

MIDDLE EAST TECHNICAL UNIVERSITY

Electrical & Electronics Engineering

Simulation Project #2

EE 463

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Introduction

In this project, we are asked to design and simulate

Q1) Single Phase Diode rectifier is built for Turkish Grid (400Vl-l and 50 Hz) system. Since single phase diode rectifiers are connected to line to neutral, 230√2 ≈ 325Vpeak is applied to the system.

Figure 1: Single Phase Diode Rectifier with RLOAD = 100 Ω.

As seen from Fig.1, 4 diodes are used with load resistance 100Ω. At first, I was having trouble with simulation in Simulink because I did not add ‘powergui’ GUI into the simulation subblock. Powergui is used for simulating any Simulink model containing Simscape™ Electrical™ Specialized Power Systems blocks. It stores the equivalent Simulink circuit that represents the state-space equations of the model.

Q2) DC Motor Drive

a.

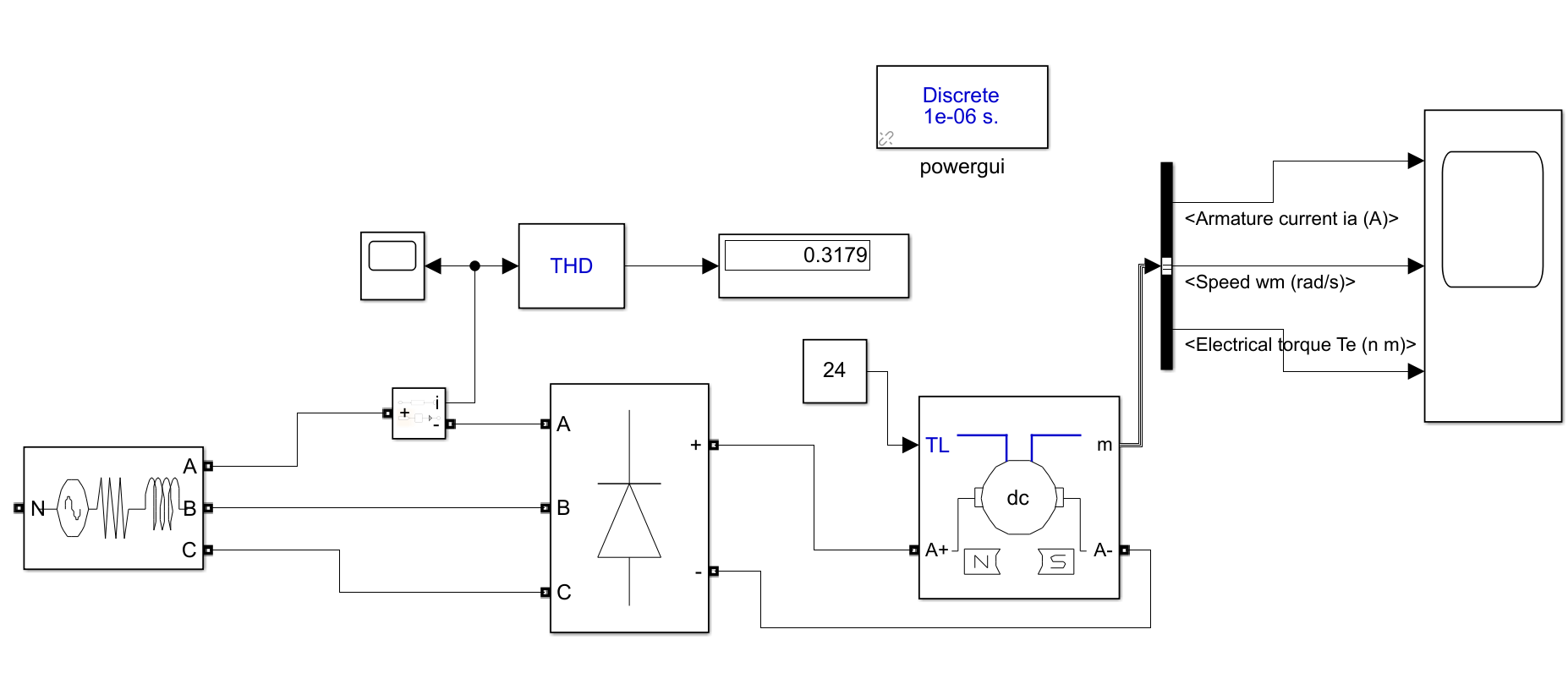


Figure : Circuit simulated DC motor drive

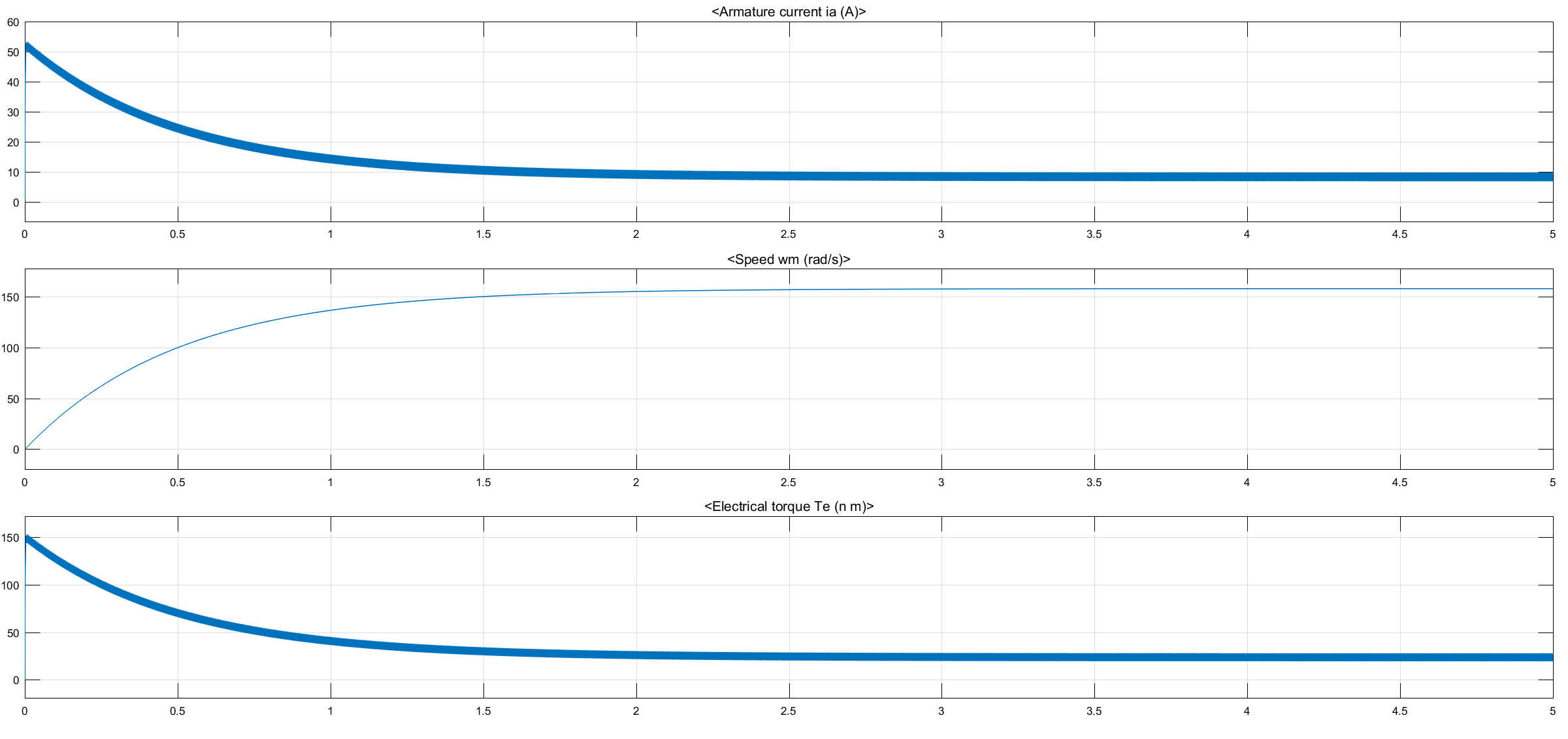


Figure : Armature Current, Speed and Electrical Torque waveforms

b. Note that THD is calculated and displayed on Figure ?? as %31.8

We want to drive our DC motor with a constant DC voltage. However, we have 3Ɵ full-bridge rectifier for DC rectification. As known, 3Ɵ full-bridge rectifier is the reason we have ripple at the output voltage, current and thus torque waveforms.

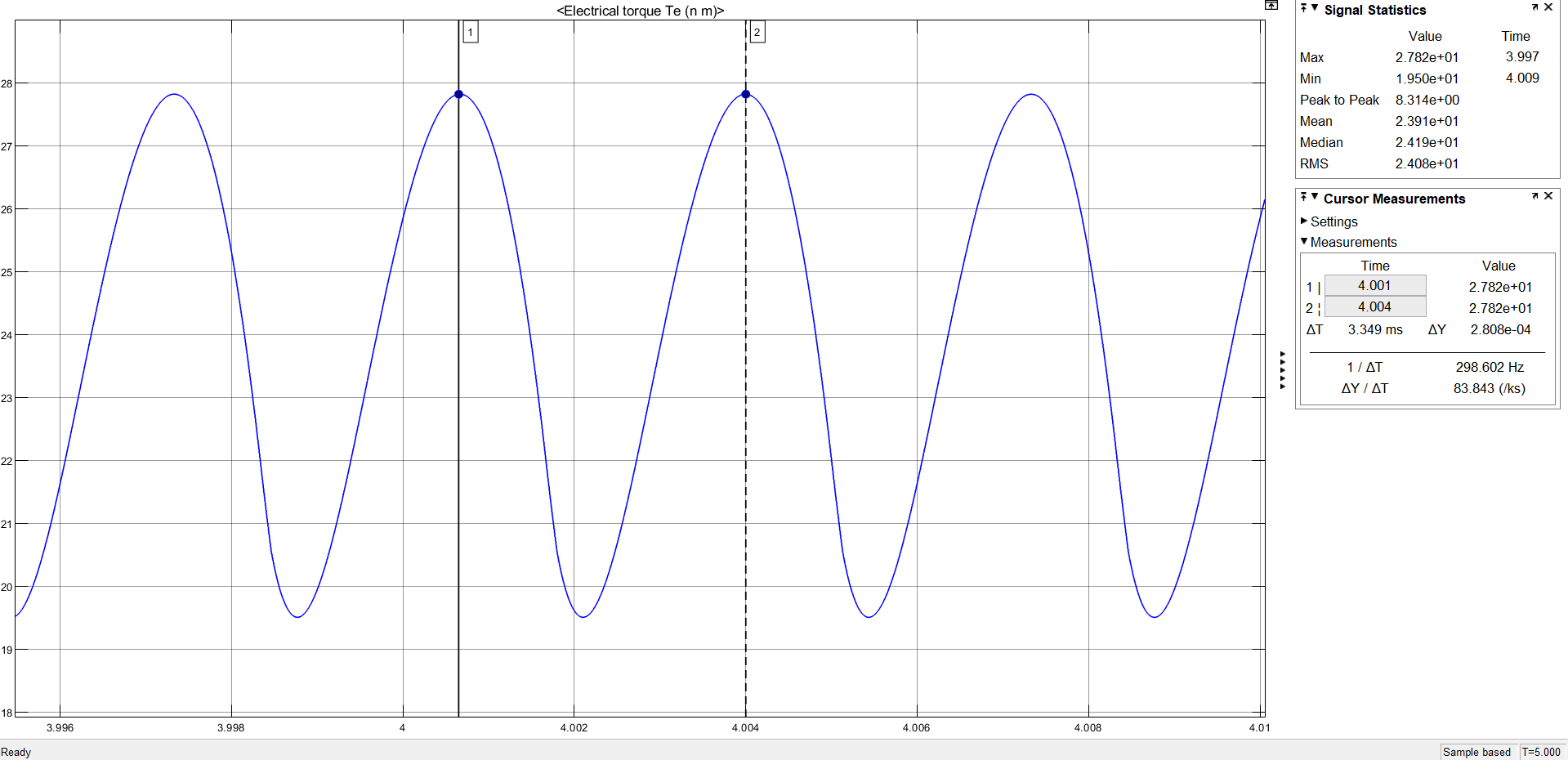


Figure : Electrical Torque waveform

In Figure ??, torque waveform is illustrated at steady state. When the cursor measurements are done, we see that torque waveform has 299Hz frequency. We expect it to be happen because at the output of 3Ɵ full-bridge rectifier, we have 6 pulses in each cycle which corresponds to 50Hz\*6=300Hz.

In magnitude case, the ripple is considerably high which oscillates between 19.5Nm to 27.5Nm where the average is 24Nm. The ripple is more than %10. In practice, it may cause problems and it should be decreased to a reasonable value.

c. To reduce the ripple, we can connect a parallel capacitor to load or connect a series inductor to load. By this way, we can reduce the output torque ripple by smoothing the current waveform and hence torque.

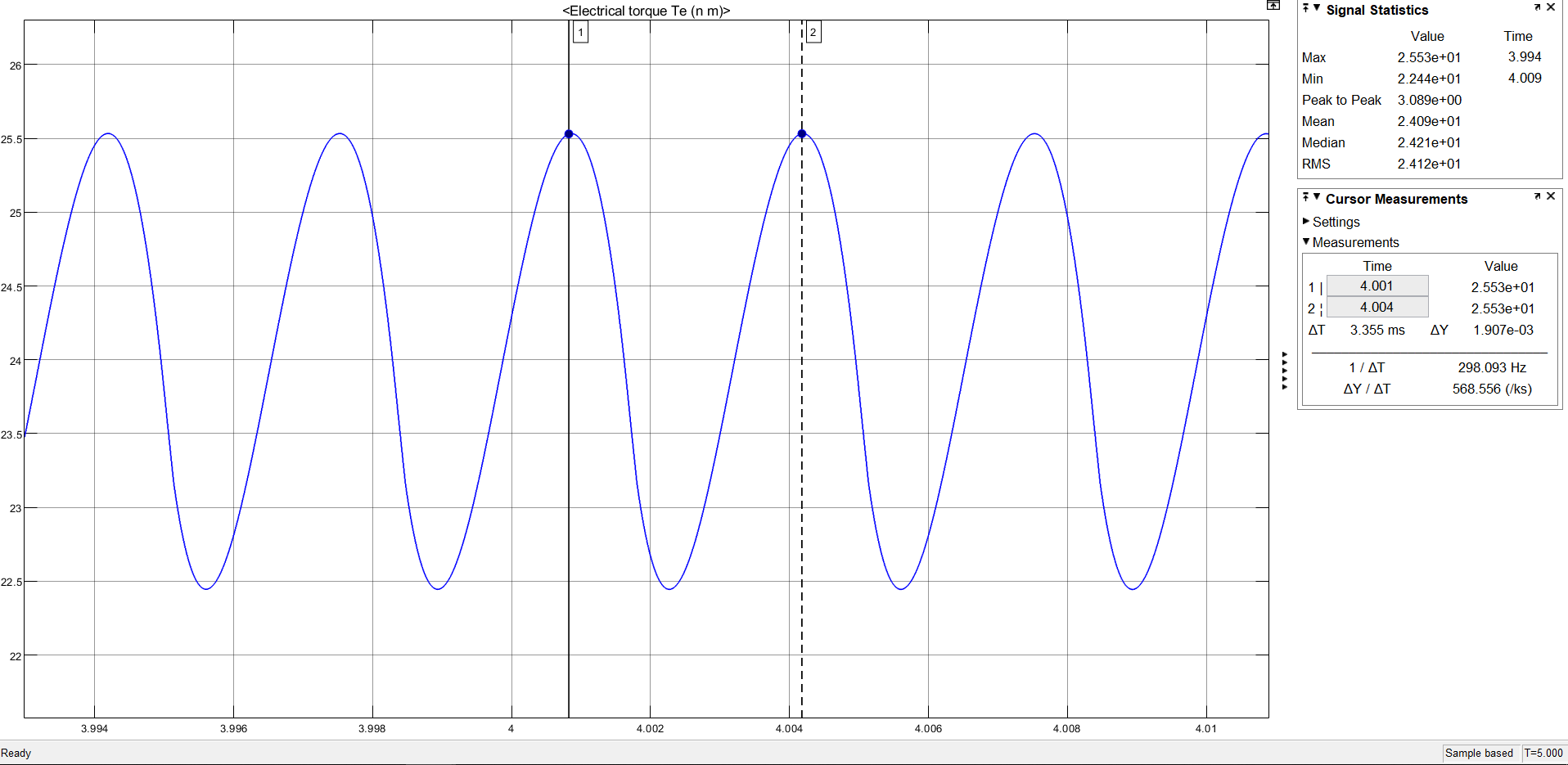


Figure : Electrical Torque waveform with L = 0.02H

As shown in Figure??, a series connection of L=0.02H reduces torque ripple about %6.

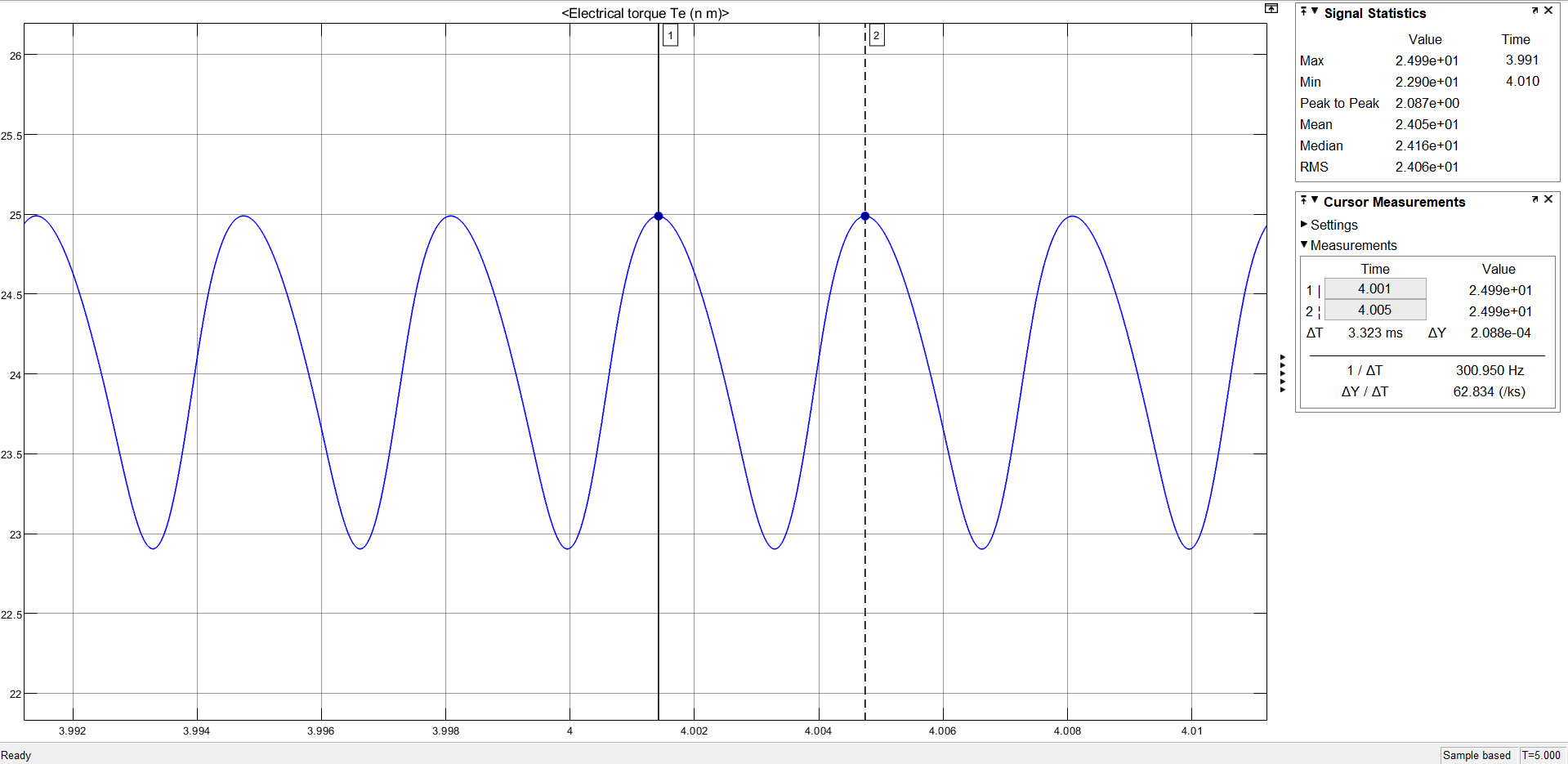


Figure : Electrical Torque waveform with C = 1mF

As shown in Figure??, a parallel connection of C = 1mF reduces torque ripple about %4.

By connecting an extra circuit component, we can reduce the ripple torque which enables us to have more reliable torque characteristics for motor. Having smoother waveform is also important for mechanical concerns. If we have too much ripple at torque output, shaft of motor cannot be durable comparing with less ripple torque case.

What we trade-off here is adding an extra component to circuit. This increases the conduction losses. Also, for higher voltage values as in our case, we need to implement high voltage and current capacity elements which is directly related with the sizes of components. Having bigger components is hard for implementing circuit into board. Furthermore, it is harder to cool the system with bigger sized components.

d.

(1)

From equation (1),

Q3)

References

[1] *Bridge Rectifier Ripple Voltage*. Retrieved from <https://www.electronics-tutorials.ws/diode/diode_6.html>

[2] Mohan, N., Undeland, T. M., & Robbins, W. P. (2002). *Power electronics: Converters, applications, and design*. New York: John Wiley.