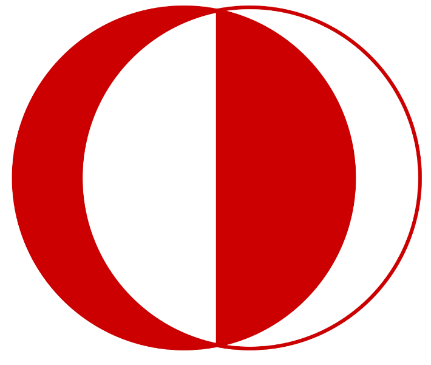
**EE 462-EE464**

**Project**

**Design of a SM-PMSM Variable Frequency Drive with Matlab/Simulink**



**Student 1 & ID: Anıl Yalçınkaya &**

**Student 2 & ID: Hüsnü Oğuz Yorgancılar & 2305787**

# **Part A: Pre-design Stage**

1)

2)

For switching frequency, we have chosen 10\* like given in EE462 course, so

3)

Source is 50Hz, 300Vl-l = 173.21Vph,rms , Vph,peak=244.95V. We have three phase voltage rectifier, so rms of the output voltage is 1.35Vl-l = 405.14V without any filter. To find resistive load equivalent to motor at rated current of 530A, P/I2=R=120000/530^2=0.4272Ω. From simulation, we determined to use LC filter with 100uF capacitor and 3mH inductor giving an output ripple of 3.1V corresponding to 0.79% ripple which is convenient. Note that voltage rms is not exactly the same as 405.14V due to losses and voltage drop on diodes.

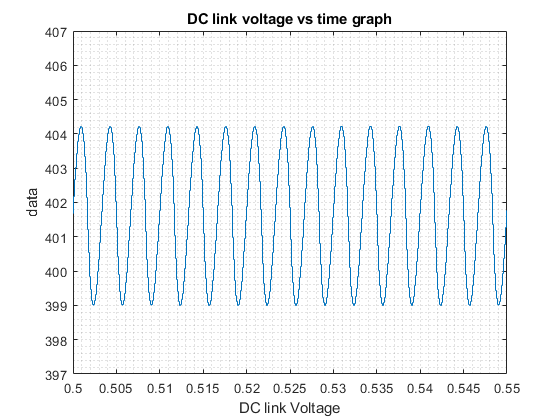


Figure 1: DC link voltage vs time graph

# **Part B: Sinusoidal PWM**

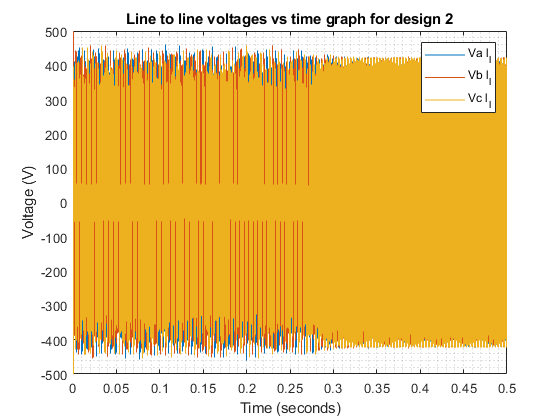
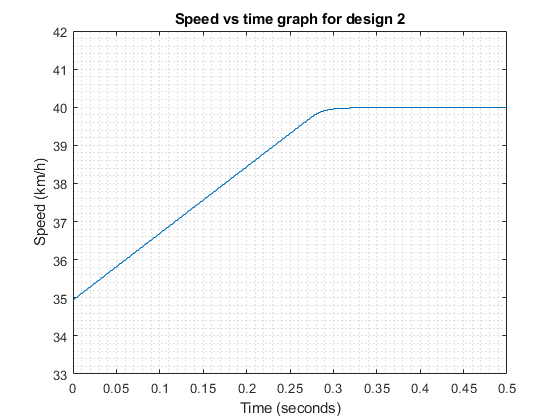
Equivalent inertia seen at the electric machine shaft is found as follows:

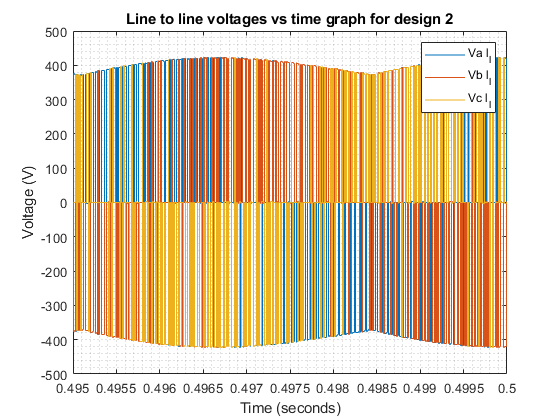
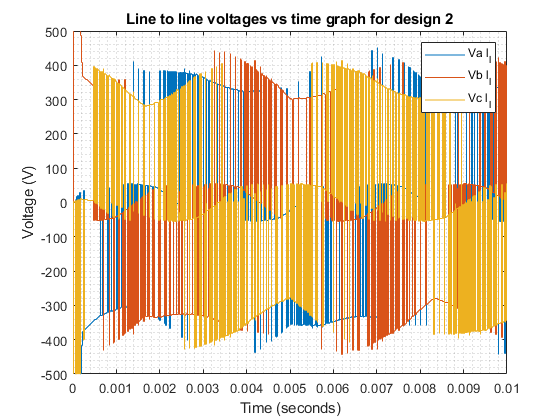
Load seen at the electric machine shaft is found as follows:

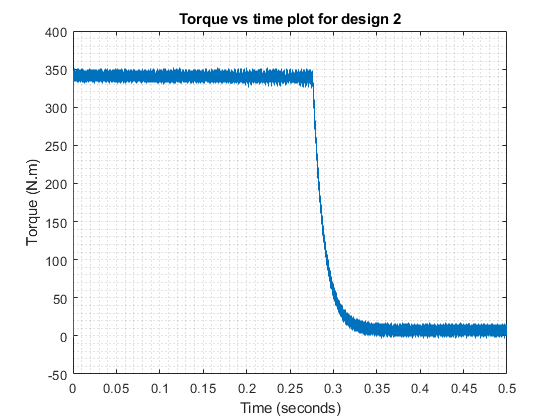
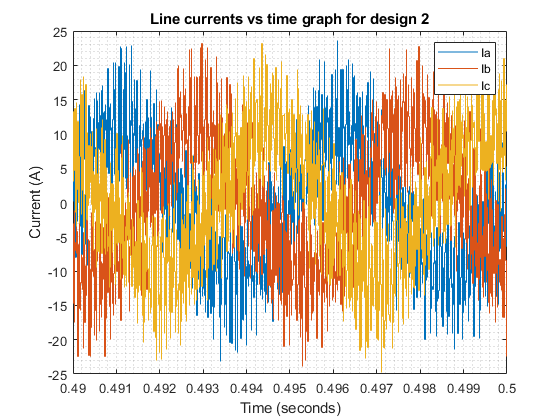
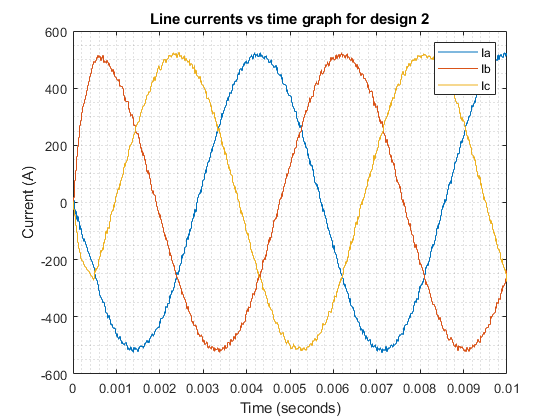
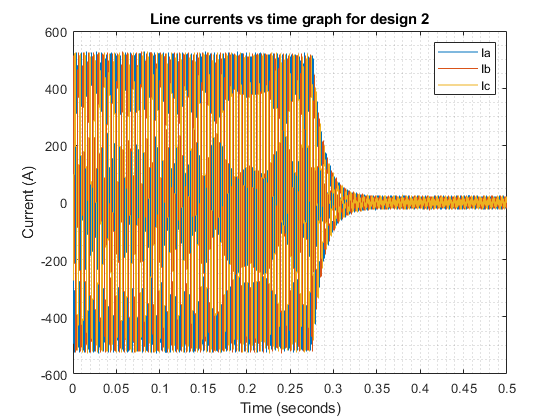
1)

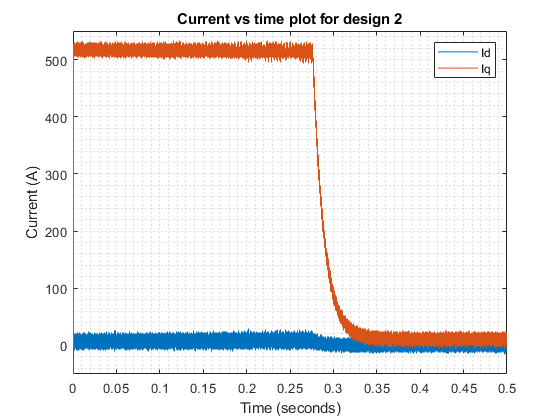
**Drive model 1:**

**Drive model 2:**



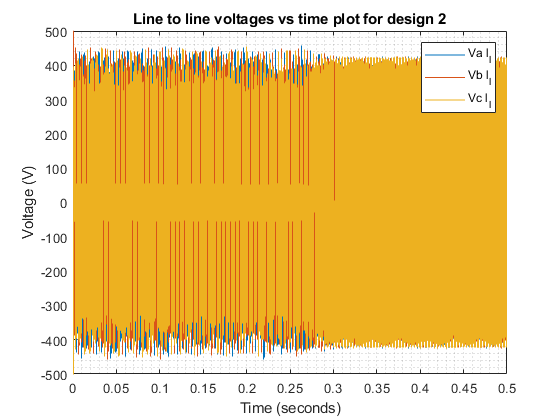
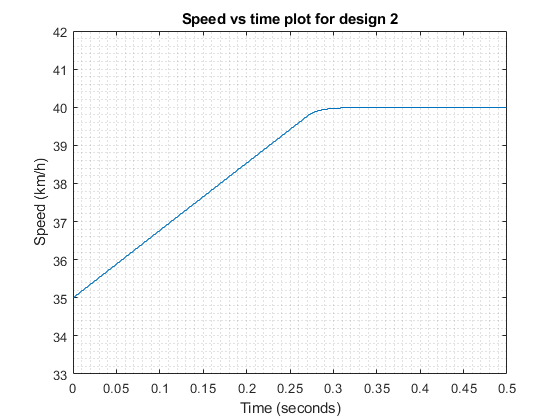


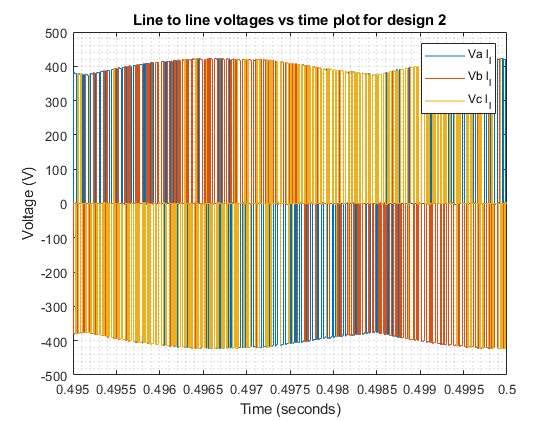
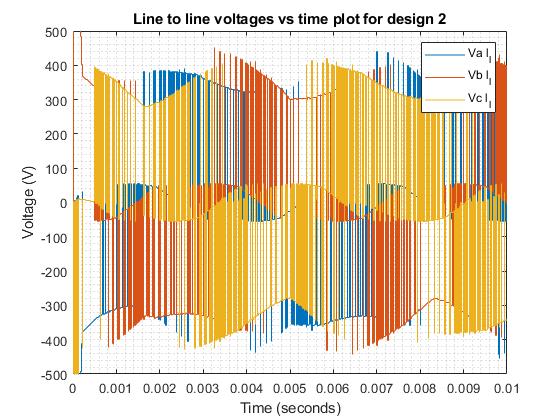


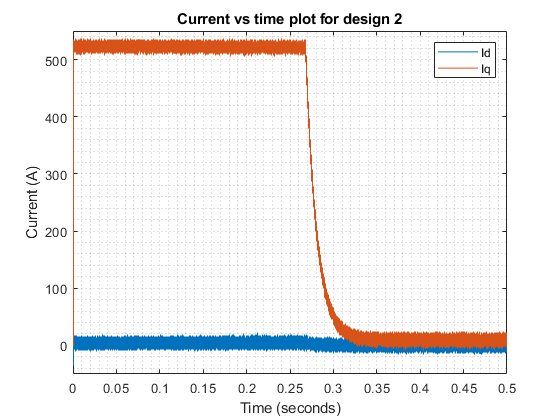
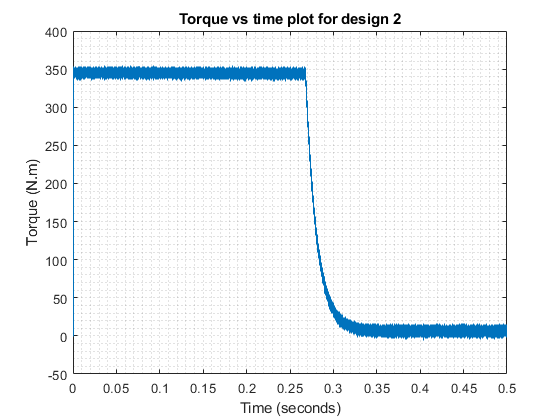
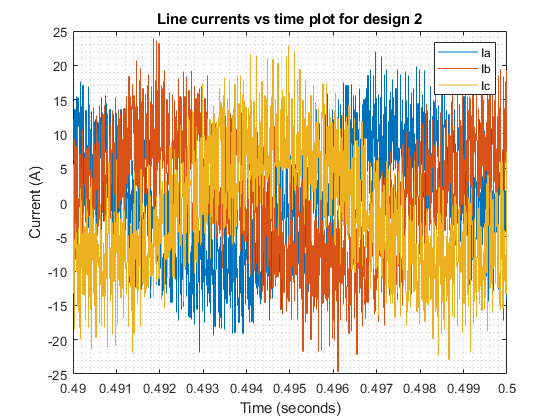
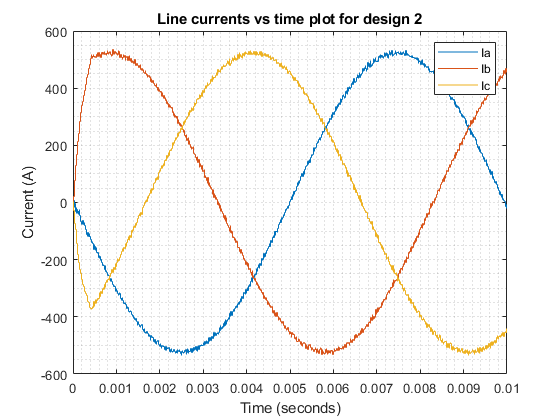
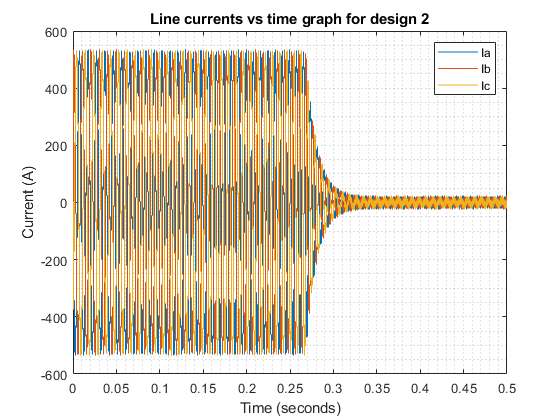


**Drive model 3:**

Design 3 35-40 km/h







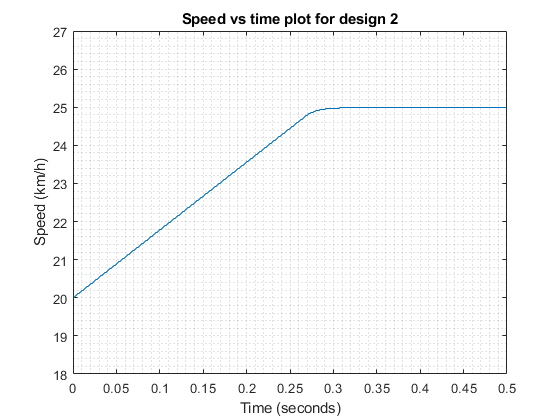
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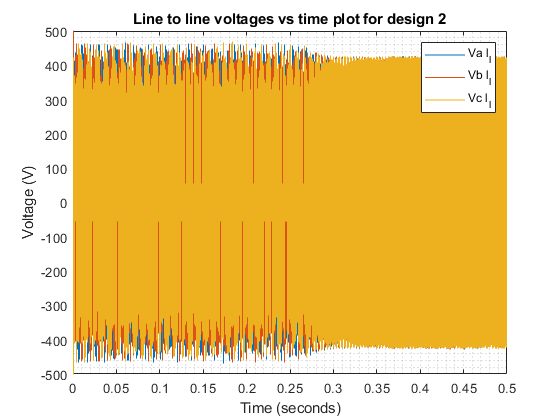
3)

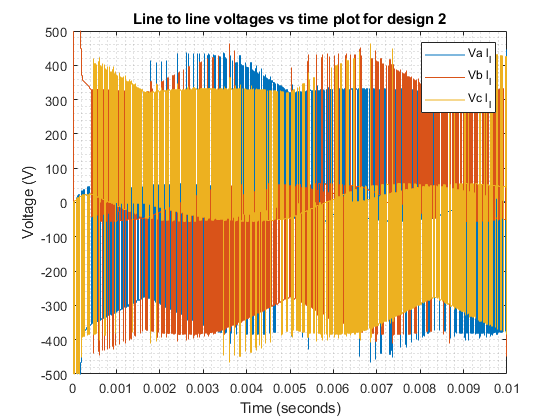
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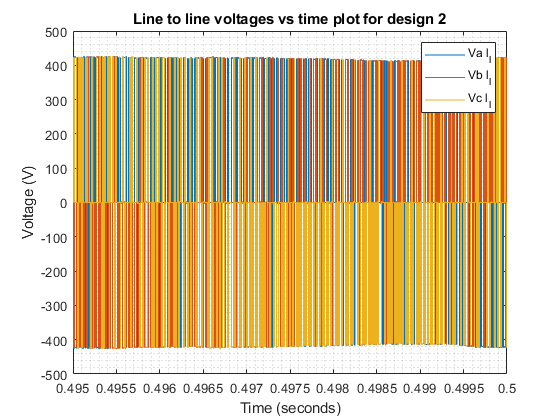
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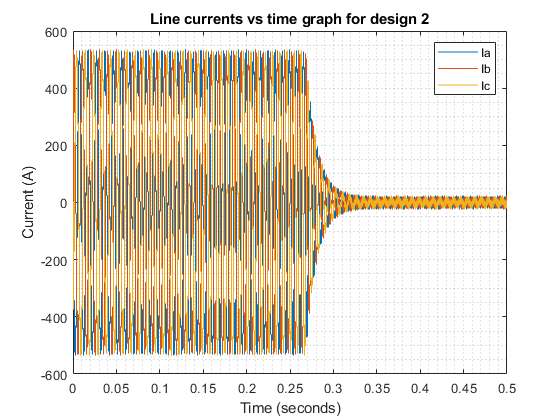
Design 2 20-25

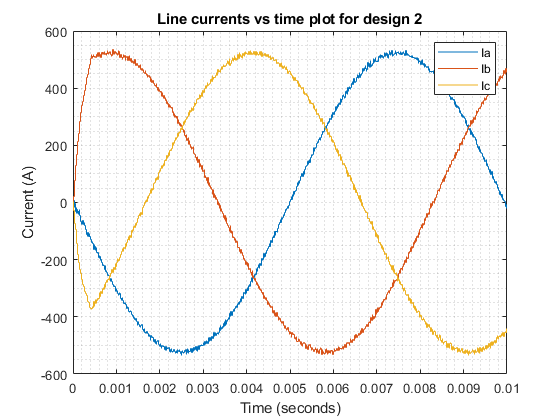


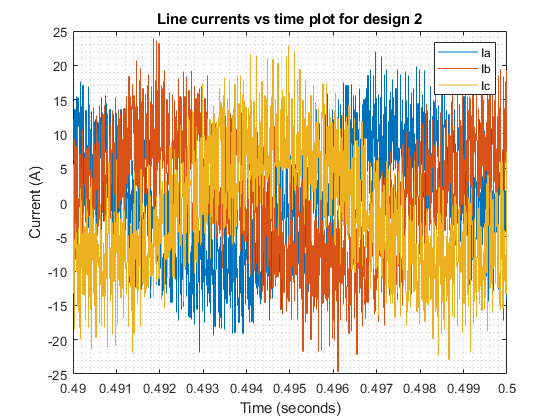


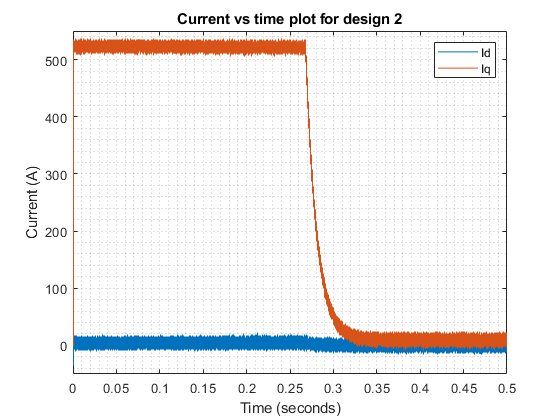
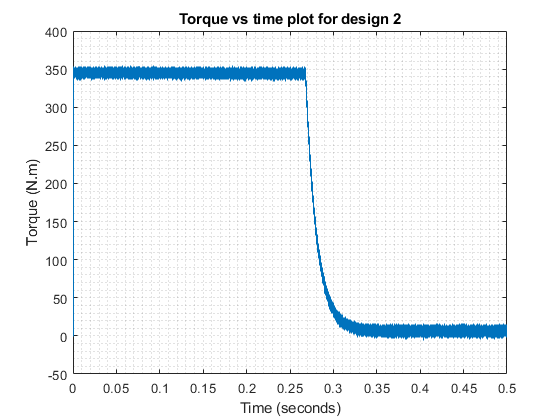




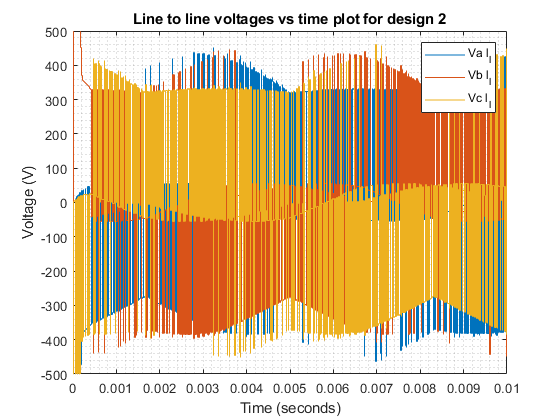
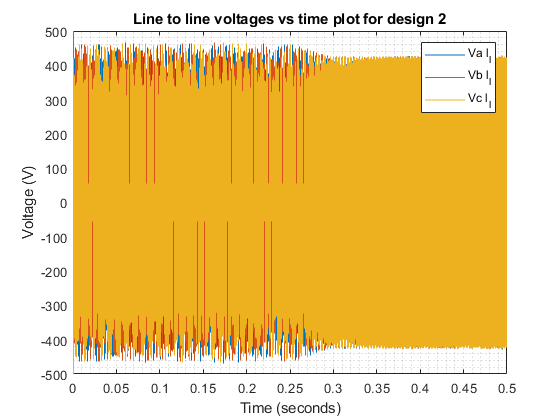
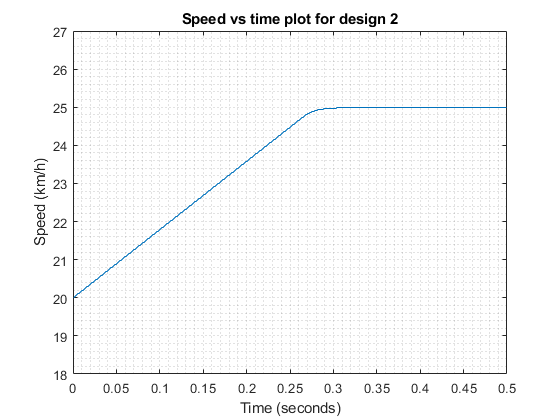


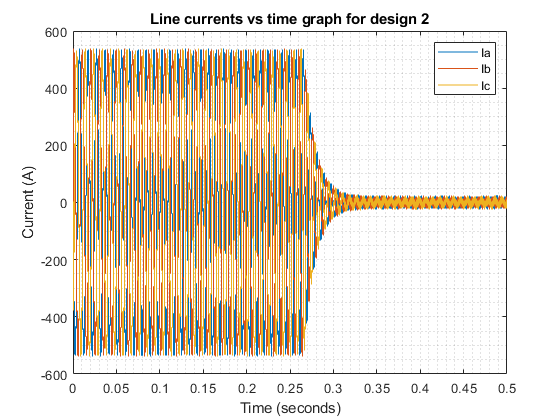
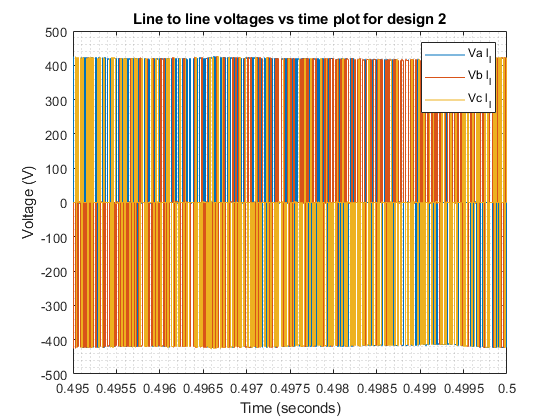


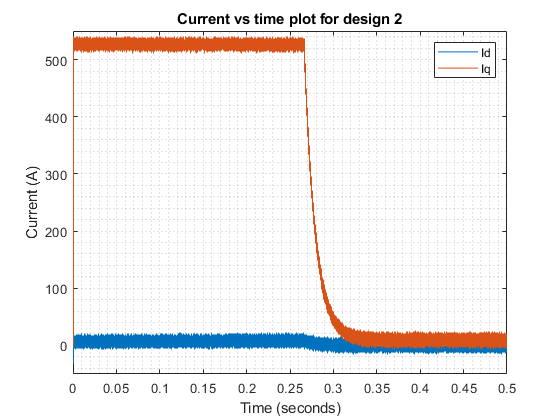
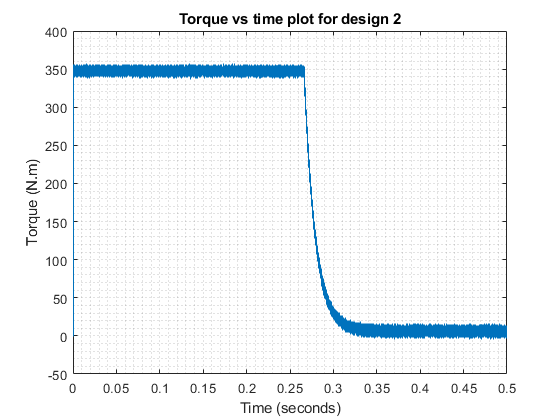
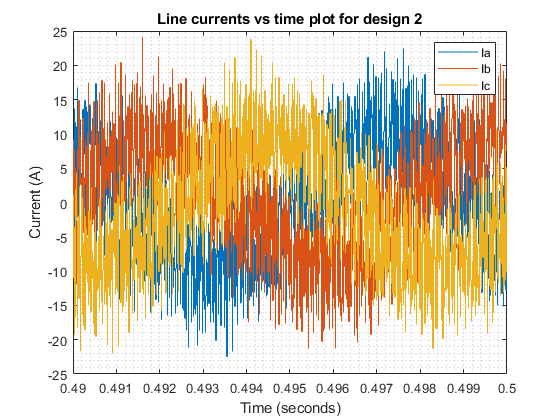
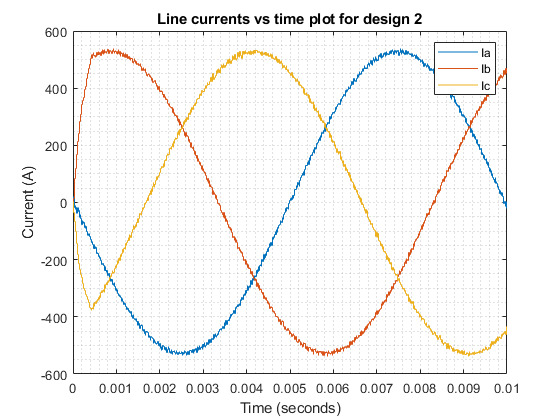




**Drive model 3:**

Design 3 20-25 kmh





4)

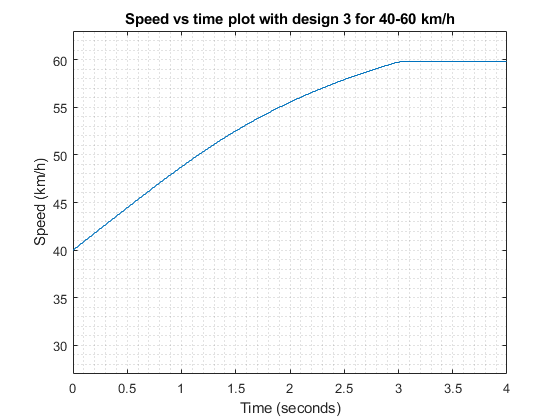
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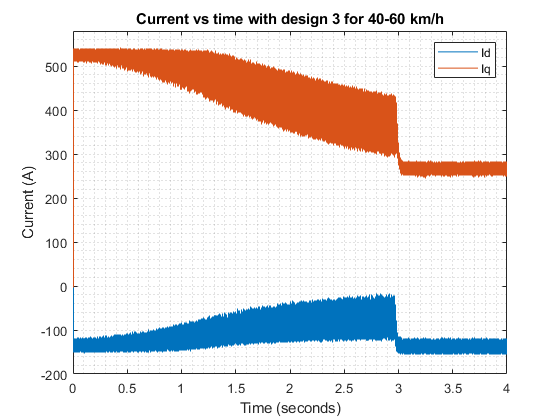
Half of the rated torque means load torque is 175Nm.

At v=60km/h means wem=472.2rad/s and at this speed, maximum torque is 120000/472.2=254.12Nm. we=1888.8 rad/s. Ld=Lq=165µH, Vph,lim=200.8V as found in part-B.

At T=254.12Nm,

Voltage limit:





# **Part C: Component Selection**

1)

As simulated in part-B, the maximum voltage and current values are found around 450V and 530A, so a safe choice for these ratings could be 600V 600A rating. To satisfy this rating, PM600CLA060 three phase 600V 600A IGBT Power Module is chosen.

2)

which is a very high loss. Since the on off times are high for this model, it highly increases the switching loss. Also, forward voltage is quite high, increasing conduction loss. All these losses increase the temperature of the device and makes the thermal management difficult.

3)