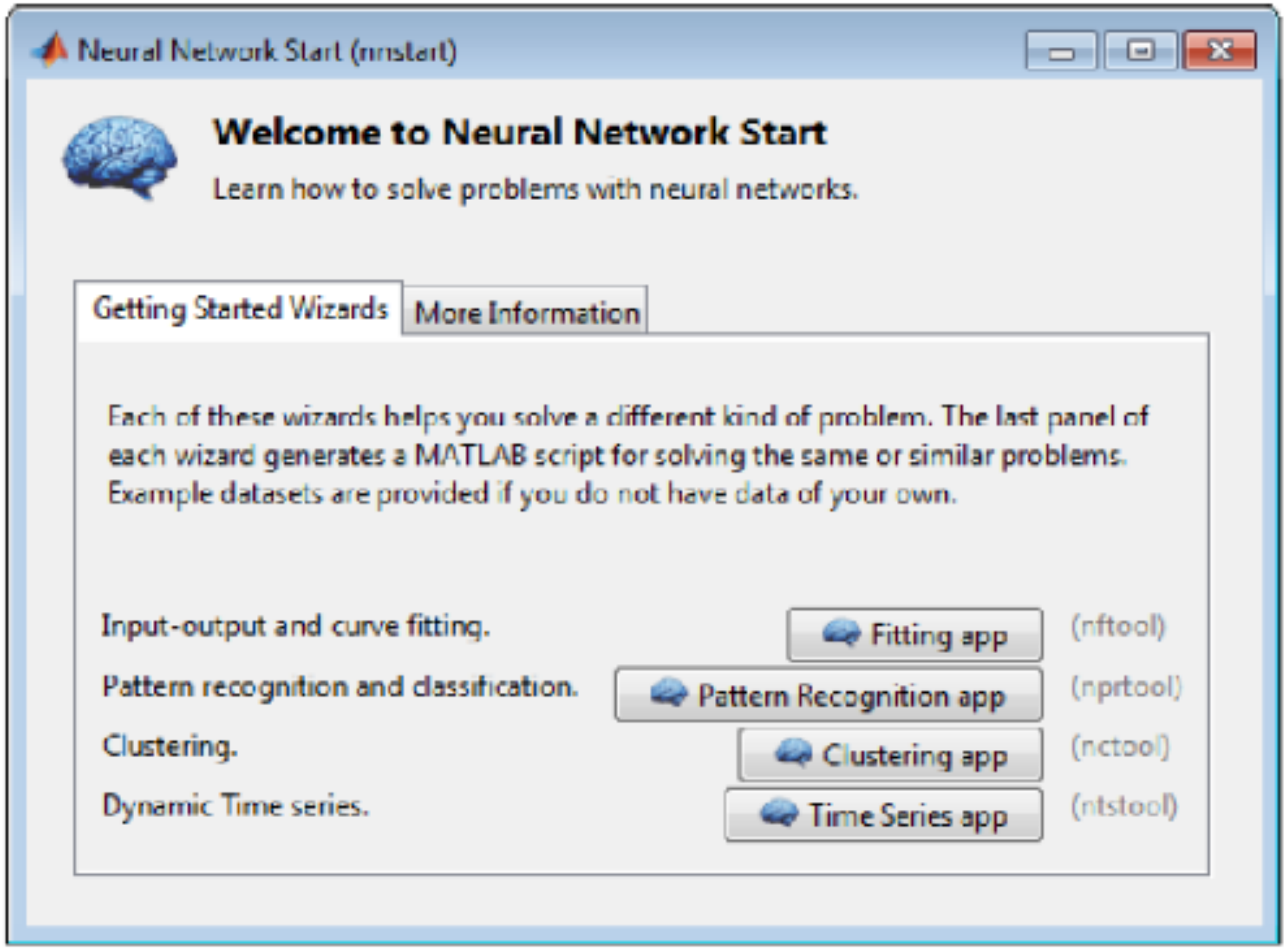
Neural Network Model And Neural Network Controller for DC Motor

Prof.P.S.V.Nataraj

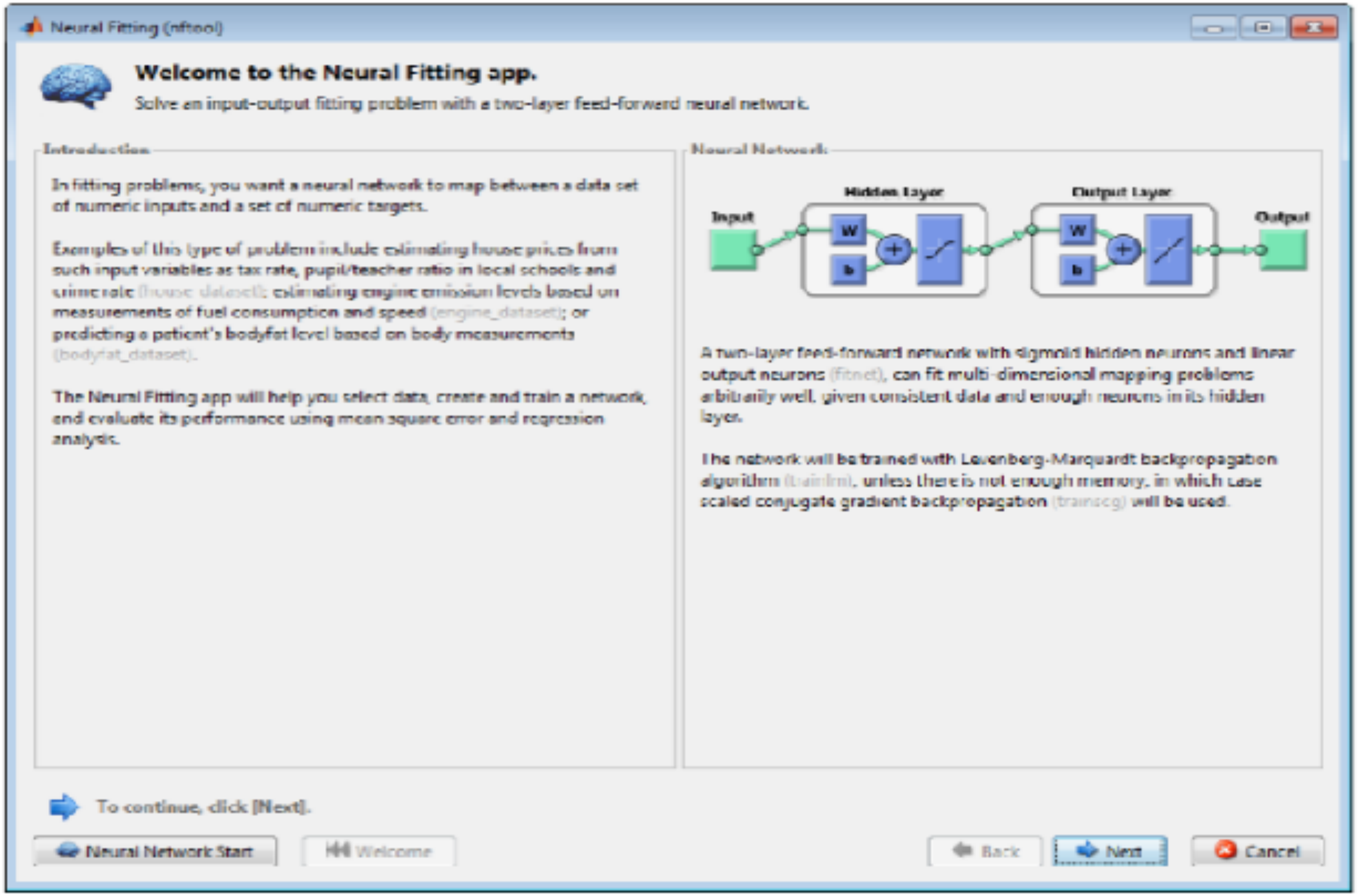
Systems and Control Engineeering

IIT Bombay

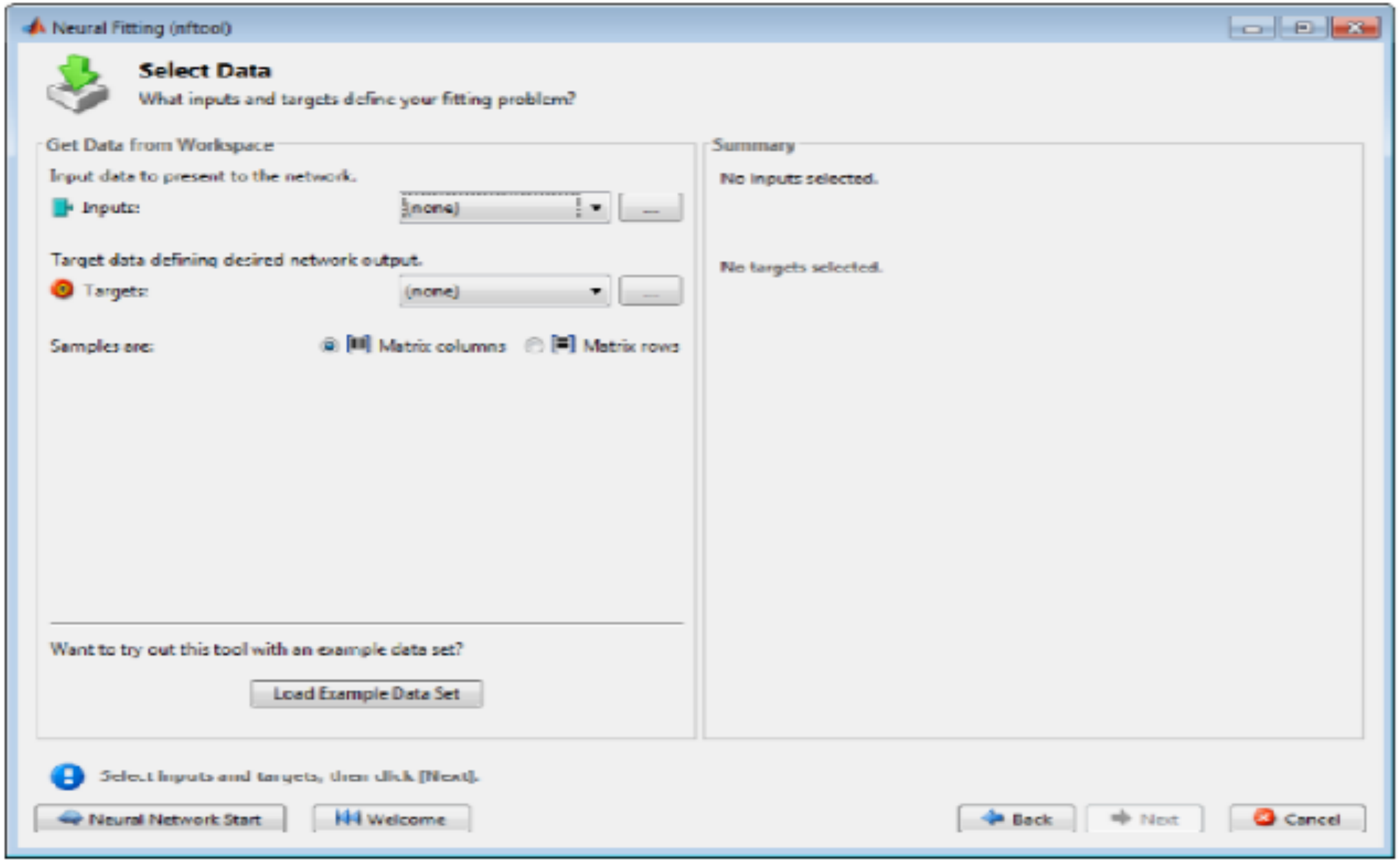
1.How to use Neural Network tools



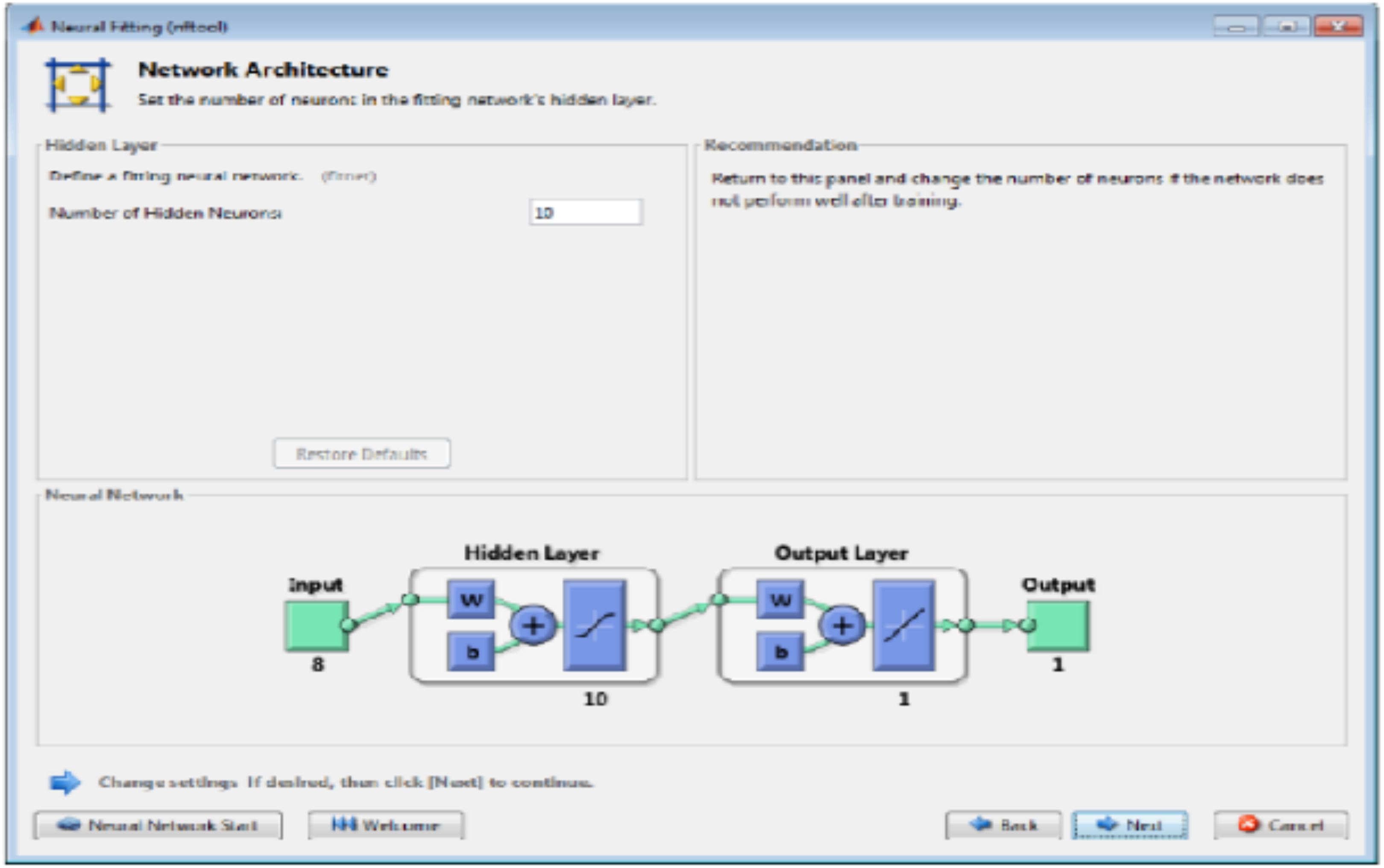
2.Network Fitting GUI



3.Data set selection

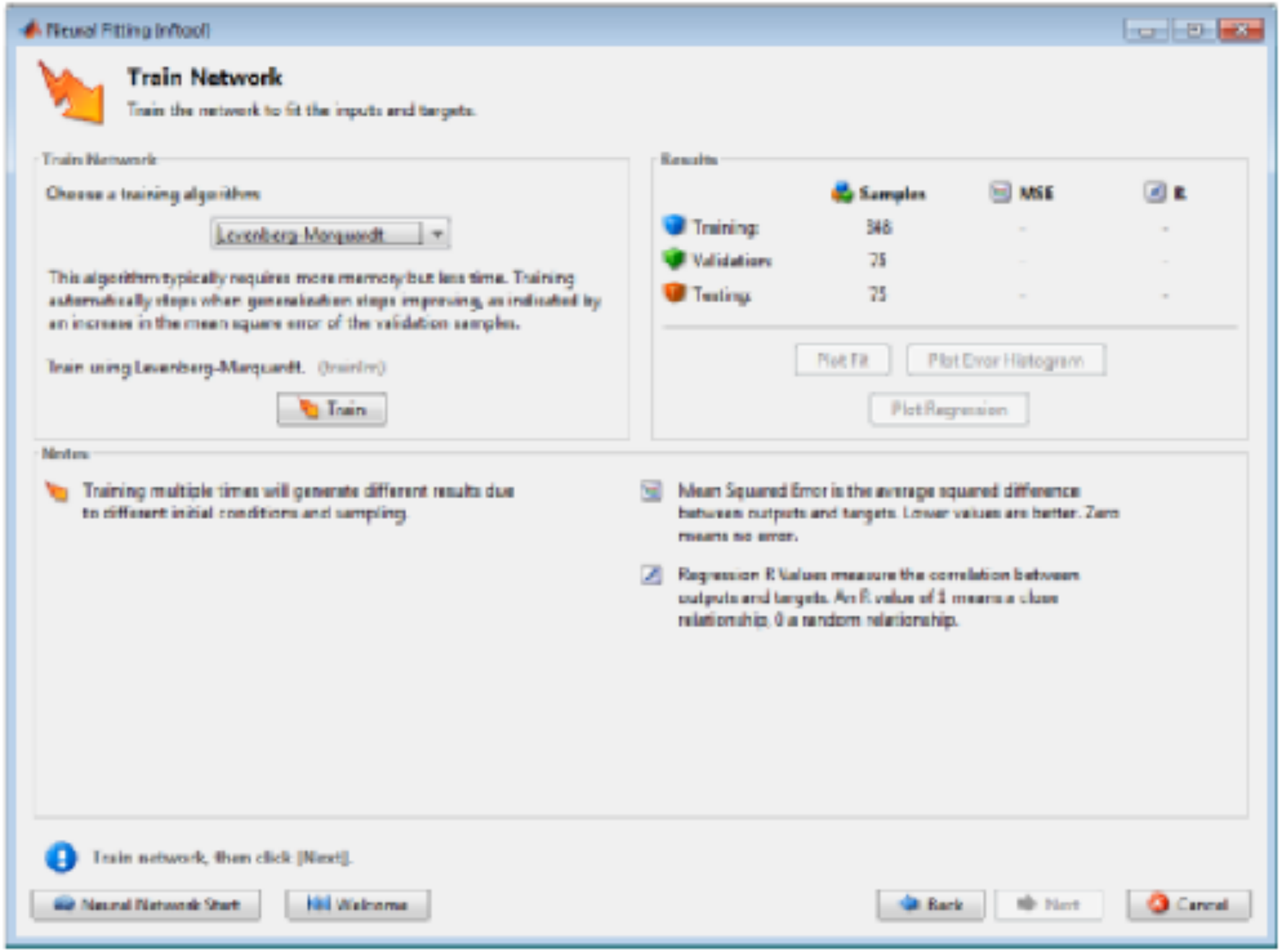


4.Network Architecture

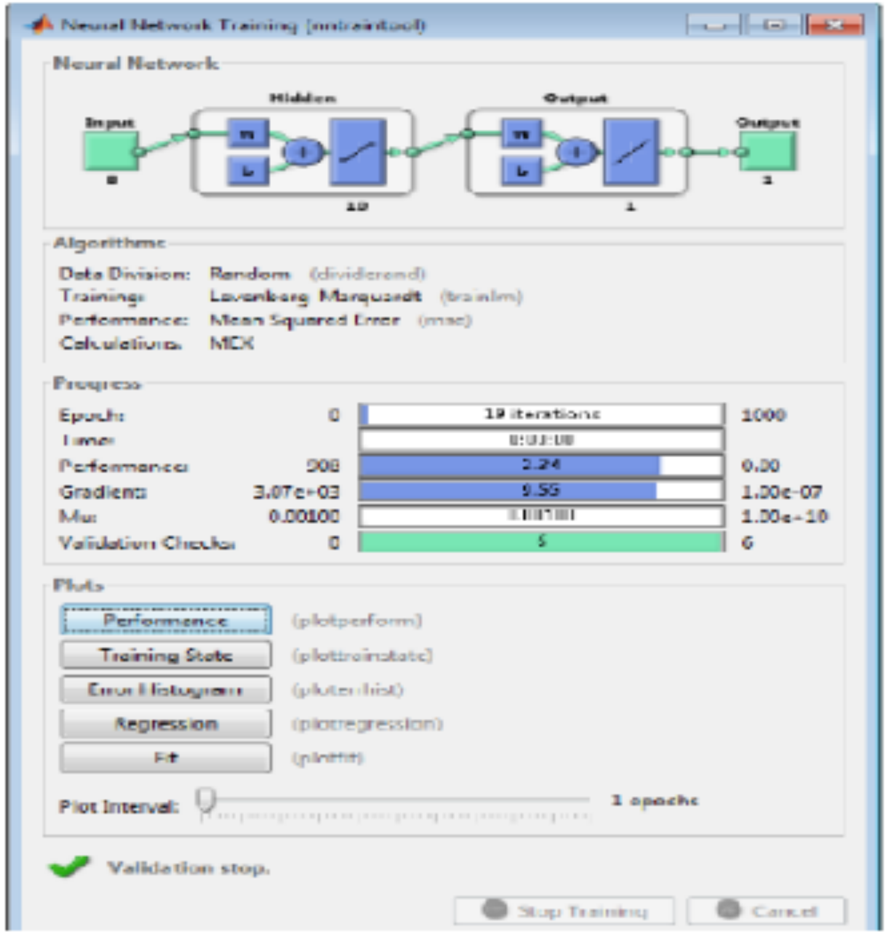


8. Click **Next**.

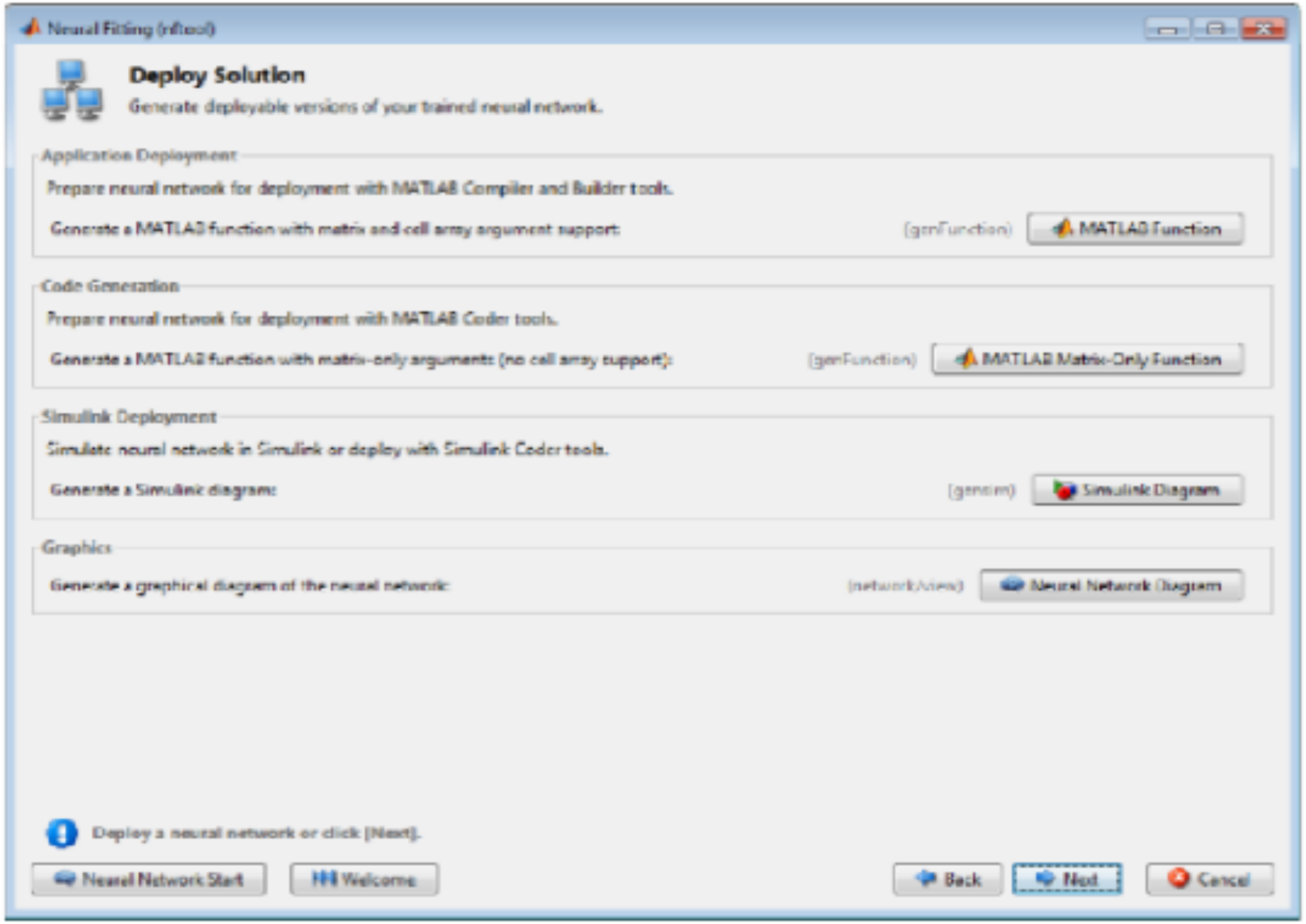
5.Train Network



6.Training Results

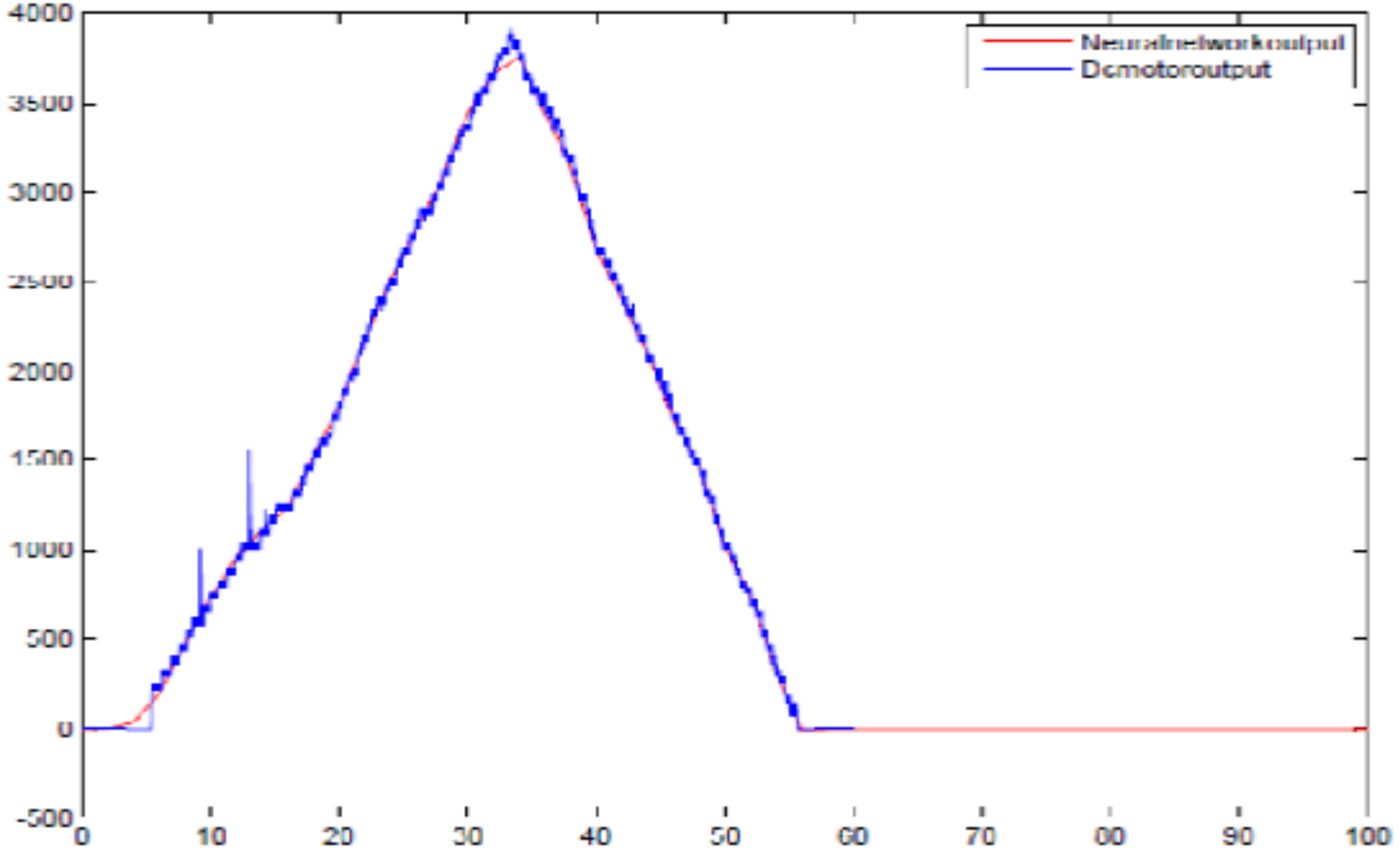


7.Deploy Solution

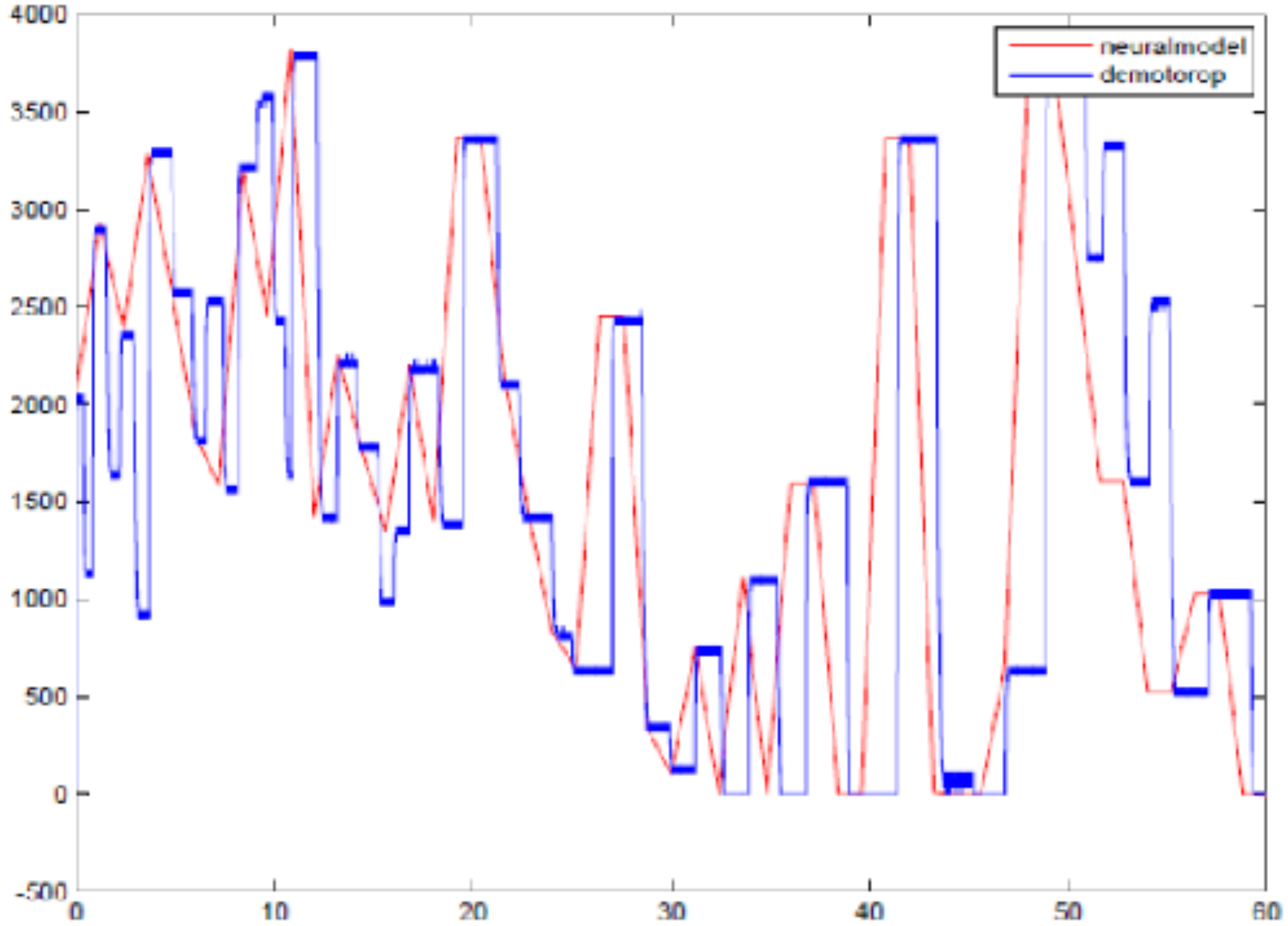


Comparison between DC Motor Model and Neural Network Model

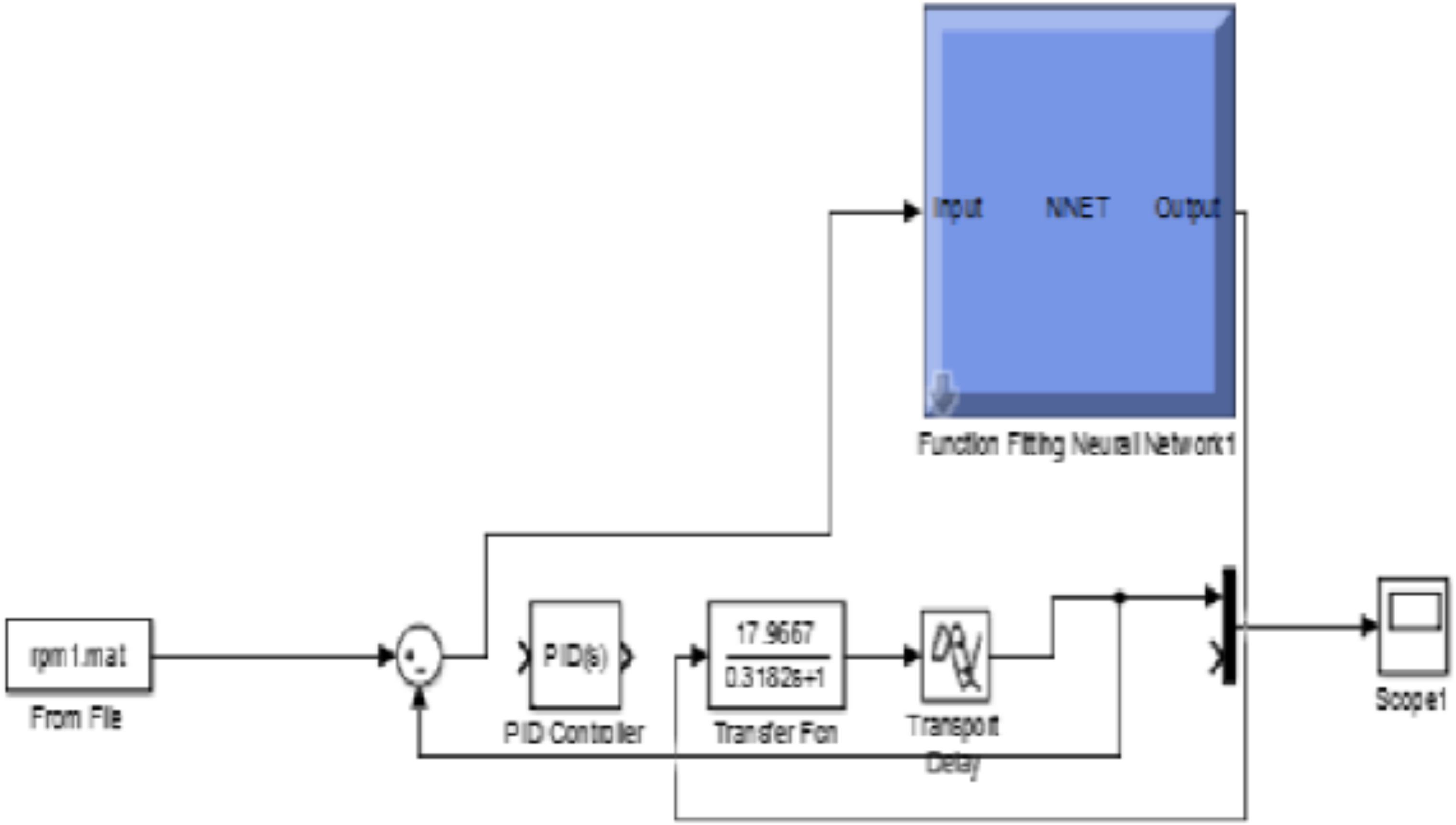
- Steady state output



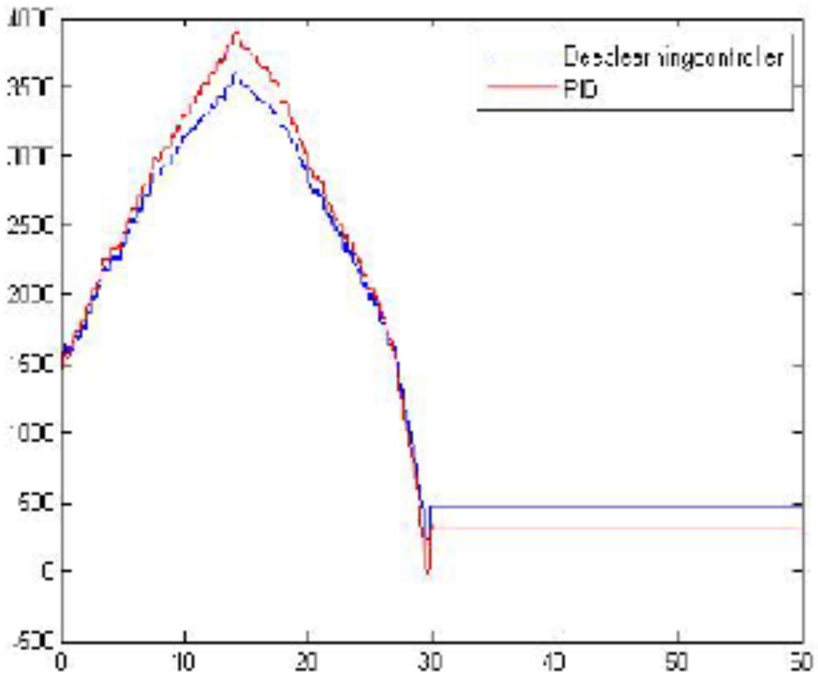
Random Reference Signal

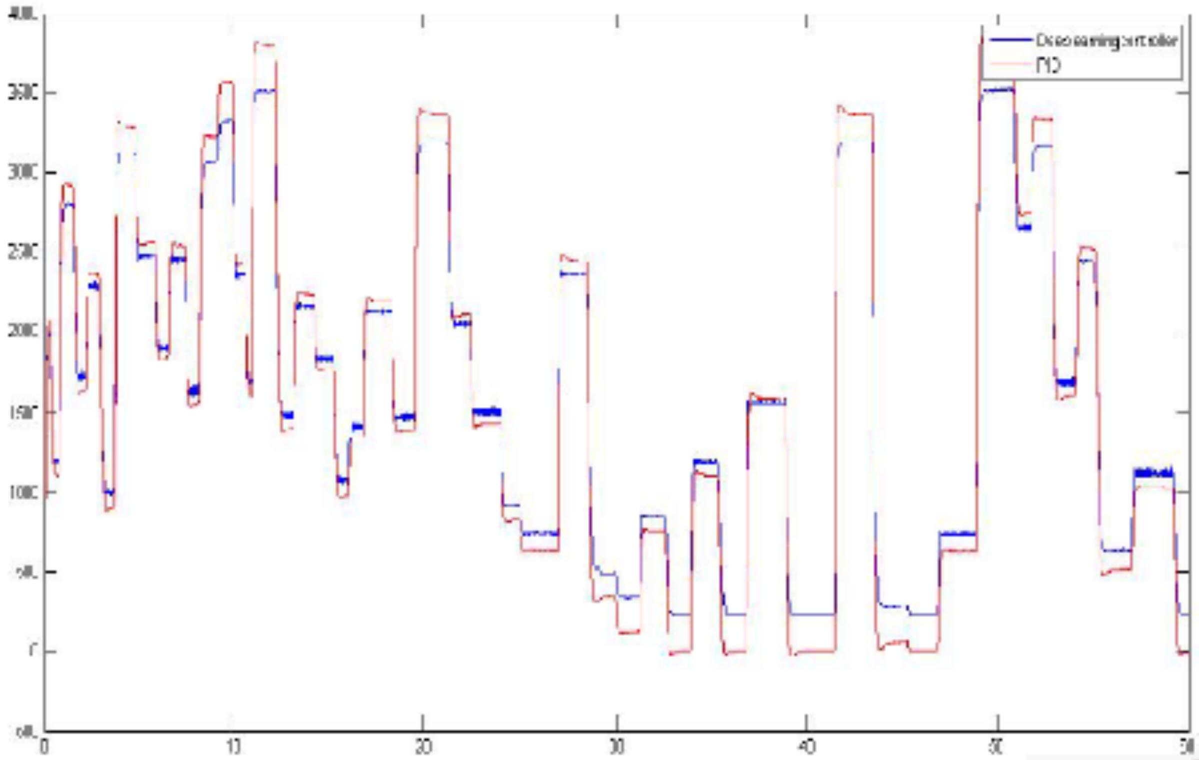


Neural Network Controller Replacing PID

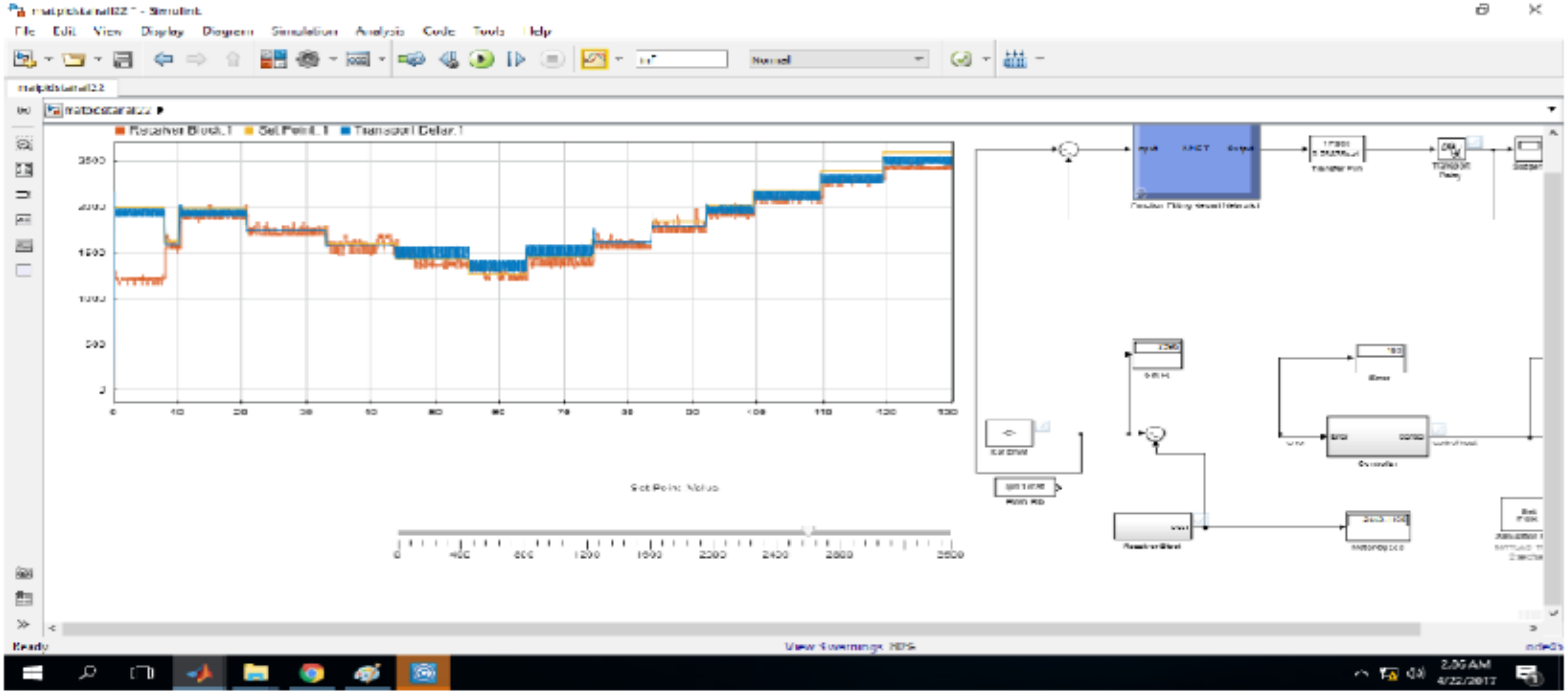


Steady state and random reference signal tracking





Neural Network Controller with DC Motor



Contact

Prof. P. S. V. Nataraj
Systems & Control Engineering IIT Bombay
nataraj@sc.iitb.ac.in

Pramod Mhaske
Sr. Project Manager
pramod.mhk@gmail.com
Tel 022-25764884 , 9320201648