Power Quality
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Lecture - 31
Improved Power Quality Converters- AC-DC Boost Converters (Contd.)

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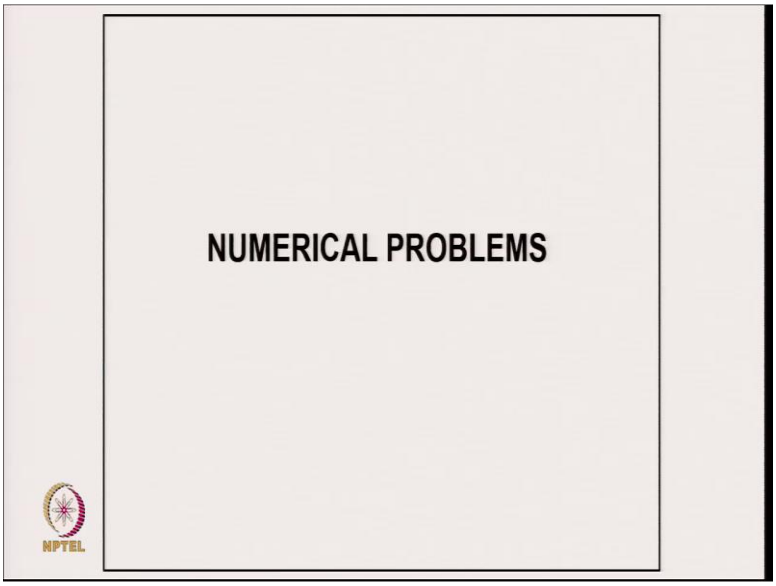

Welcome to the course on Power Quality. We will discuss the numerical problems on Improved Power Quality Boost Converter.

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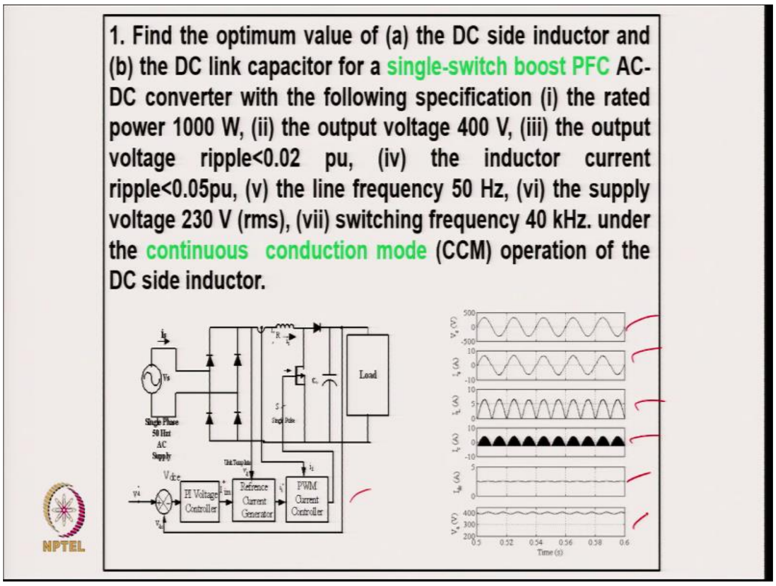

Coming to the Example-1. Find the optimum value of (a) DC side inductor and (b) DC link capacitor, for a single switch power factor correction AC-DC converter with the following specification (i) the rated power of 1000 watt, (ii) the output voltage 400 volt, (iii) the output voltage ripple less than 2%, (iv) the inductor current ripple less than 5%, (v) the line frequency 50 hertz, (vi) supply voltage 230 volts, (vii) switching frequency 40 kilohertz, under the continuous conduction mode operation of the DC side inductor.

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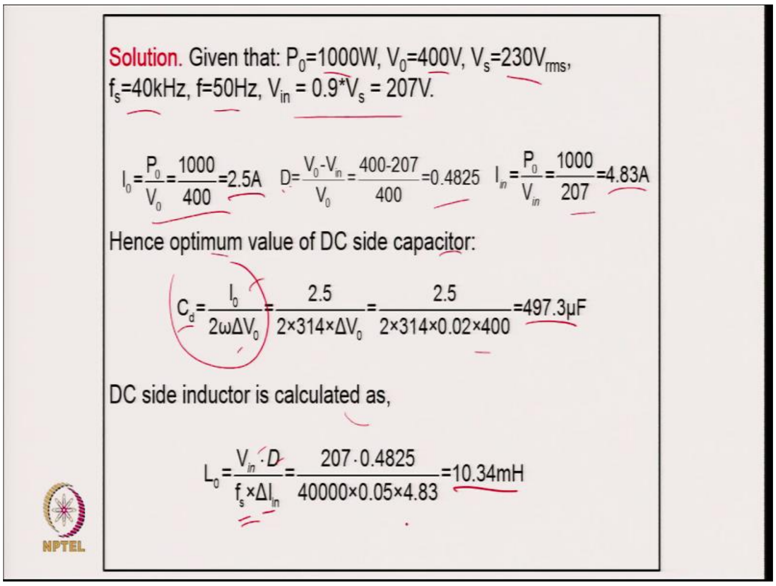

The solution for Example-1 is given in the abovemention slides.

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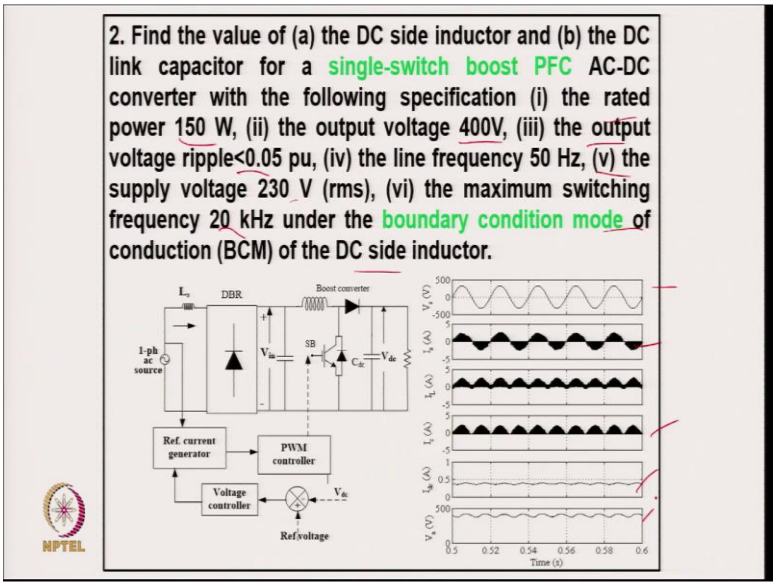

Coming to Example-2, find the value of (a) the DC side inductor and (b) the DC link capacitor for a switch-single switch boost converter AC-DC converter with following specifications, (i) the rated power of 150 W, (ii) the output voltage 400 V, (iii) the output voltage ripples less than 5%, (iv) the line frequency 50 Hz and voltage of 230 V, (v) the maximum switching frequency 20 kilo hertz under the boundary condition mode of the DC side.

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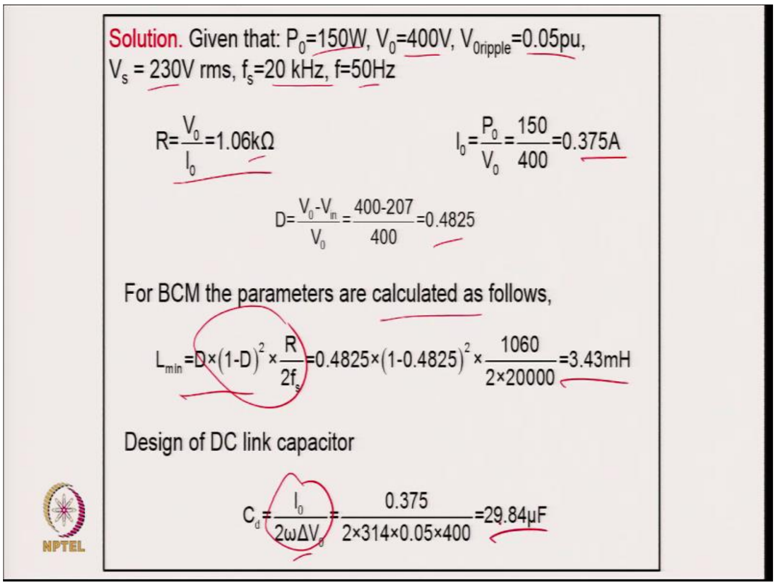

The solution for Example-2 is given in the abovemention slides.

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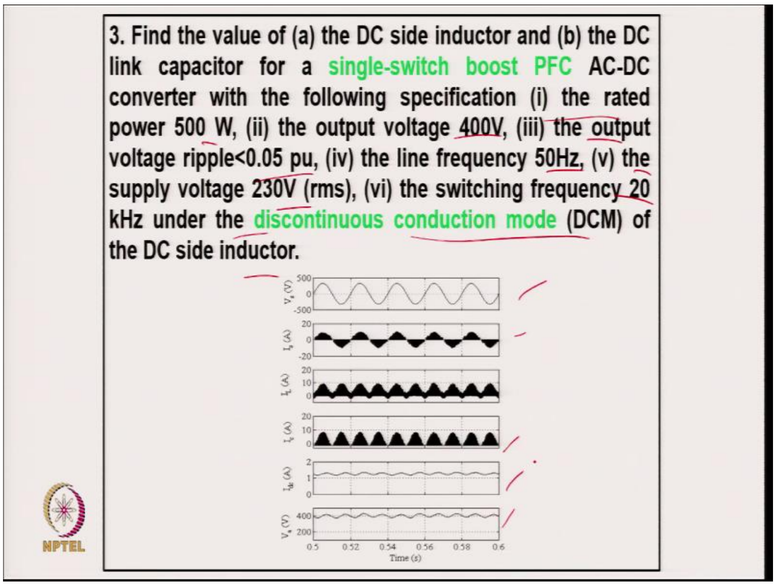

Coming to the Example-3, find the value of (a) DC side inductor, and (b) DC link capacitor of a single switch boost converter with the following specifications, (i) the rated power of 500 W, (ii) the output voltage 400 V, (iii) output voltage ripple less than 5%, (iv) the frequency 50 Hz (v) the voltage 230 V and switching frequency 20 kHz. Under discontinuous conduction mode of the DC side inductor.

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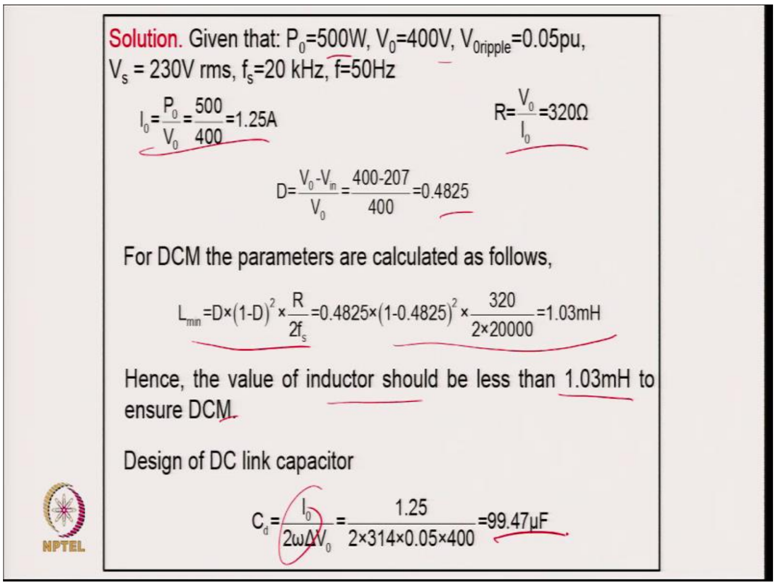

The solution for Example-3 is given in the abovemention slides.

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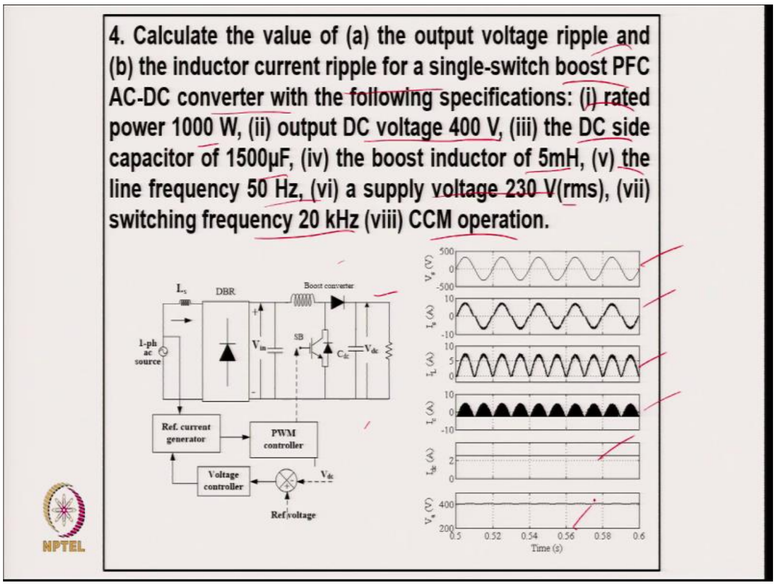

Coming to Example-4, calculate the value of (a) the output voltage ripple and (b) the inductor current ripple for a single-switch boost PFC converter with the following specifications, (i) rated power 1000 W, (ii) output DC voltage 400 V, (iii) DC side capacitor 1500 µF, (iv) the boost inductor of 5 mH, (v) the line frequency of 50 Hz, (vi) supply voltage of 230 V and the switching frequency of 20 kHz, and (vii) the CCM operation.

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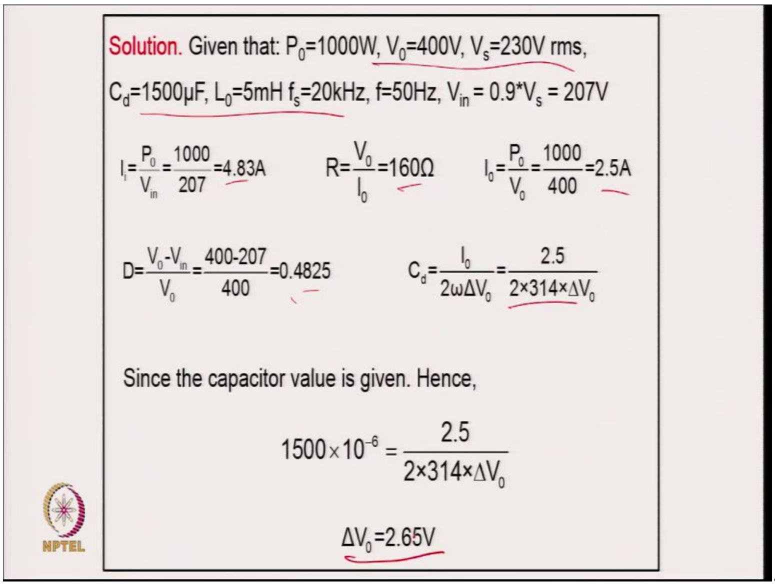

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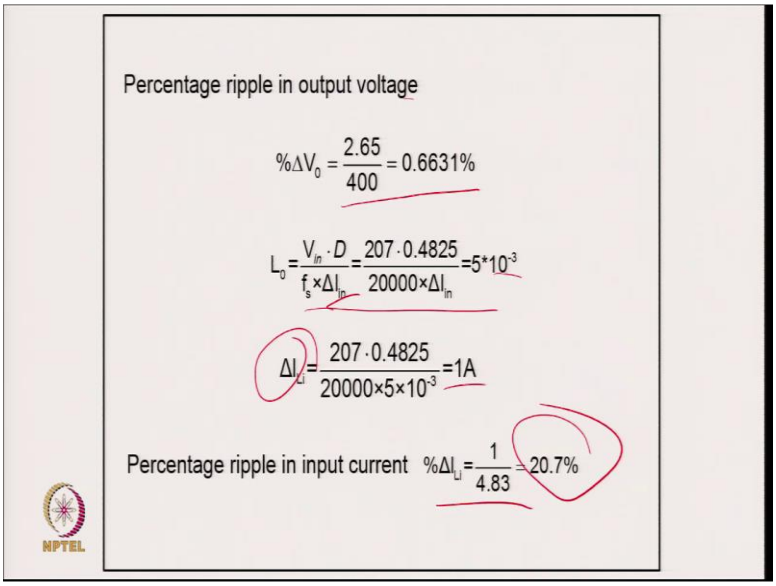

The solution for Example-4 is given in the abovemention slides.

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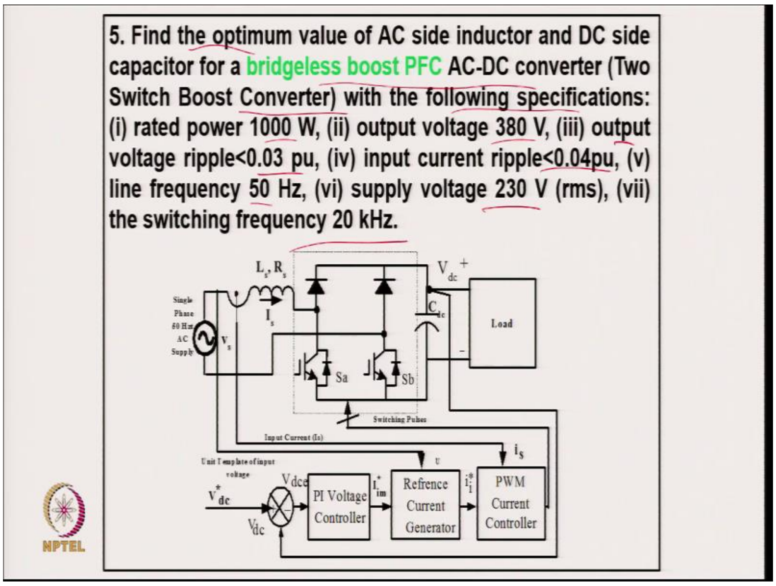

Coming to Example-5, find the optimum value of AC side inductor and DC side capacitor for bridgeless boost PFC converter (two switch boost converter) with the following specification, (i) rated power of 1000 W, (ii) output voltage 380 V, (iii) output ripples 3%, (iv) input current ripple 4%, (v) supply voltage of 230V/50 Hz and (vi) the switching frequency of 20 kHz.

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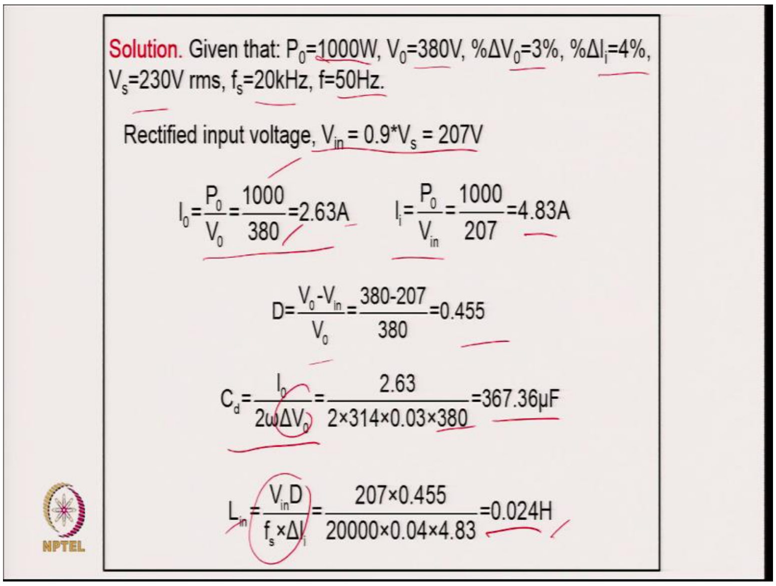

The solution for Example-5 is given in the abovemention slides.

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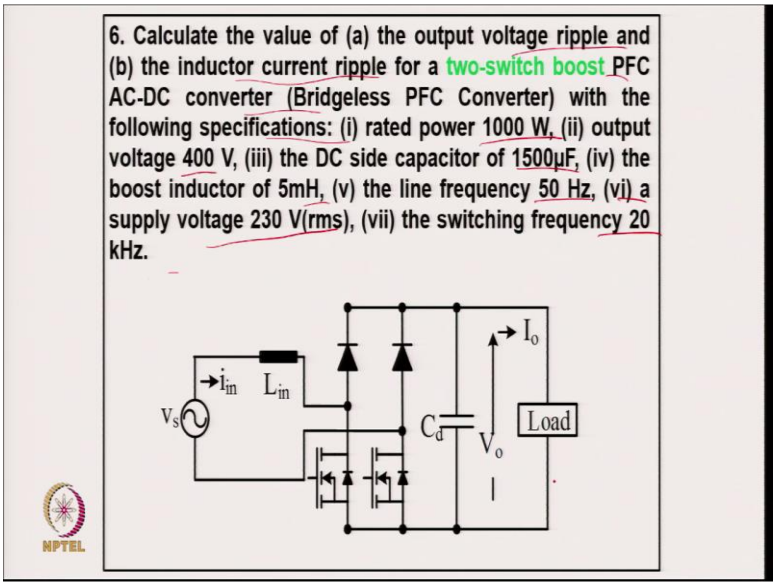

Coming to Example-6, calculate the value of (a) the output voltage ripple and (b) the input current ripple, of a two switch PFC boost AC-DC converter with a following specifications (i) rated power 1000 W, (ii) output voltage 400 V, (iii) DC side capacitor 1500μF, (iv) the boost inductor 5mH, (v) line frequency of 50 Hz and supply voltage of 230 V, and (vi) switching frequency 20 kHz.

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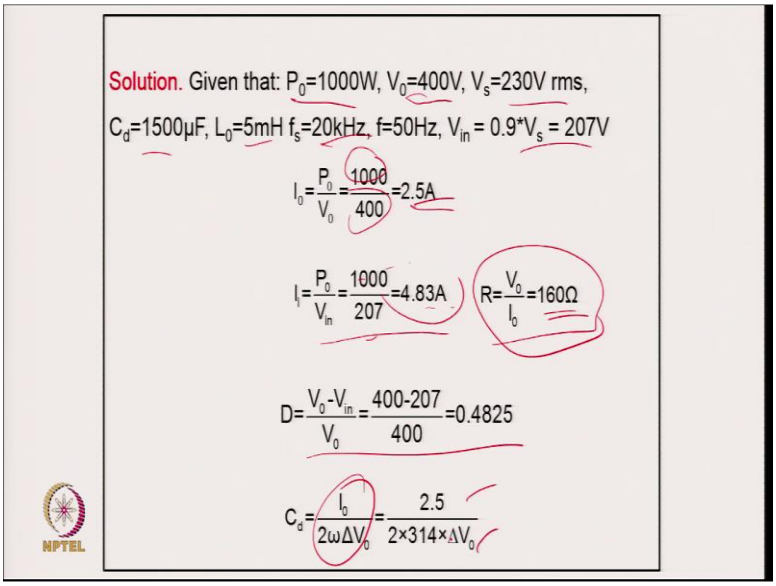

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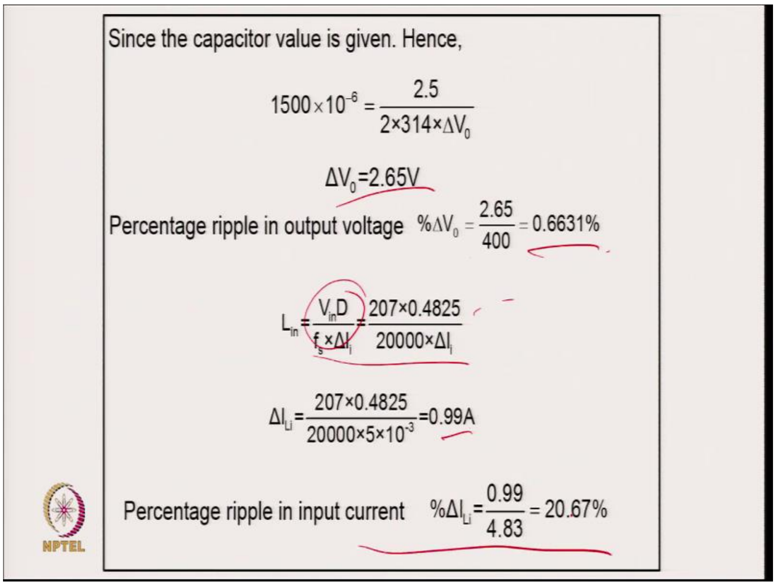

The solution for Example-6 is given in the abovemention slides.

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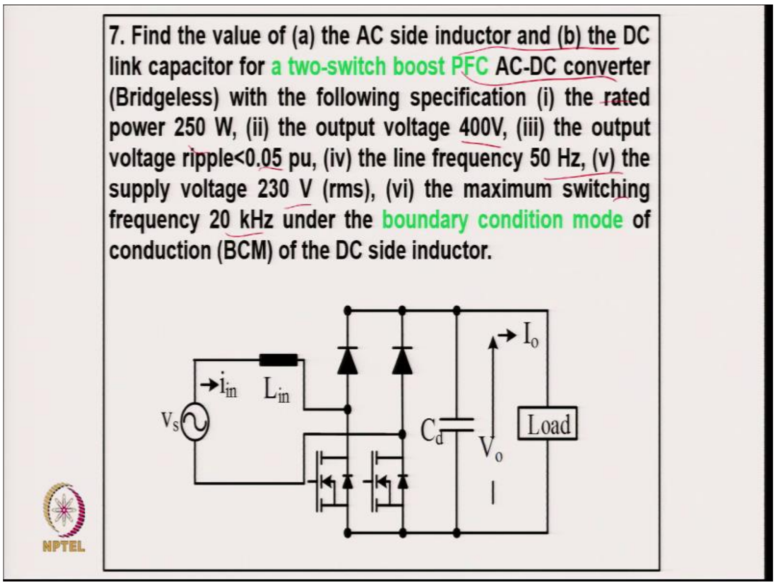

Coming to Example-7, find the value of (a) AC side inductor, and (b) the DC link capacitor of two switch boost PFC AC-DC converter with the following specification, (i) the rated power of 250 W, (ii) output voltage of 400 V, (iii) the output voltage ripple less than 5%, (iv) line frequency 50Hz, (v) the supply voltage 230 V, and (vi) the maximum switching frequency 20 kHz, under the boundary condition mode (BCM) of the DC side inductor of this bridgeless boost converter.

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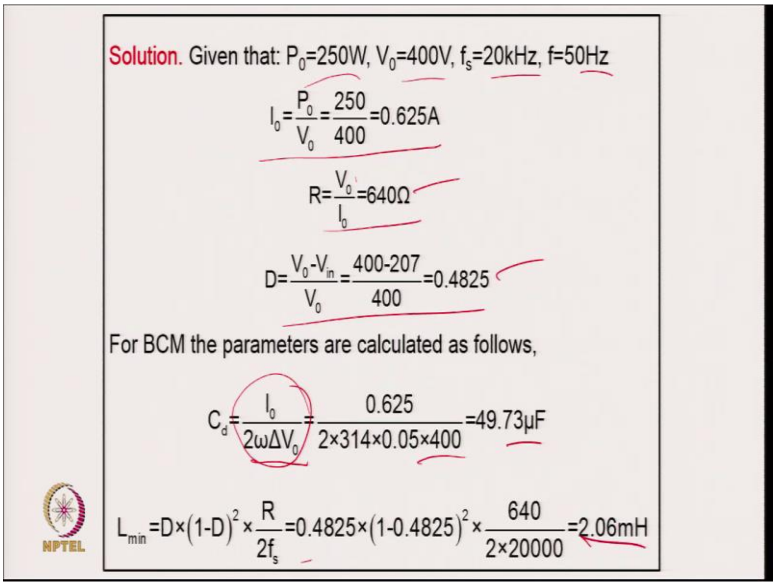

The solution for Example-7 is given in the abovemention slides.

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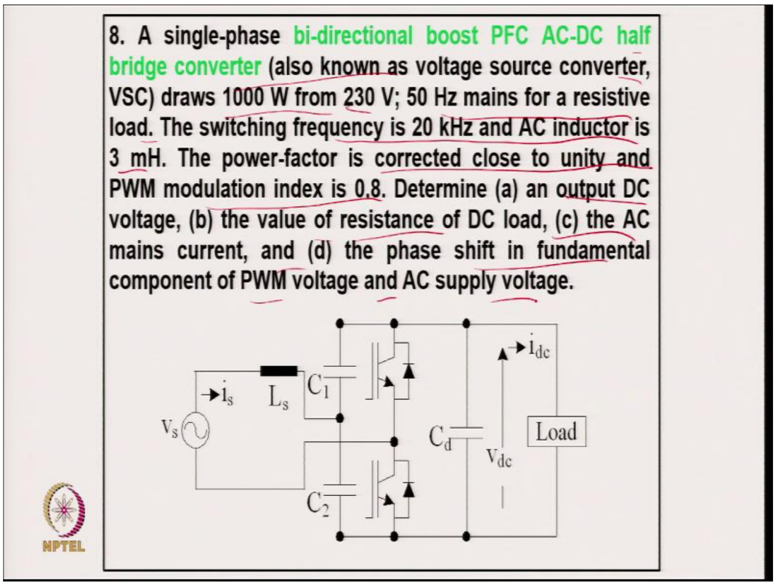

Coming to the Example-8, a single phase bidirectional boost PFC AC-DC converter half bridge (also known as a voltage source converter, VSC) draws 1000 W from 230 V, 50Hz mains for a resistive load, the switching frequency 20 kHz, AC inductor is 3mH. The power factor is corrected close to unity and the modulation index is 0.8. Determine (a) the output DC voltage, (b) the value of resistance of DC load, (c) AC mains current, (d) phase shift of fundamental component of PWM voltage and AC supply current.

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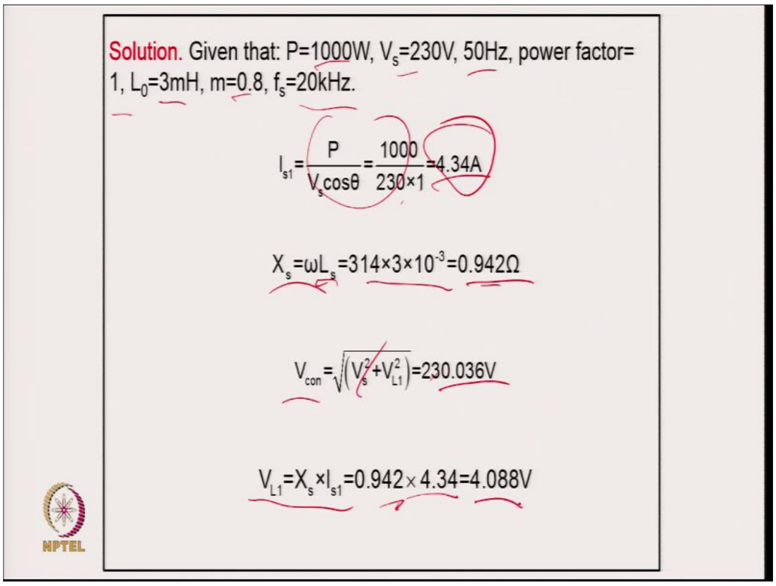

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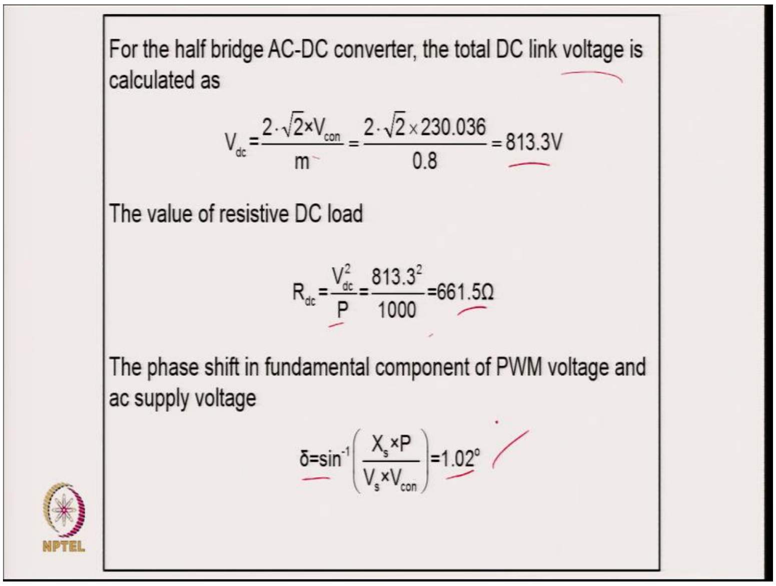

The solution for Example-8 is given in the abovemention slides.

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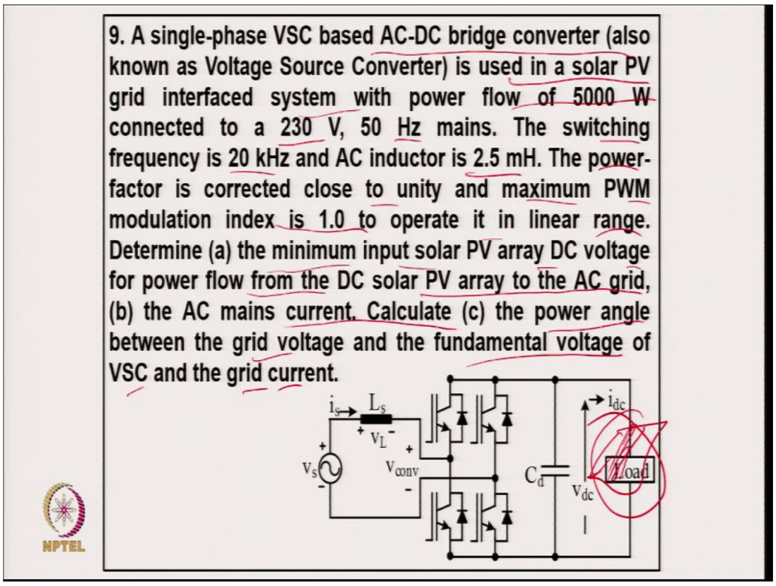

Coming to Example-9, a single phase voltage source converter based AC-DC bridge converter is used in a solar power grid interface system with the power flow of 5000 W and connected to 230V/50Hz, the switching frequency 20 kHz and AC inductor 2.5 mH. The power factor is corrected close to unity and maximum power maximum PWM modulation index is one to operate in linear range. Determine (a) the minimum input solar PV array voltage for power flow from DC solar array to the AC grid (b) the AC mains current, (c) the power angle between the grid voltage and the fundamental voltage of the voltage source converter and the grid current.

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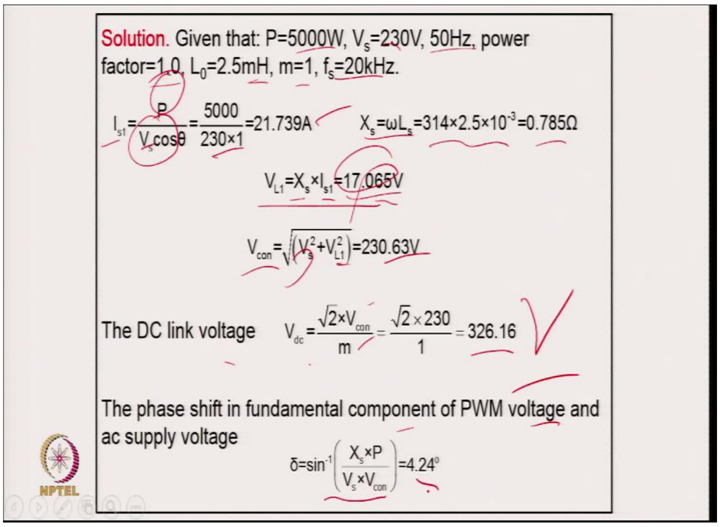

The solution for Example-9 is given in the abovemention slides.

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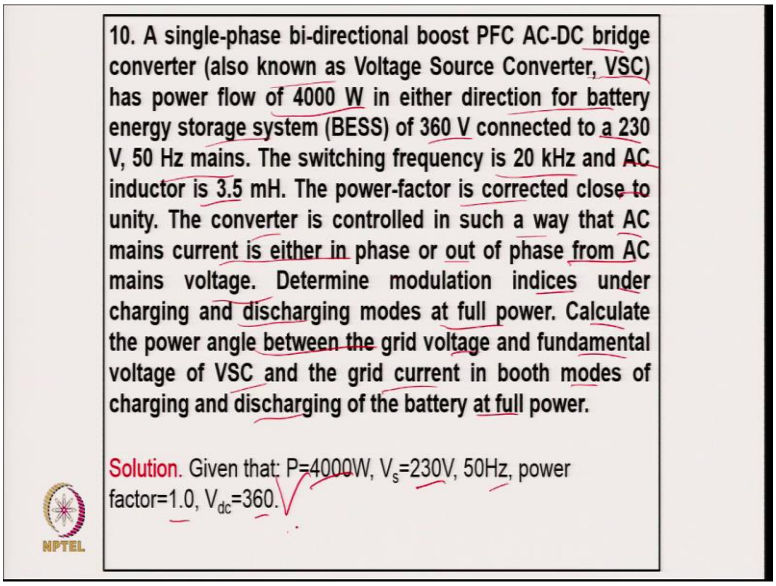

Coming to Example-10, a single phase bidirectional PFC boost AC-DC bridge converter has a power flow of 4000 W in either direction for battery energy storage system of 360 V connected to the 230V/50Hz mains and switching frequency of 20 kHz and AC inductor is 3.5 mH. The power factor is corrected to close to unity and converter is controlled in such a way that AC mains current is either in phase or out of phase from the AC mains voltage. Determine the modulation indices under the charging and recharging mode at full power. Calculate the power angle between the grid voltage and the fundamental voltage of the voltage source converter and the grid current in both mode charging and discharging.

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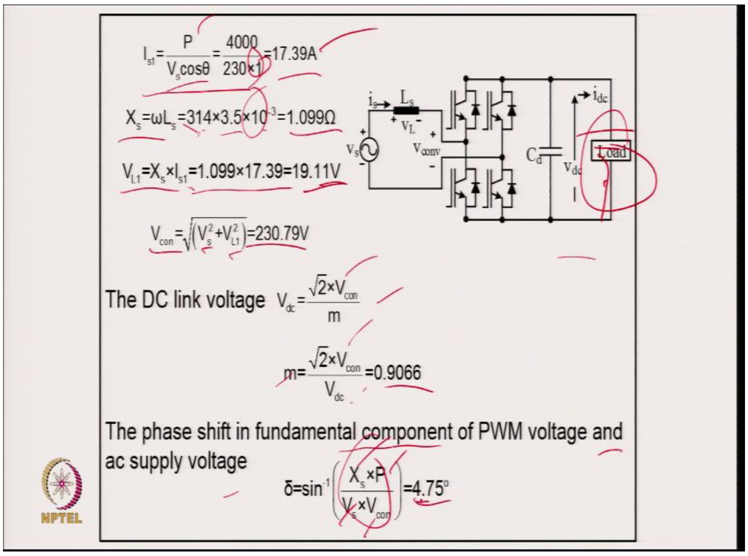

The solution for Example-10 is given in the abovemention slides.

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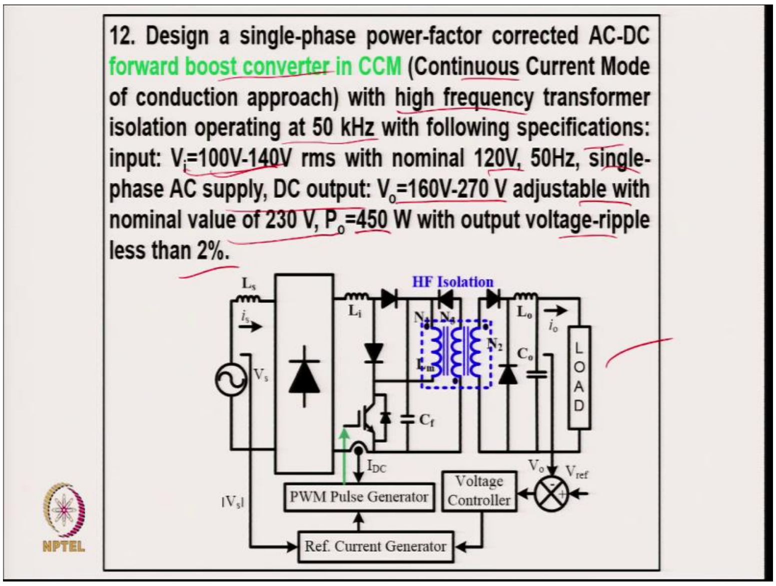

Coming to Example-11, design a single phase power factor corrected AC-DC forward boost converter in continuous conduction mode with the high frequency transformer isolation operating at 50 kHz with the following specifications, the input voltage varies from 100 V to 140 V RMS and nominal voltage of 120 V/50Hz, single phase AC supply and DC output 160 V- 270 V adjustable with the nominal voltage of 230 V and 450 W with the output voltage ripple of less than 2%.

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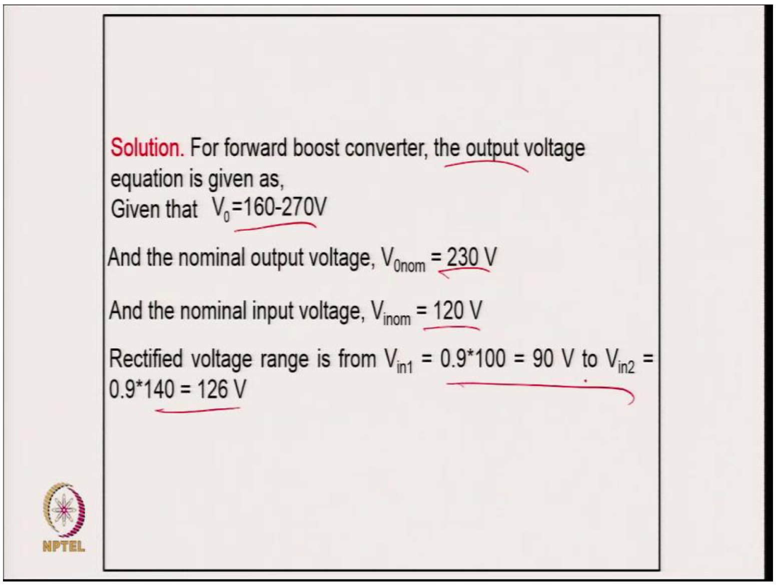

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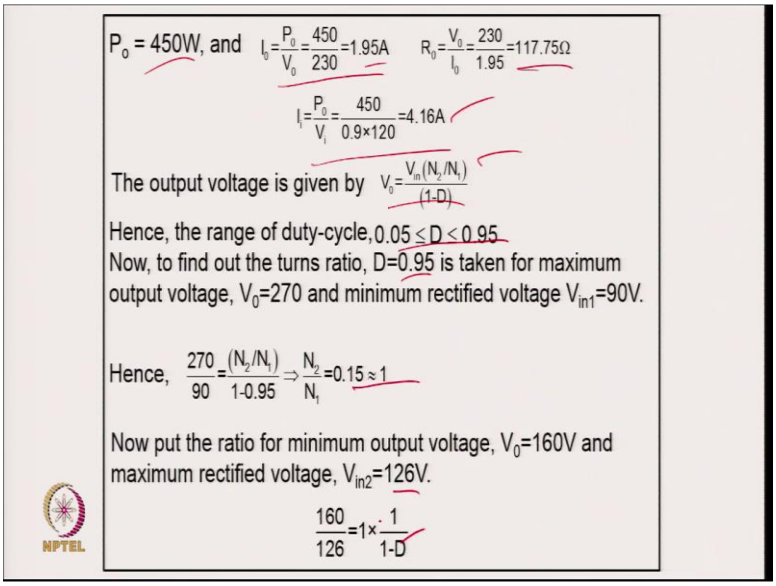

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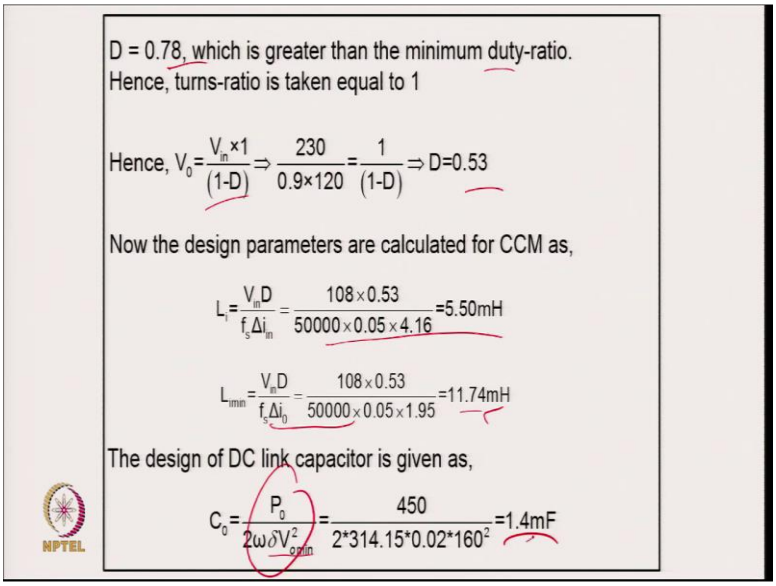

The solution for Example-11 is given in the abovemention slides.

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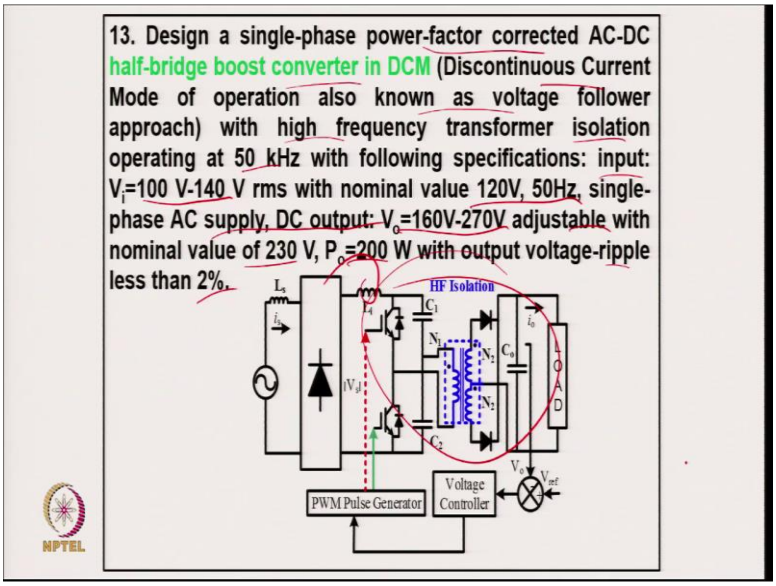

Coming to the Example-12, design a single phase power factor corrected half bridge boost converter in discontinuous mode with high frequency transformer isolation operating at 50 kHz with the following specification, input voltage of 100 V to 140 V RMS with the nominal voltage of 120V/50Hz single phase AC supply, DC output is 160 V – 270 V with nominal value of 230 V and power output 200 W with output voltage ripple less than 2%.

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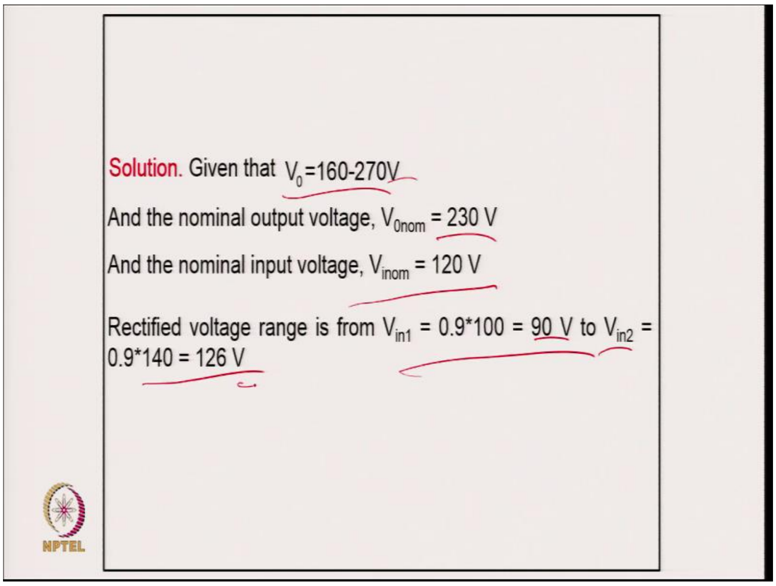

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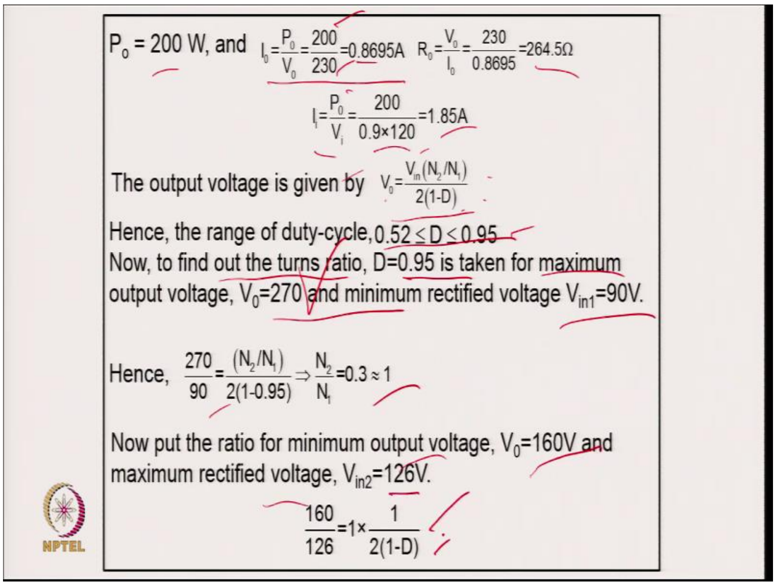

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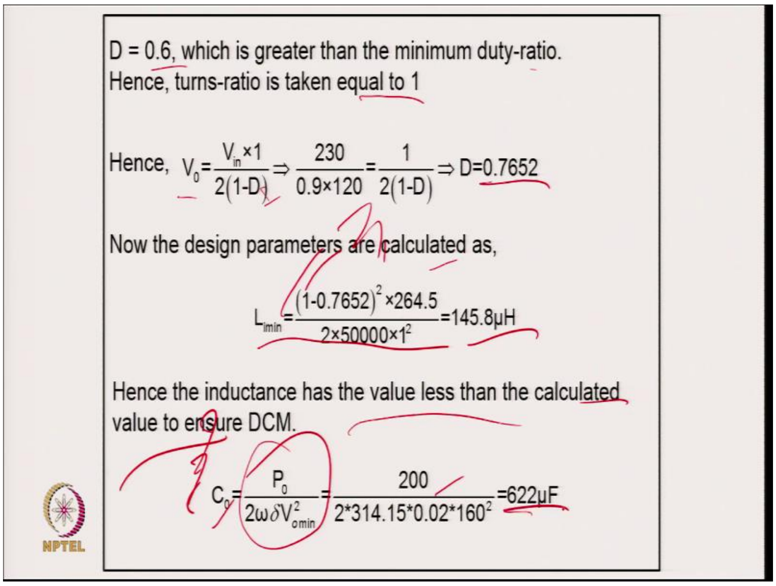

The solution for Example-12 is given in the abovemention slides.

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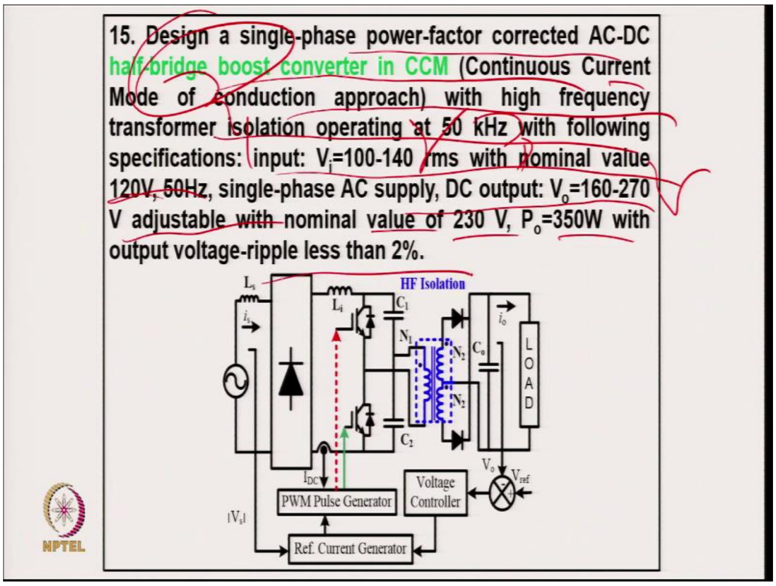

Coming to Example-13, design a single phase power factor corrected half bridge boost converter in CCM with the high frequency transformer isolation operating 50 kHz with the following specifications, input voltage of 100 V–140 V RMS with the nominal voltage of 120 V/50 Hz single phase AC supply, output DC voltage of 160 V-270 V with nominal voltage of 230 V, output power 350 W and output ripple less than 2%.

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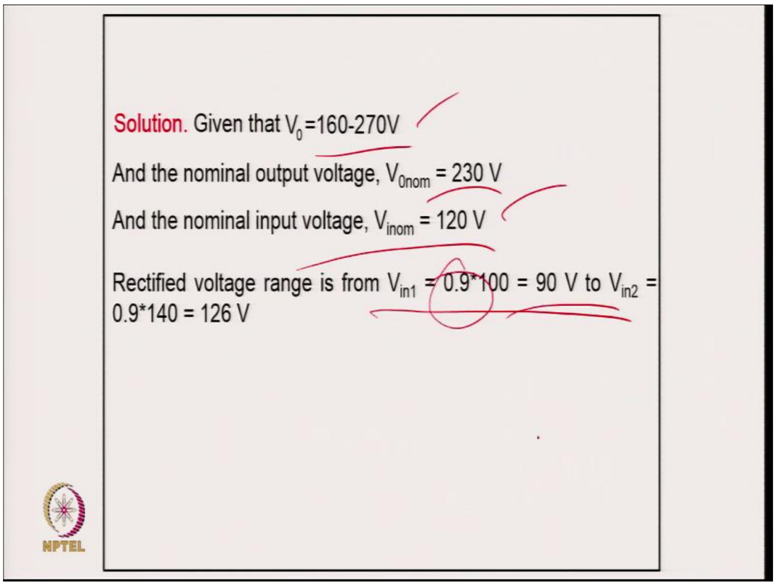

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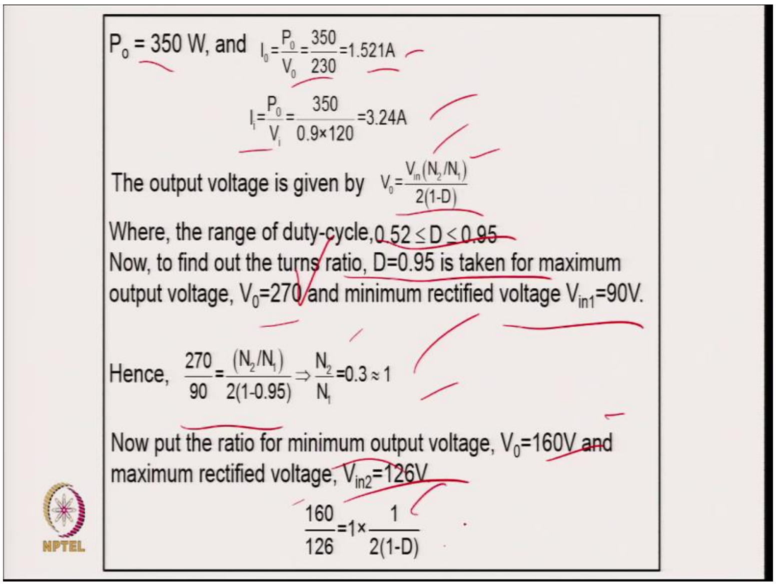

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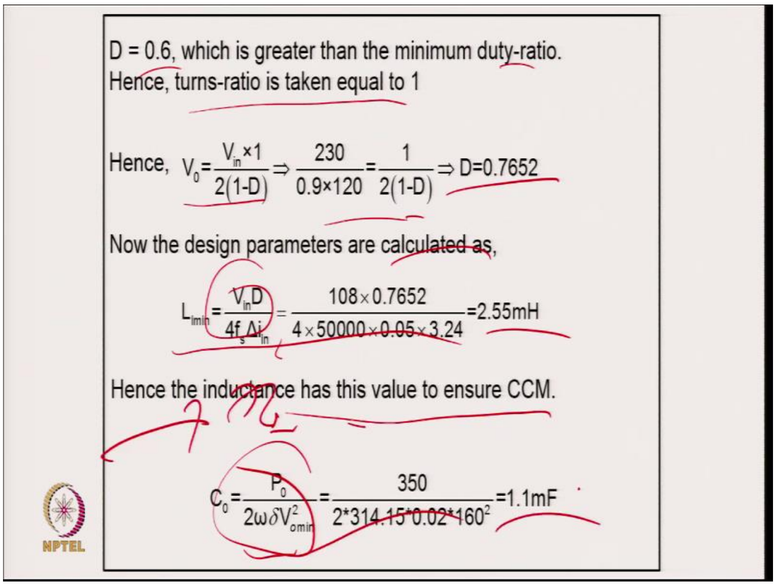

The solution for Example-13 is given in the above mention slides.

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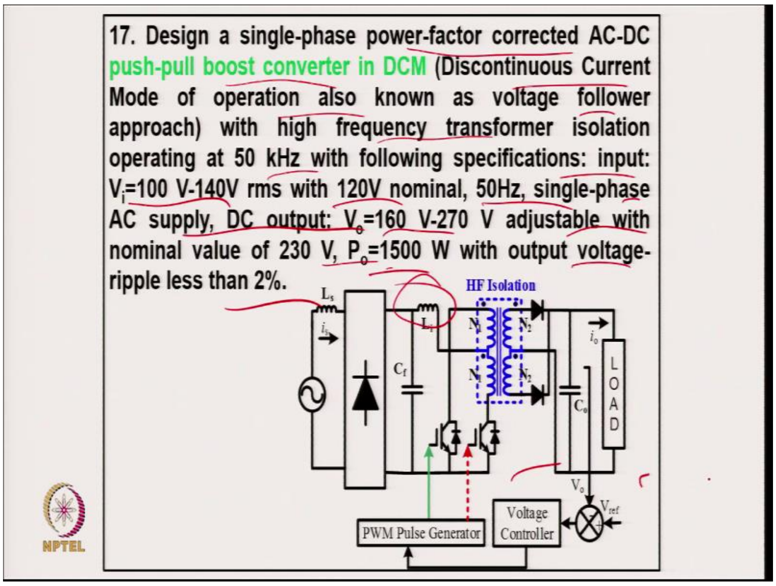

Coming to Example-14, design a single phase power factor corrected push pull boost converter in DCM with the high frequency transformer isolation operating at 50 kHz with the following specification, input voltage: 100 V-140 V with the nominal rating of 120V/50Hz single phase AC supply, DC voltage of 160 V-270 V with nominal voltage of 230 V and output power of 1500 W with the voltage ripples less than 2%.

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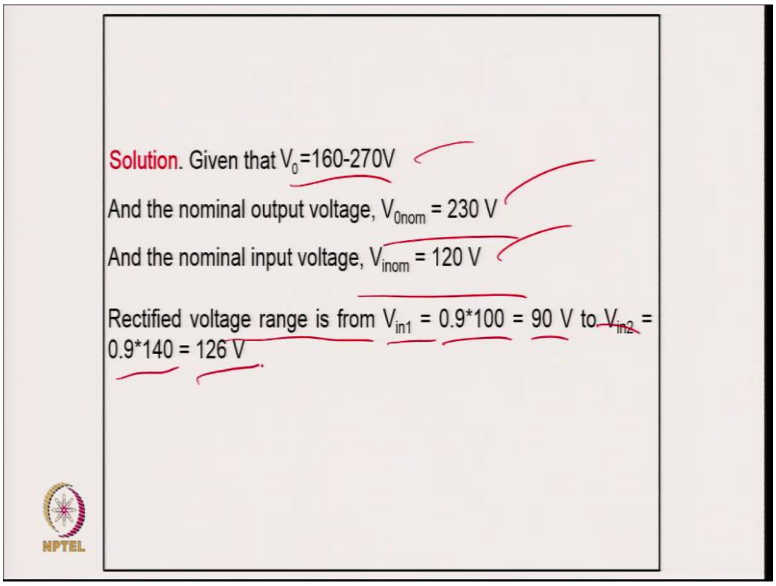

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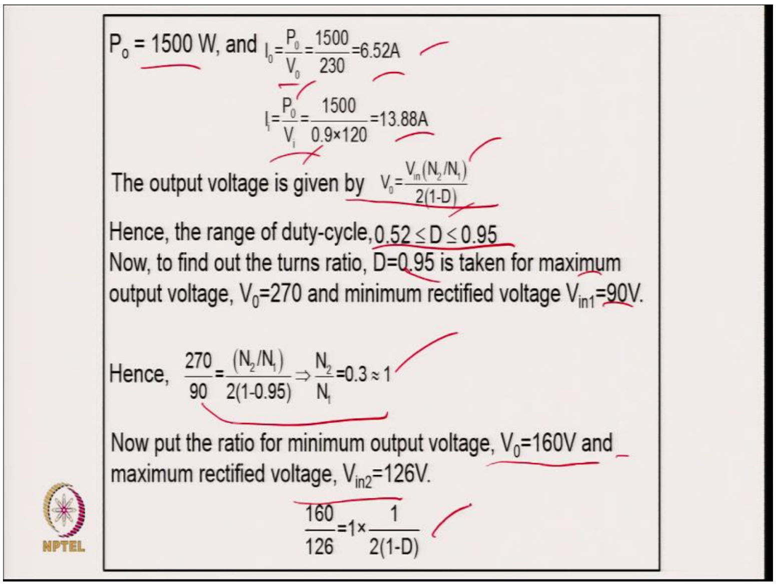

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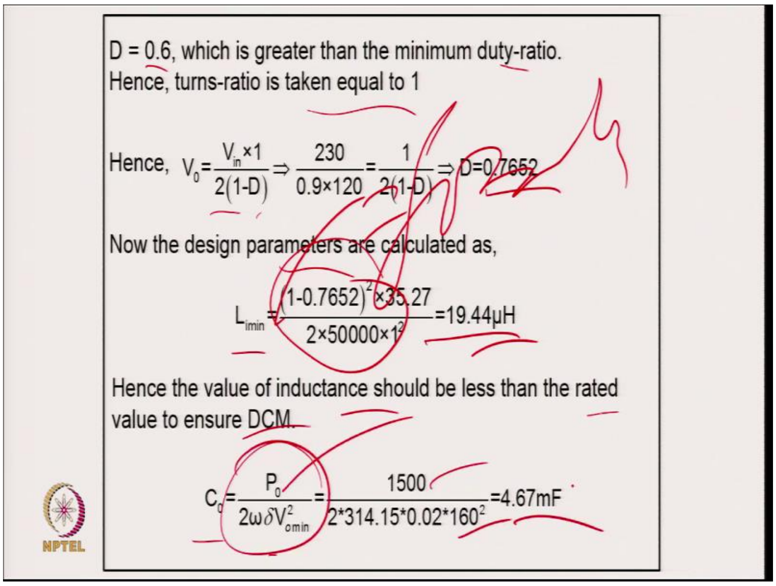

The solution for Example-14 is given in the above mention slides.

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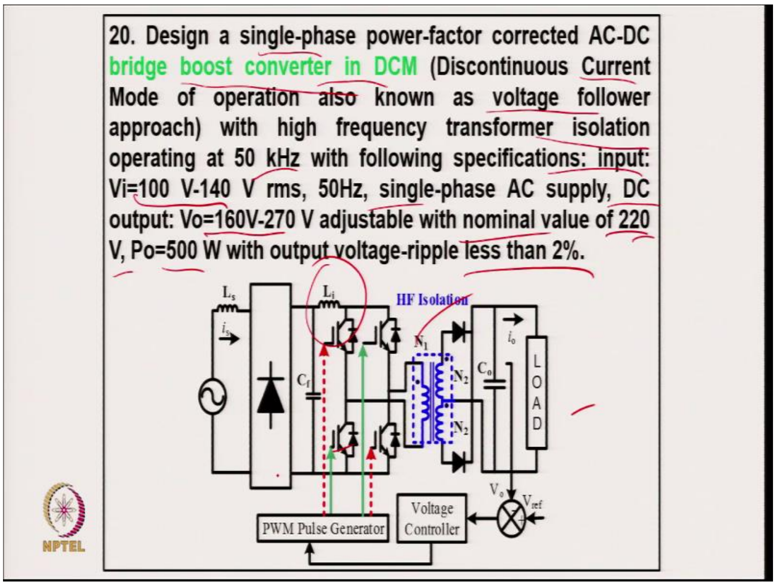

Coming to Example-15, design a single phase PFC AC-DC bridge boost converter in DCM with the high frequency transformer isolation at 50 kHz with the following specifications, input voltage of 100 V – 140 V, 50Hz single phase AC supply, DC output voltage equal to 160 V – 270 V at 500 W with output voltage less than 2%.

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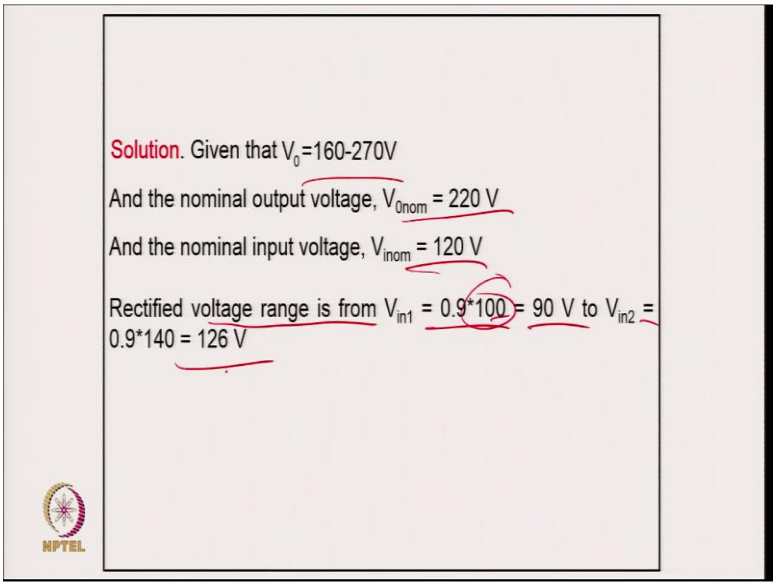

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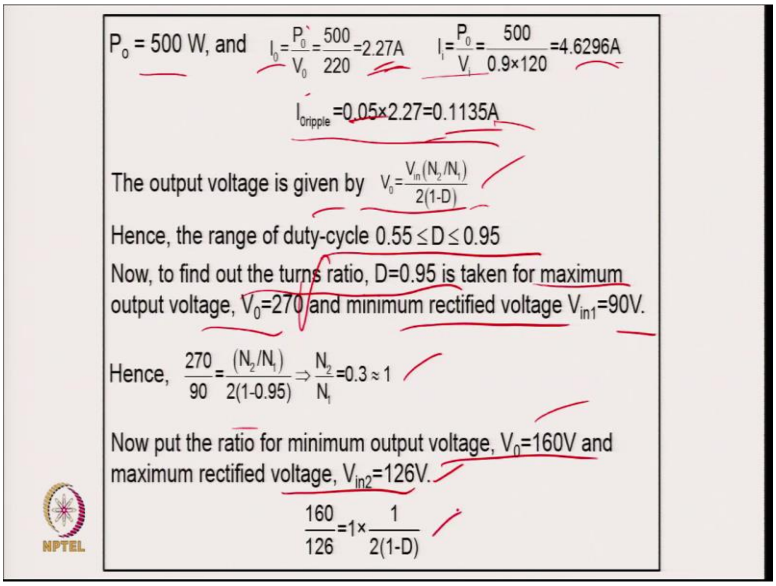

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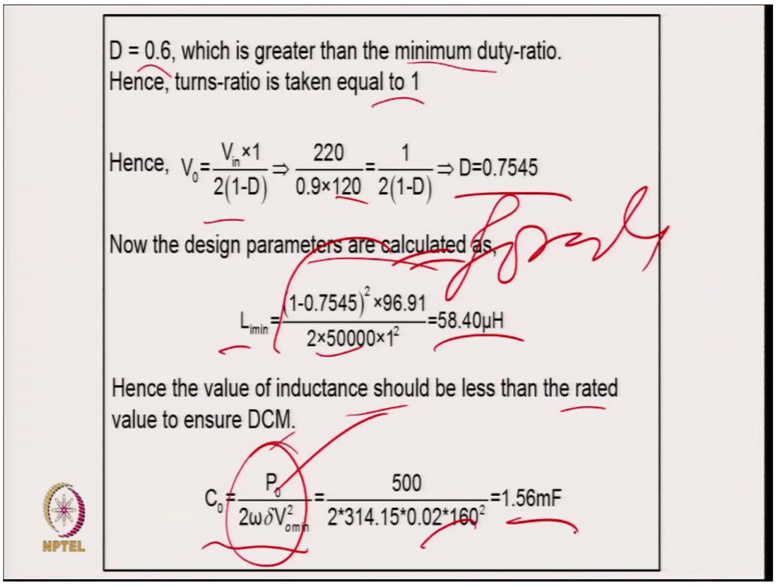

The solution for Example-15 is given in the above mention slides.

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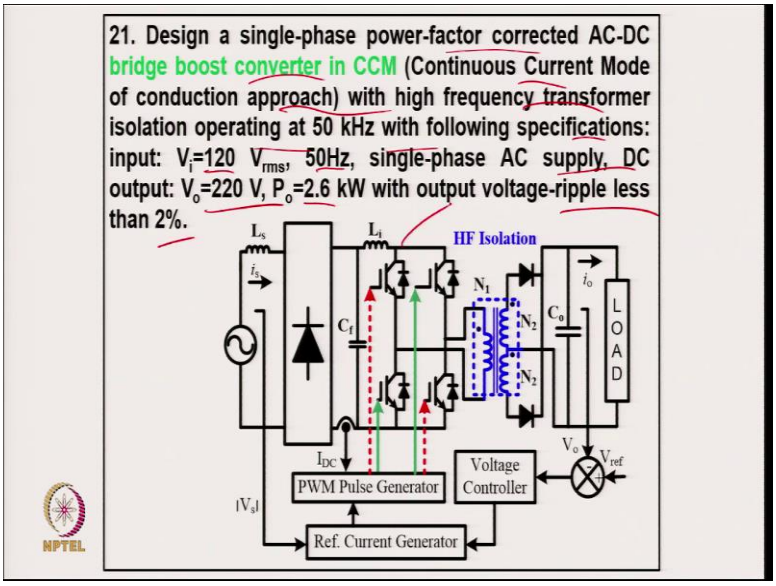

Coming to Example-16, design a single phase power factor corrected AC-DC bridge boost converter in CCM with the high frequency transformer isolation operating at 50kHz with the following specifications, input voltage of 120 V/50 Hz single phase AC supply, output voltage of 220 V at power of 2.6 kW with the output voltage ripple of 2%.

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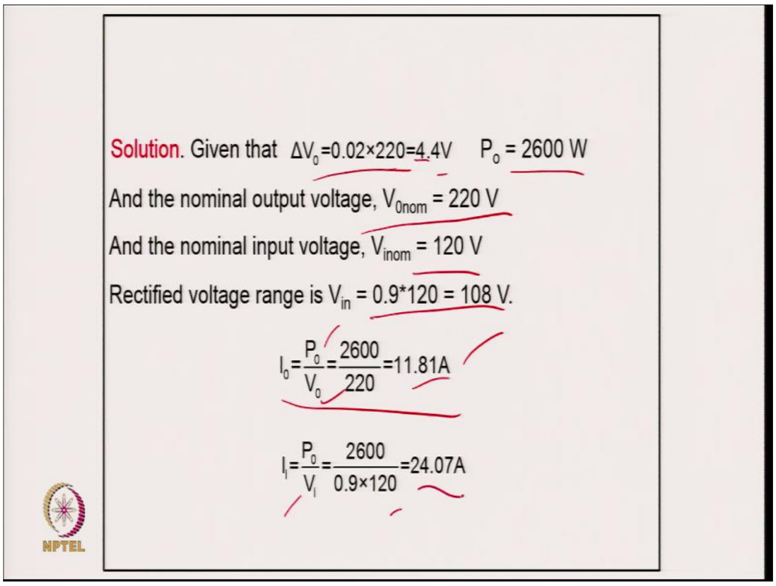

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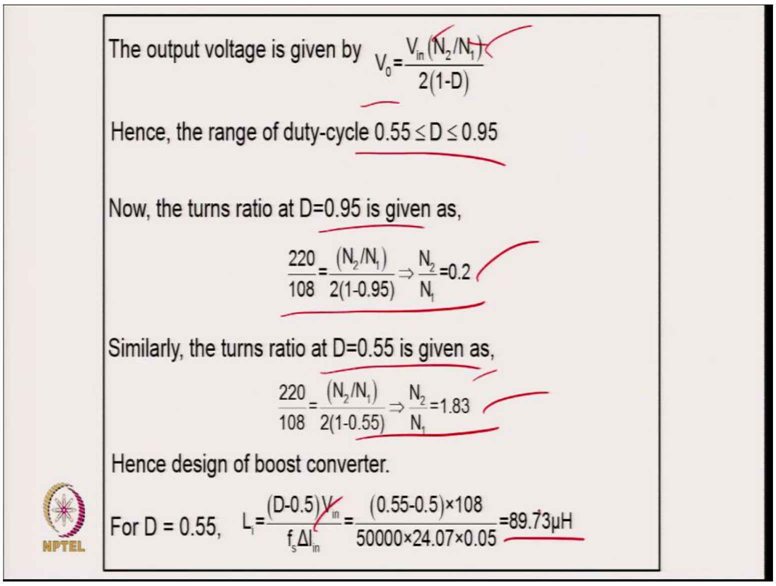

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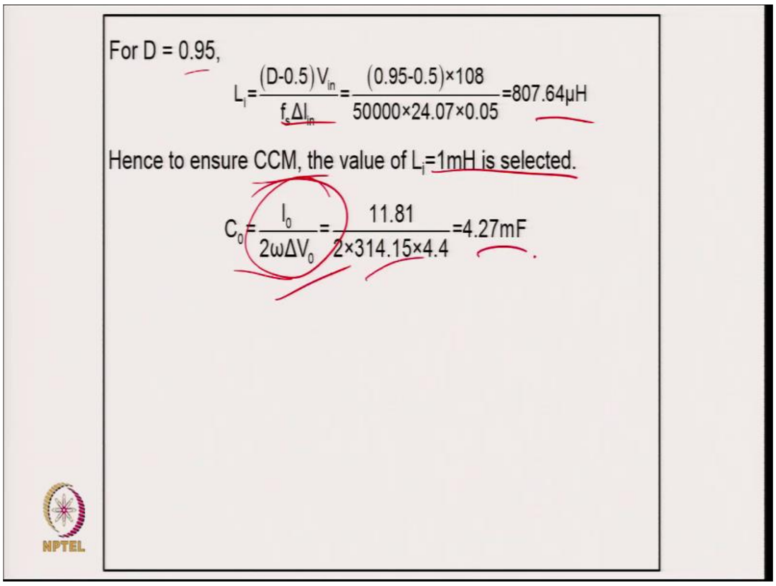

The solution for Example-16 is given in the above mention slides.

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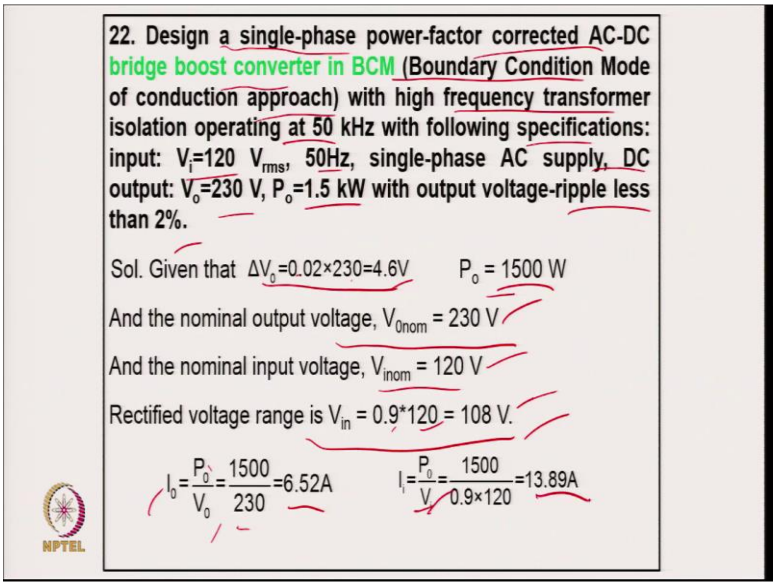

Coming to Example-17, a single phase power factor corrected AC-DC bridge boost converter in BCM with the high frequency transformer isolation operating 50kHz with the following specifications, input voltage of 120V/50 Hz single phase AC supply, and DC voltage of 230V and output power 1.5 kW with output ripple of 2%.

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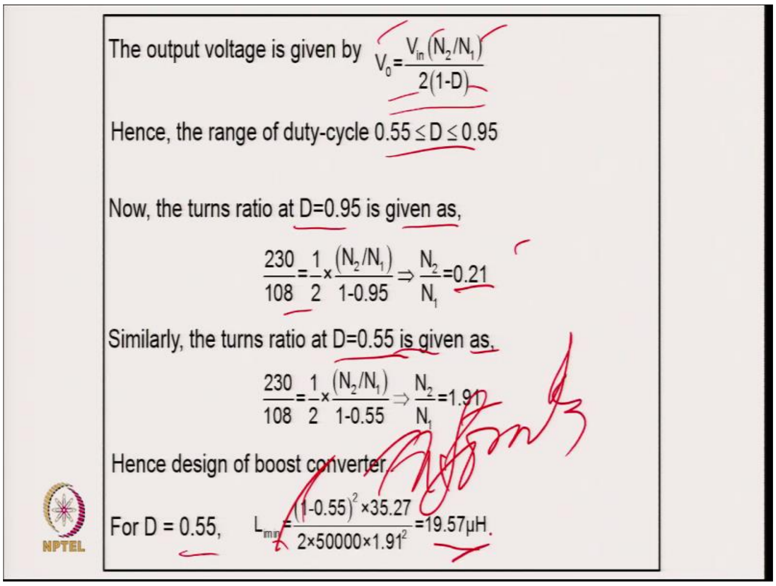

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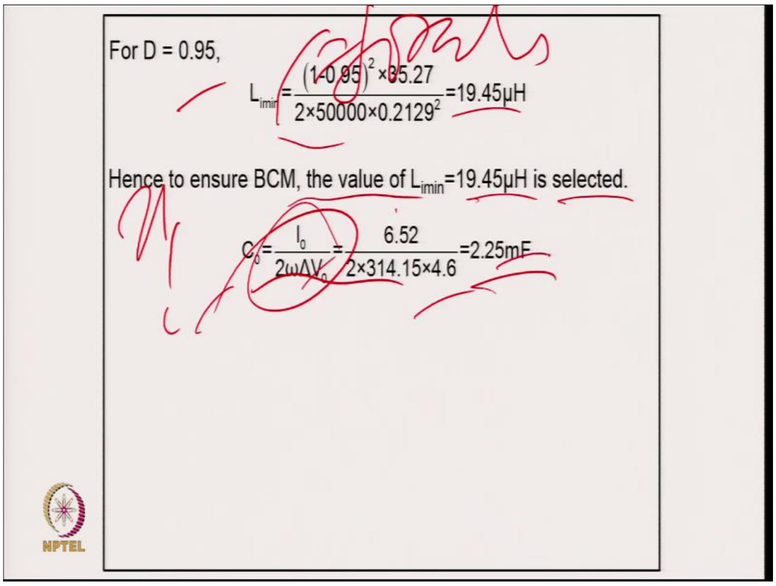

The solution for Example-17 is given in the above mention slides.

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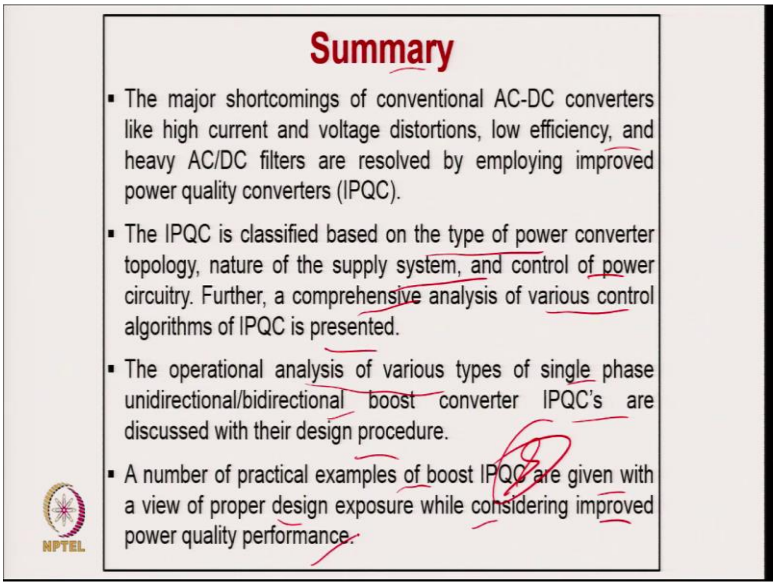

With this, we would like to summarize, the major short comings of the conventional AC-DC converter like high current and voltage distortion, lower efficiency and heavy AC-DC filters are resolved by employing the improved power quality converters, and the improved power quality converter is classified based on the type of power converter topology, nature of supply system and control of power circuitry.

Further a comprehensive analysis of various control algorithm of IPQCs are presented here and operational analysis of various type of single phase unidirectional, bidirectional boost IPQCs are discussed with the design procedure and number of practical examples of boost improve power quality converters are given with the view of proper design exposure while considering the improved power quality performance.

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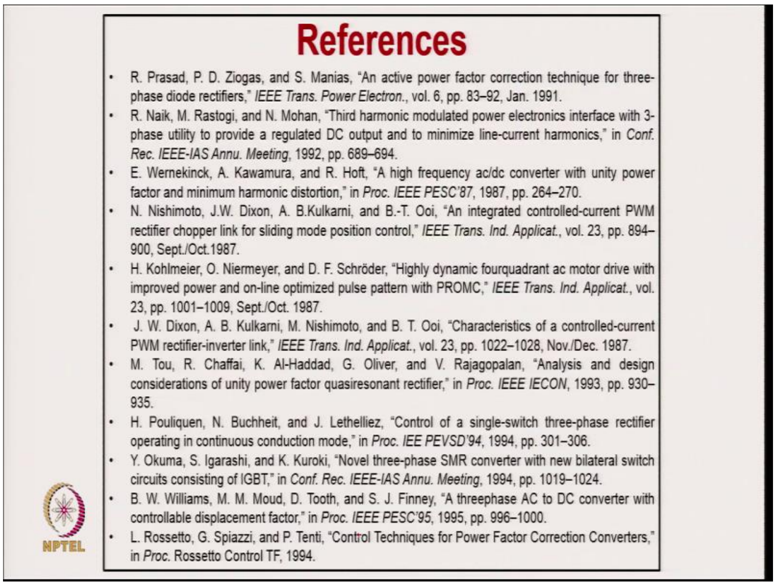

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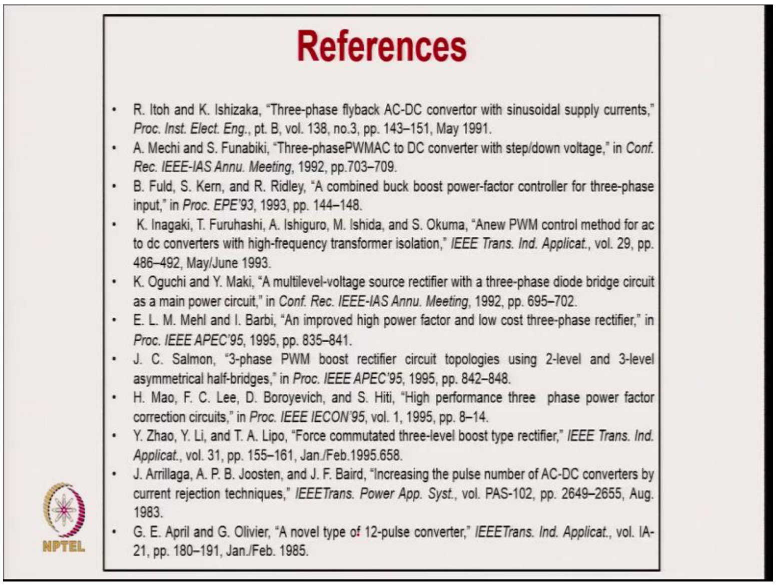

These are the references.

Thank you.