

Simulation: Closed Loop Control of Wound Rotor IM

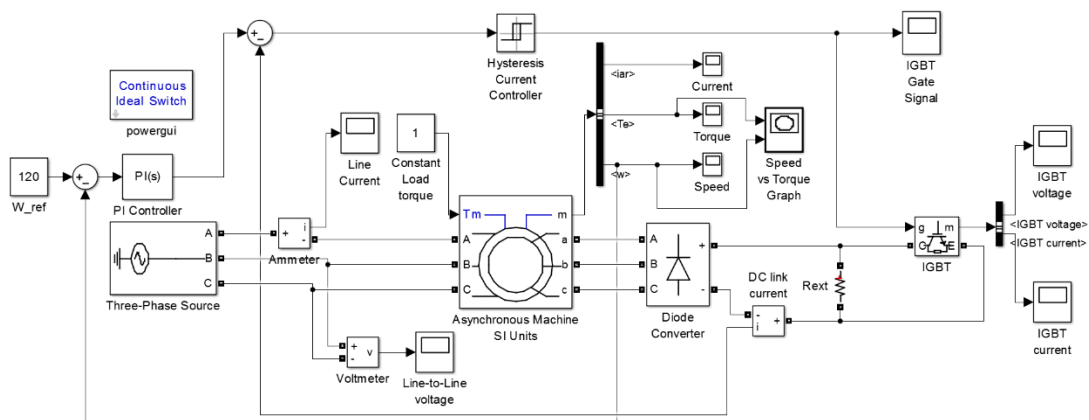
Objective:

- Speed-torque characteristics of rotor resistance controlled wound rotor induction motor drive
- A closed loop control achieves the required speed at any given torque by adjusting the duty ratio.

Components Used and parameters:

- For Speed torque characteristics:
 - Three phase source
 - Phase-to-phase RMS voltage: 400V
 - Induction motor
 - Type: Wound rotor
 - Nominal power, S: 2200 VA
 - $R_s=8\Omega$, $R_r'=1\Omega$, $L_s'=L_r'=2.03822$ mH, $L_m=95.5414$ mH
 - Moment of inertia, $J = 0.09$ kg/m²
 - Mechanical Power, $P = 2200$ W
 - Pole pairs, $p/2 = 2$
 - Diode converter
 - Default parameters
 - IGBT (for switch)
 - Default parameters
 - Pulse Generator (for IGBT)
 - Frequency, $f = 2$ kHz
 - Pulse width, $\delta = 99\% = 0.99$
 - Amplitude, $V = 1$ V
- Extra components for closed loop control
 - PI controller
 - Form: $1+1/s$
 - Relay (for Hysteresis Current Controller)
 - This is used in place of pulse generator

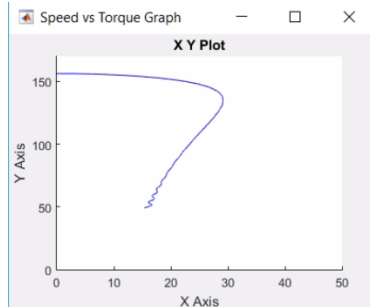
Simulink Model overview:



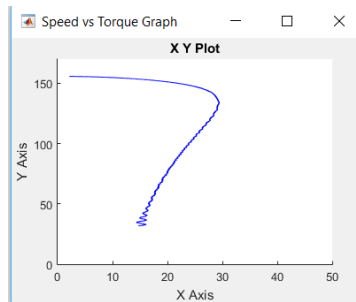
Observations:

1. The speed-torque characteristics were obtained as expected, with the stable and unstable regions of IM operation with constant load torque.

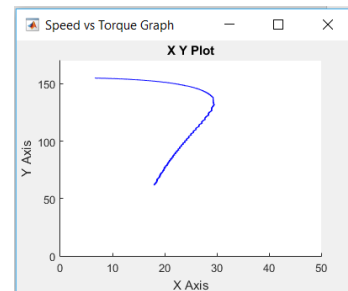
The values in the final characteristic obtained did not contain the lower values of speed and torque, *possibly* because of Simulink's limited capability of storage of data points.



(a) $T = 1 \text{ N-m}$



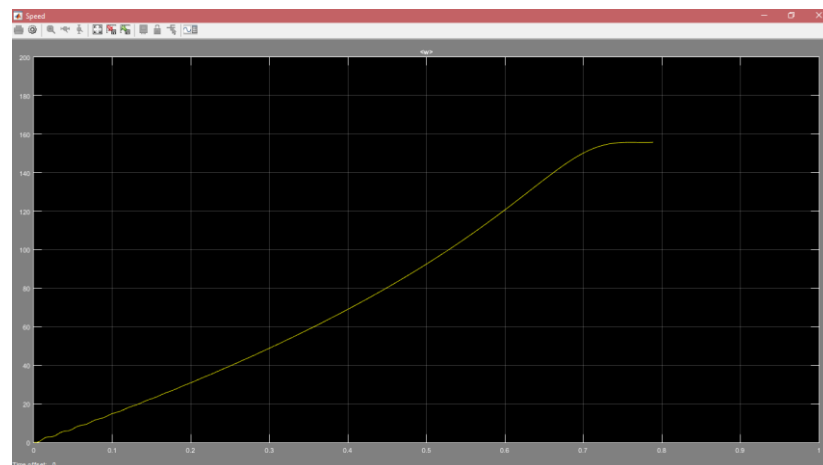
(b) $T = 2 \text{ N-m}$



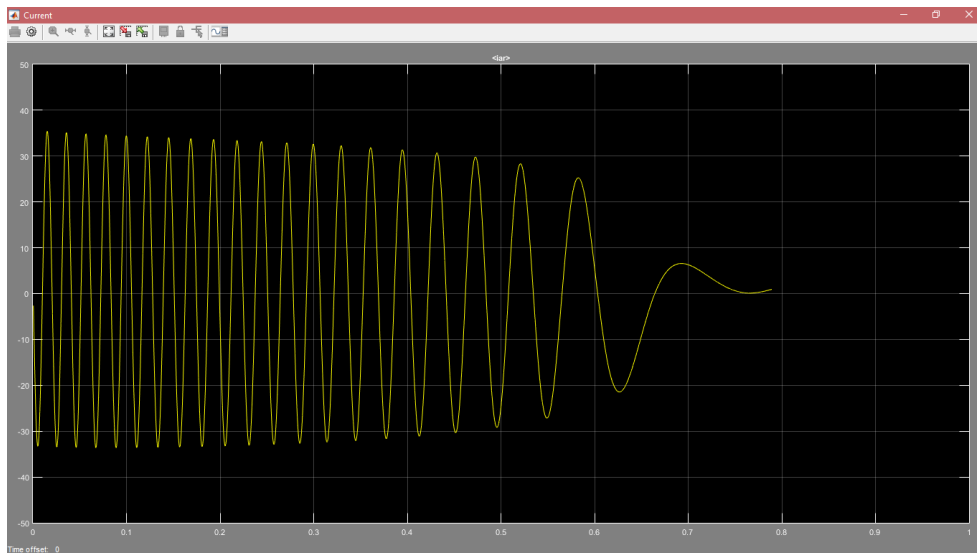
(c) $T = 5 \text{ N-m}$

For observing the complete graph, please refer to the MP4 file.

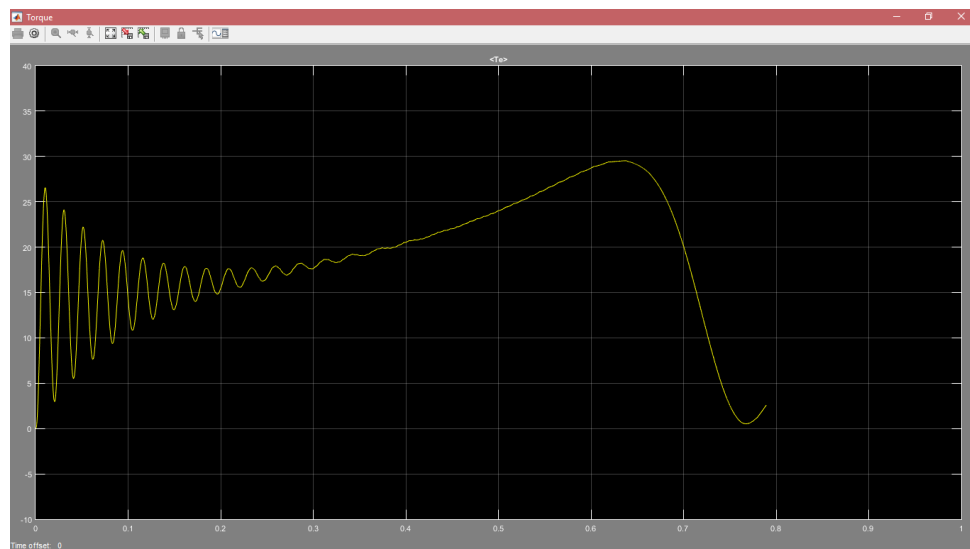
2. The waveforms for variations (with time) of motor voltage, current, speed and torque were obtained as follows:



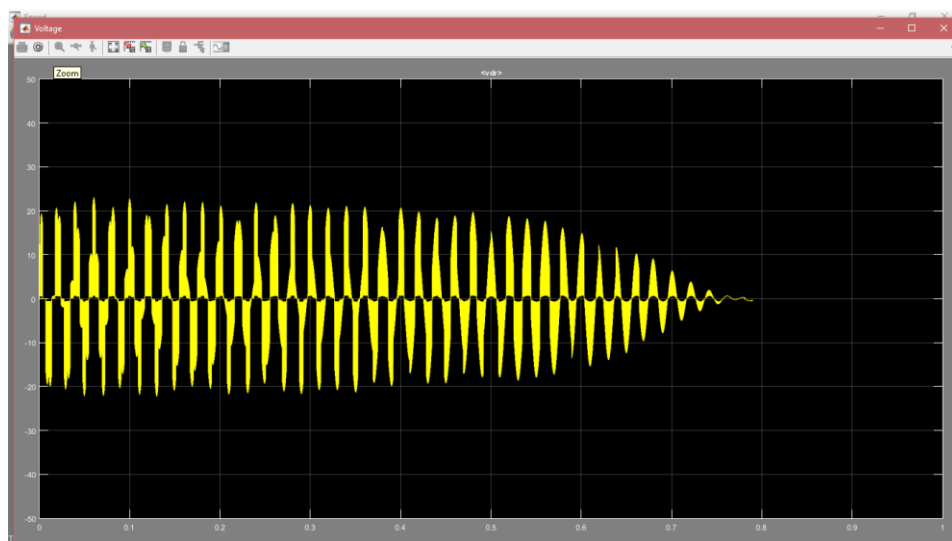
(a) Speed versus time



(b) Current versus time



(c) Torque versus time



(d) Voltage versus time