Course Project Report

Subject: High Power Converters Design Control and Operation - EE798M

Name: Vinayak Kumbhar

Roll No: 22104137

Que No: 12

Model data:

- 18 Pulse AC DC multiwinding transformer:
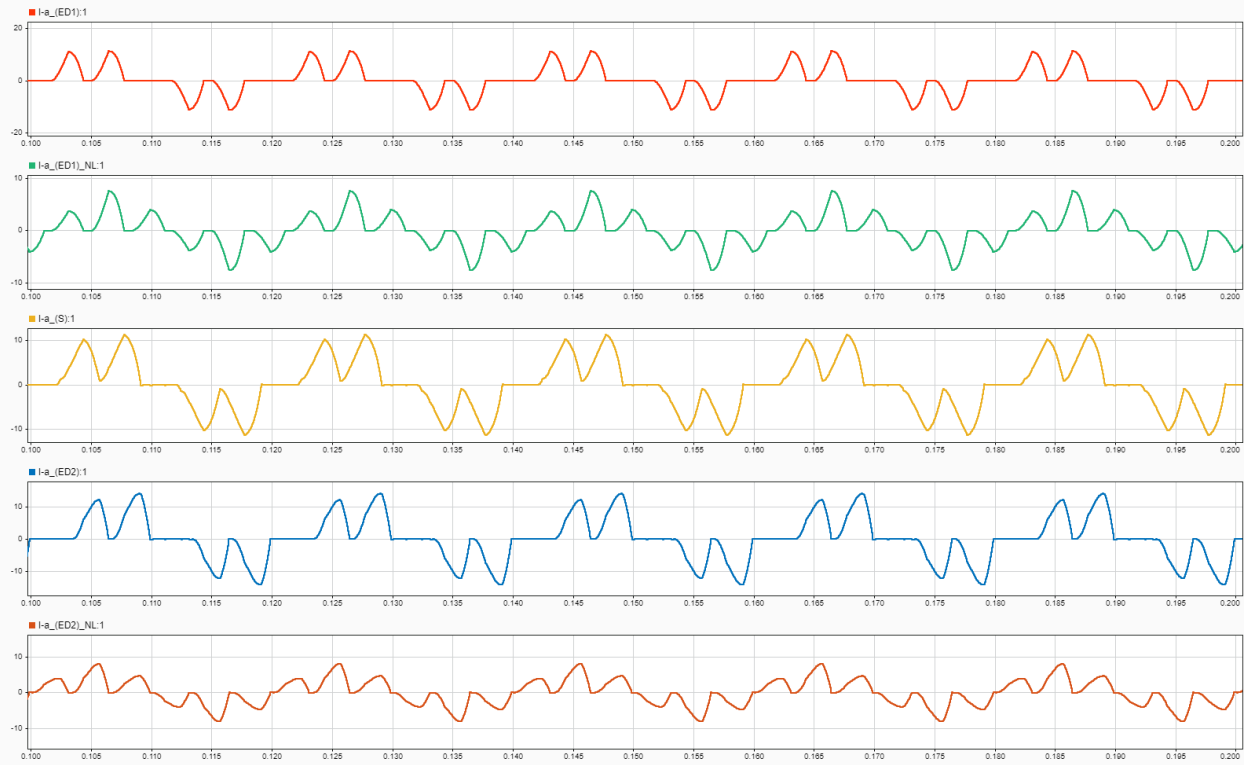- Primary: Star connected; Secondary: Extended Delta (+20°), Star (0°), Extended Delta (-20°)

Sr No.	Voltage	Value
1	Primary Winding Phase Voltage	239.6 V
2	Secondary Star Winding Phase Voltage	86 V
3	Secondary Ex-Delta Large Winding Voltage	78.8 V
4	Secondary Ex-Delta Small Winding Voltage	45.5 V

- DC Link Capacitors: 4700µF
- Load: RL load - 50Ω, 10mH
- Carrier Frequency: 1550Hz; (fm=31)

Note: RL Load on individual DBRs has been used to generate observation no **c) 3)** & it has been commented out from the model.

a)

i)   Secondary & Primary winding currents - Phase a:

Figure 1: +20° Extended delta connected secondary winding: (Ns) Small winding current (I-a_(ED1)) & Large winding current (I-a_(ED1)_NL), 0° Star connected secondary winding current (I-a_(S)), -20° Extended delta connected secondary winding: (Ns) Small winding current (I-a_(ED2)) & Large winding current (I-a_(ED2)_NL) respectively.

ii)   Primary winding currents - Phase a:
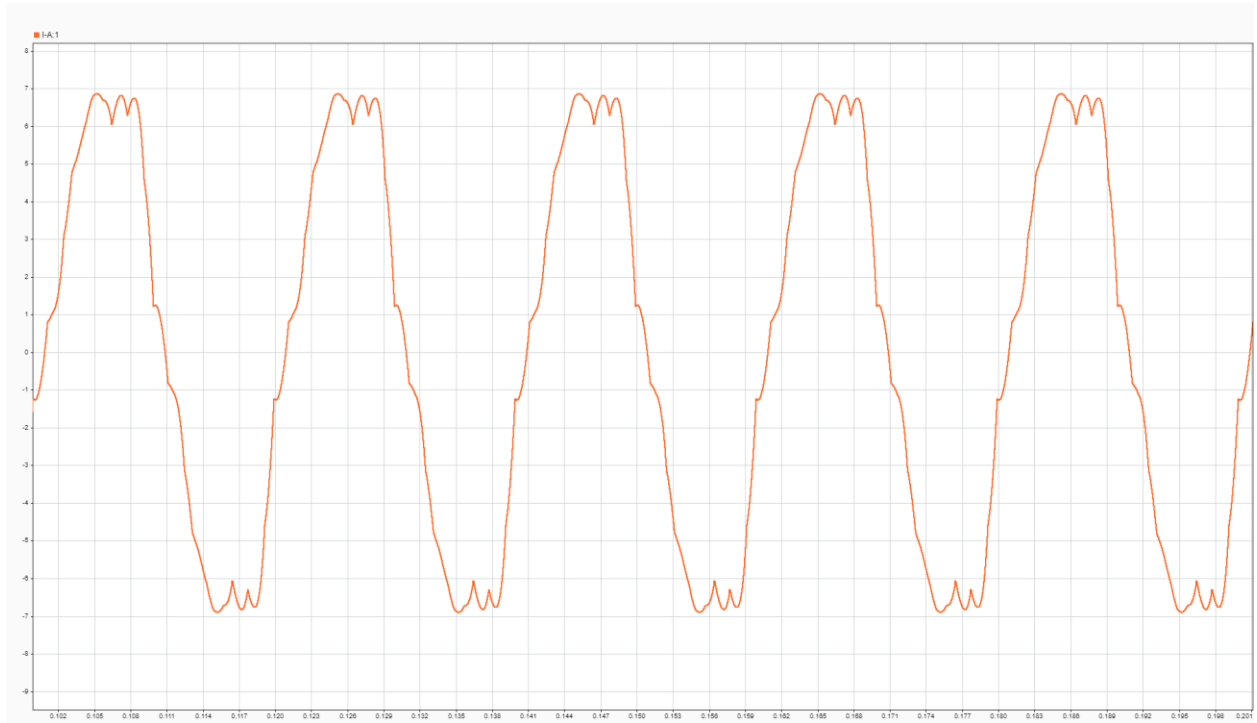
Figure 2: Star connected primary winding current (I-A).

iii)   Input line current - Phase a:
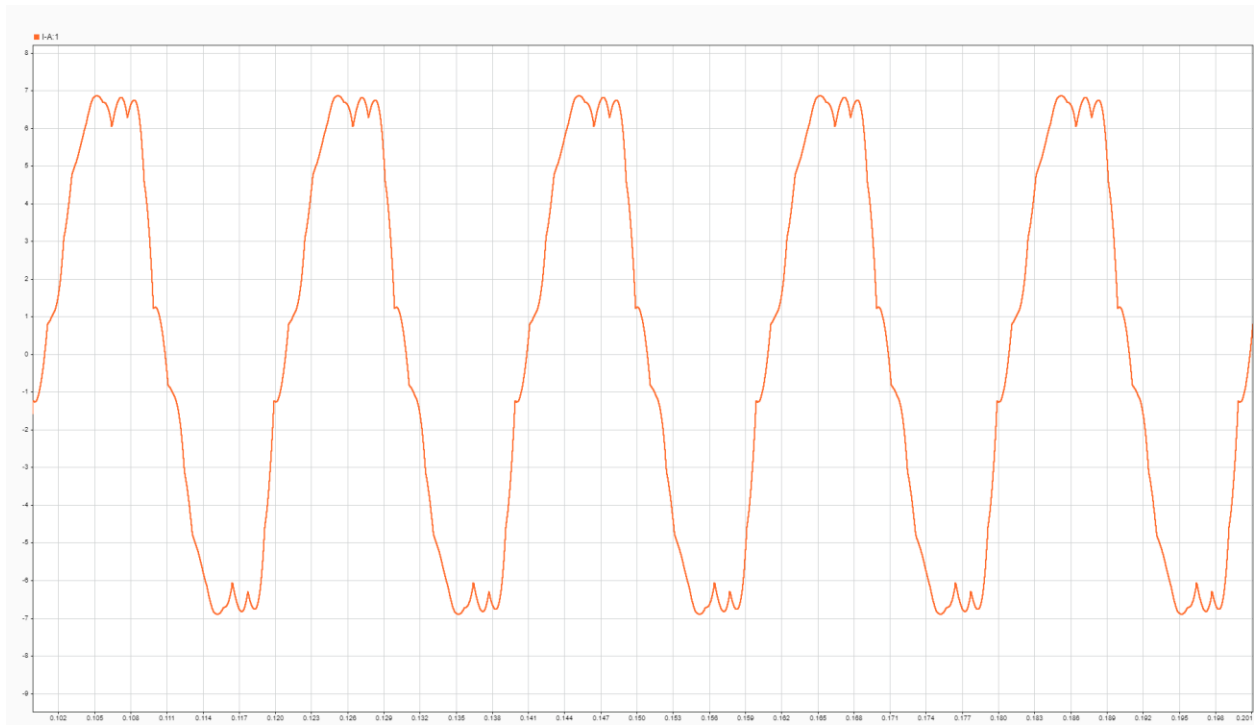
Figure 3: Input line current (I-A).

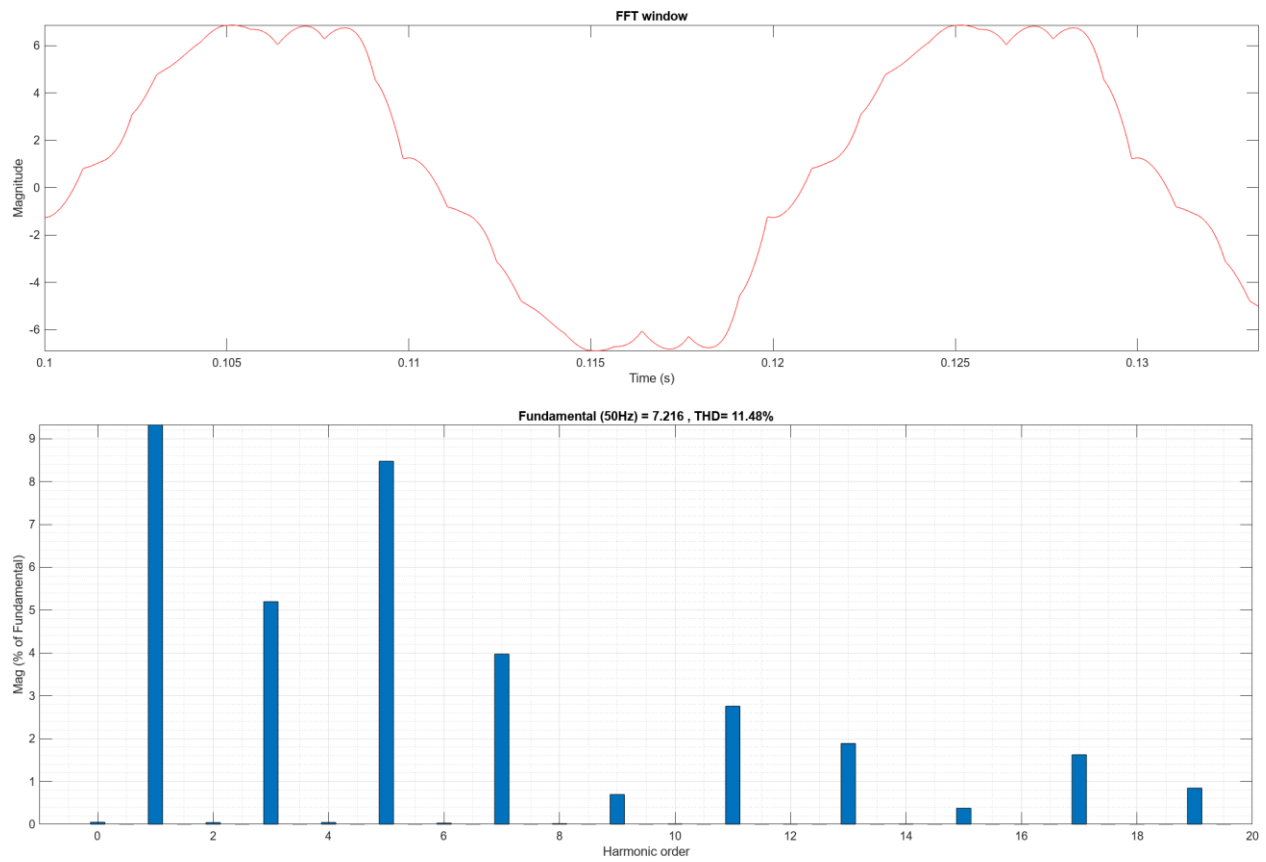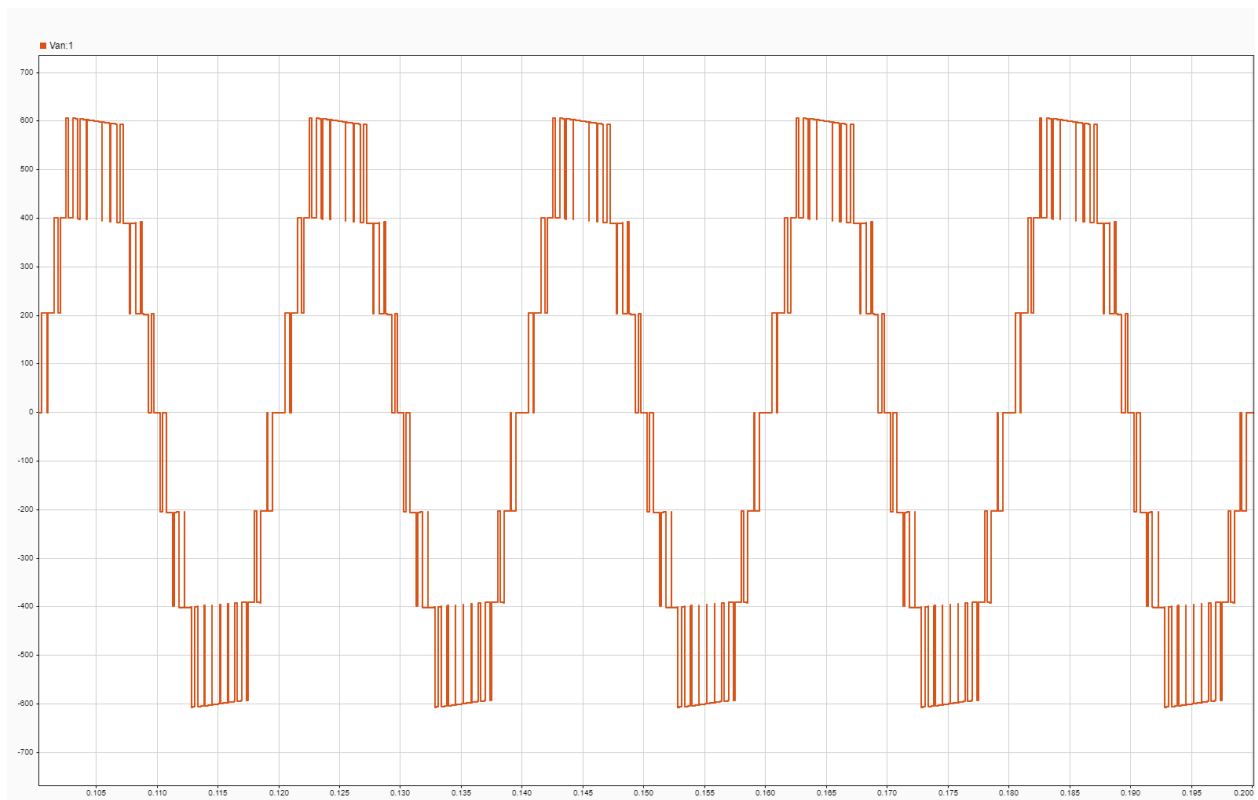iv)   FFT of input line current - Phase a:

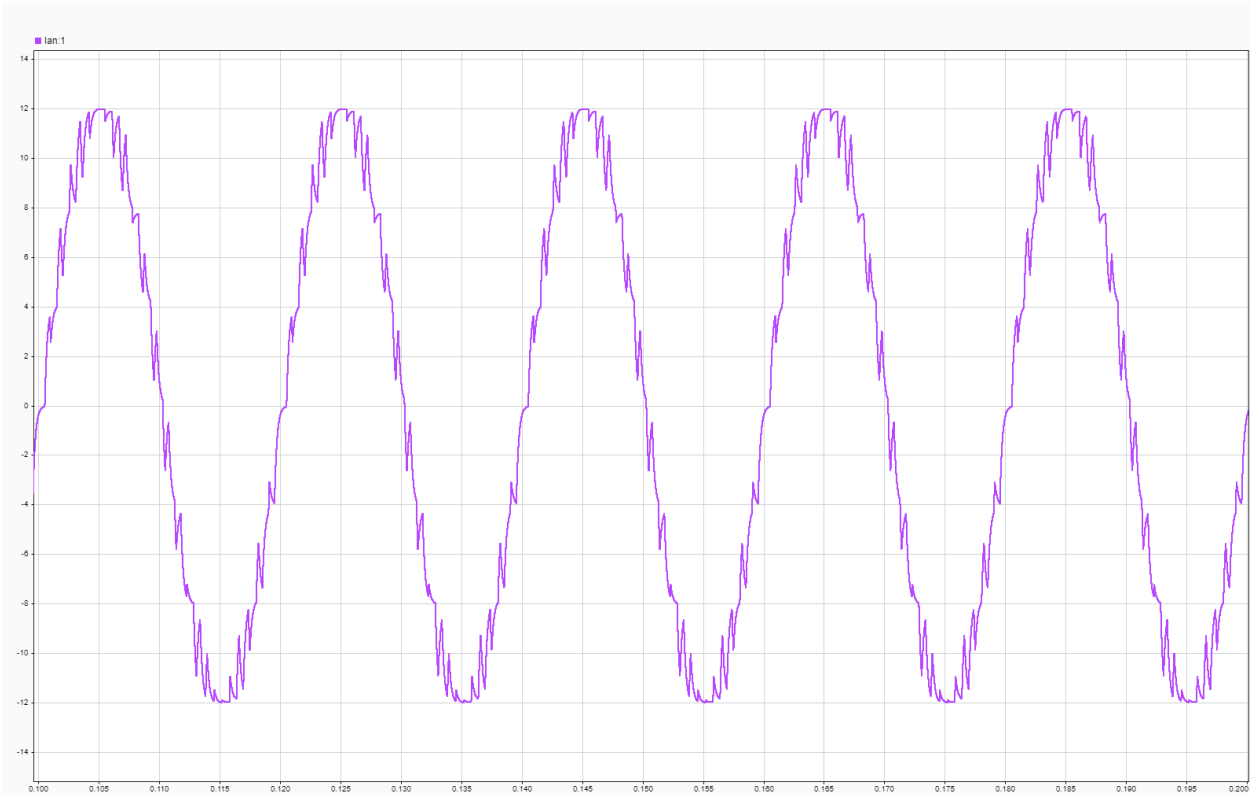**Figure 4:** FFT of input line current (I-A).

b)
  i)   Pole voltage:

Figure 5: Pole voltage of inverter - (Van).

ii)   Load current:

Figure 6: Load current of inverter - (Ian).
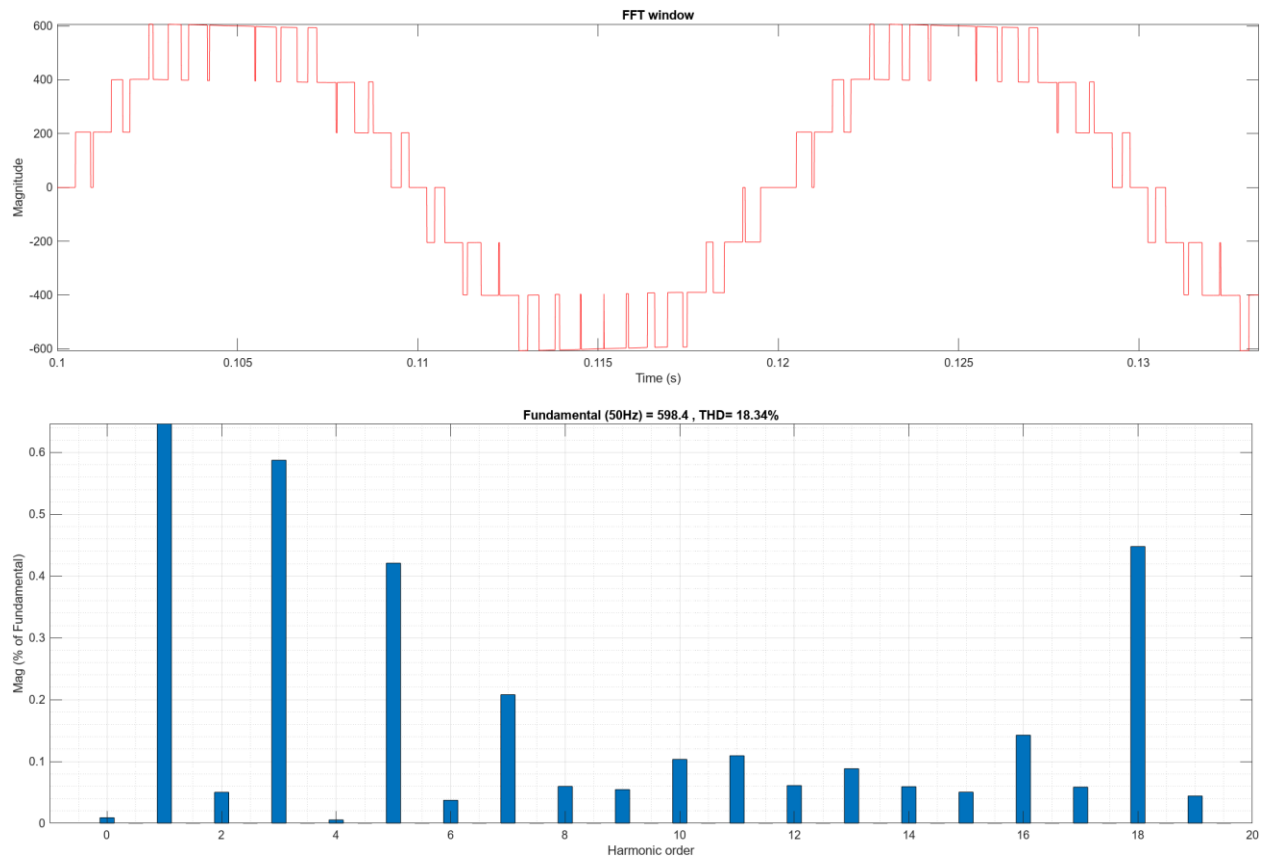
iii)   FFT of pole voltage:

**Figure 7:** FFT of pole voltage (Van).

c) Useful observations:
   1) 18 Pulse AC-DC converter output voltage of each DBR = 200 V_{dc}
   2) DBR output voltages get slightly unbalanced because of unequal loading on individual DBR from 7 Level Binary cascaded MLI.
   3) Effect of transformer leakage inductance on input line current waveform:
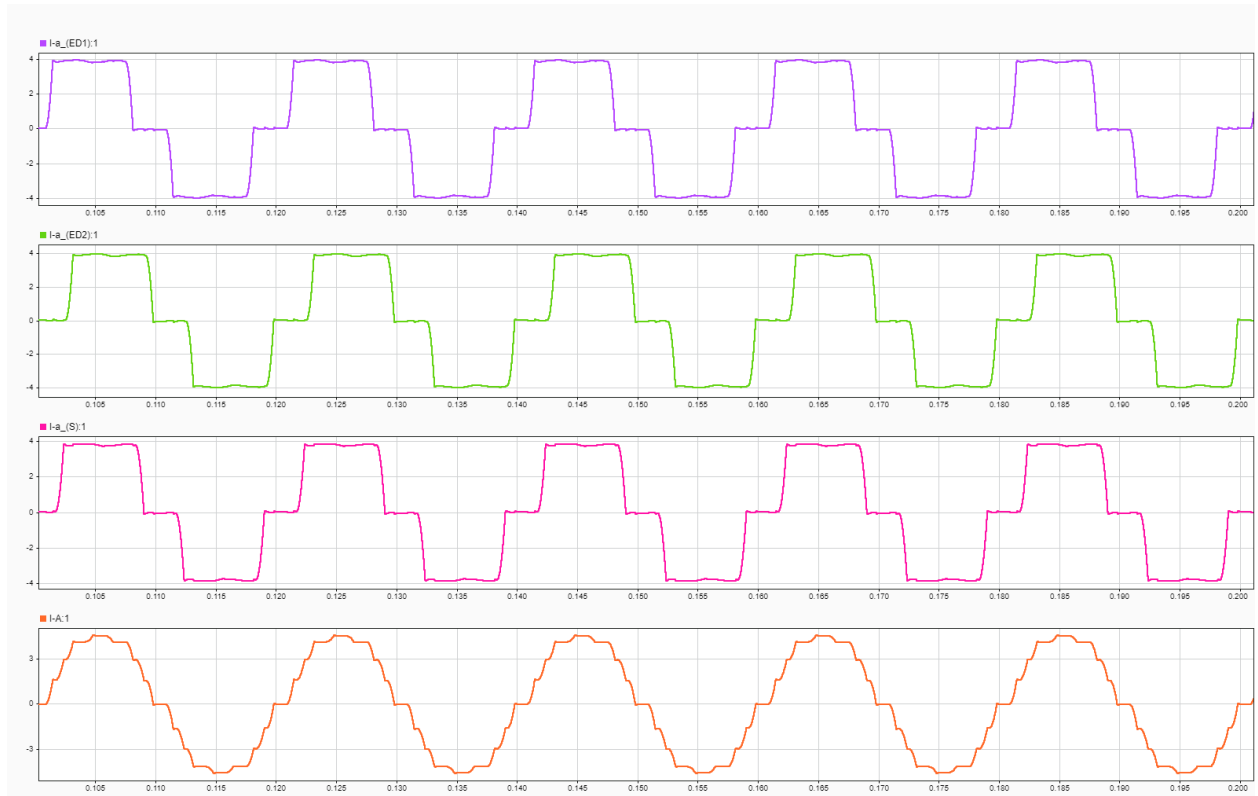   i) With leakage inductance = 0 pu, the input line current contains more harmonics:
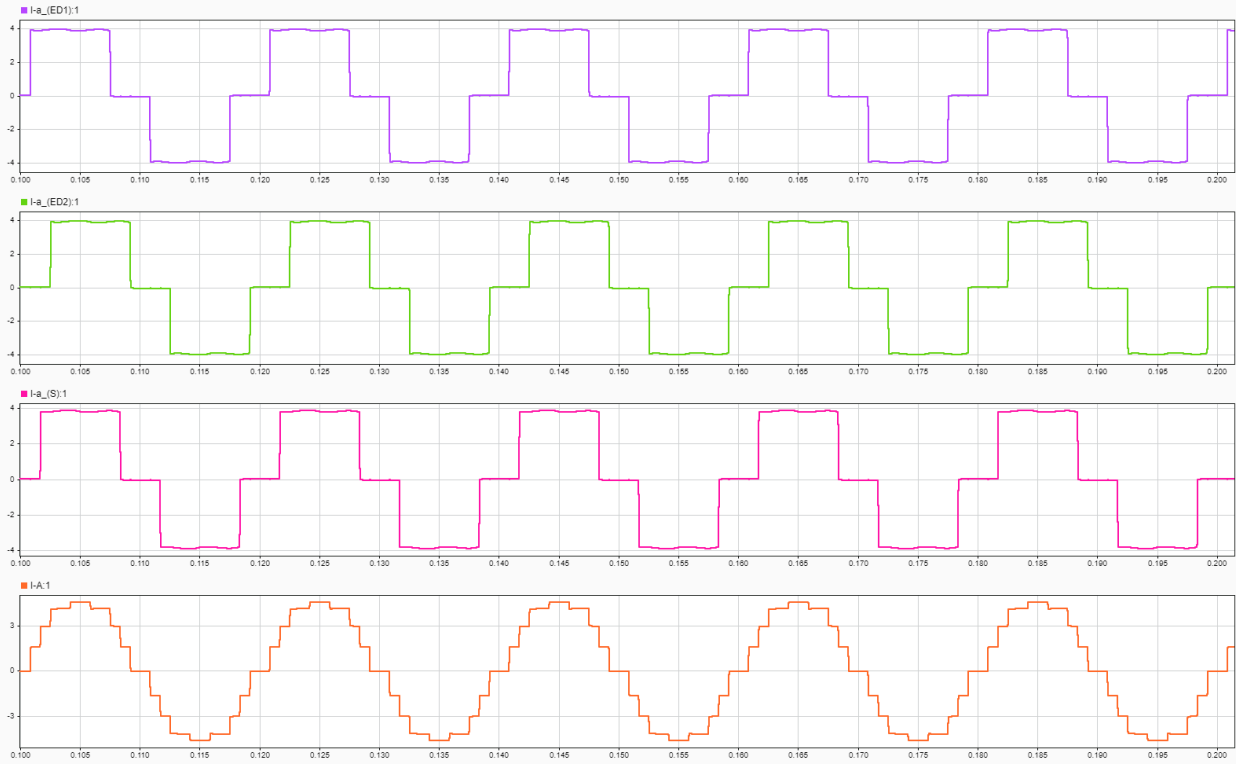
Figure 8: +20° Extended delta connected secondary line current (I-a_(ED1)), 0° Star connected secondary line current (I-a_(S)), -20° Extended delta connected secondary line current (I-a_(ED2)), & Star connected primary line current (I-A) respectively with MLI stage disconnected & highly inductive load.
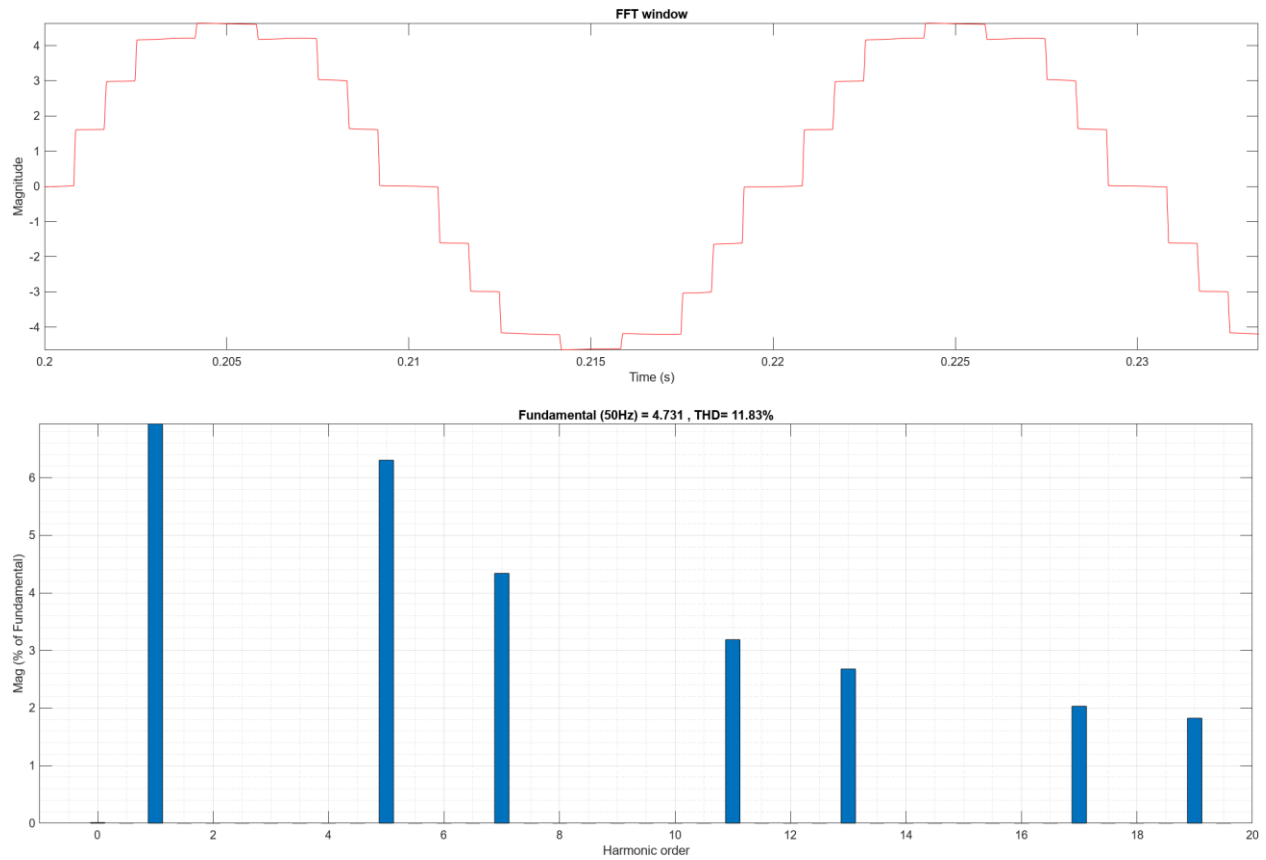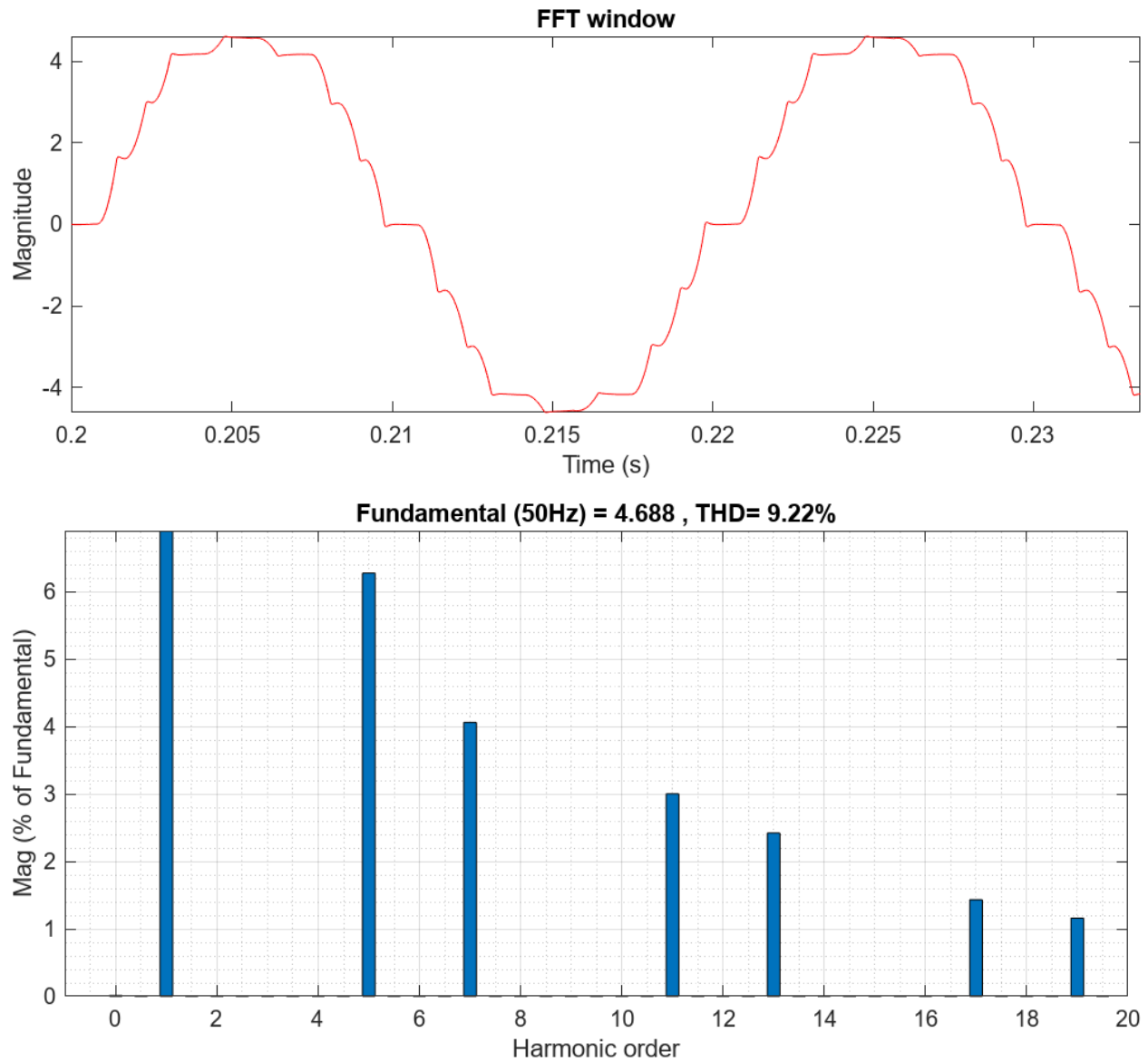
Figure 9: FFT of input line current (I-A) with leakage inductance = 0 pu.

ii) With leakage inductance = 0.05 pu, the input line current contains more harmonics:

Figure 10: +20° Extended delta connected secondary line current (I-a_(ED1)), 0° Star connected secondary line current (I-a_(S)), -20° Extended delta connected secondary line current (I-a_(ED2)), & Star connected primary line current (I-A) respectively with MLI stage disconnected & highly inductive load.

Figure 11: FFT of input line current (I-A) with leakage inductance = 0.1 pu.

The leakage inductance of transformer has filtering effect on supply current & also THD is reduced.

4) THD tabulation for input current & pole voltage:

Sr. No.	Variable	%THD
1	Input line current (I-A)	11.48
2	Pole Voltage (Van)	18.34