EECE 451 - POWER ELECTRONICS

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Assignment #2

Due December 10th, 2021
Submit a typed report (Canvas submission).
Include the procedure, steps and any relevant comment to obtain the results.

1. Design a PWM DC/AC Converter (Inverter) with the following specifications:

- DC Input Voltage (V_{dc}) = 380 V
- Desired AC Output Voltage (V_o) = 220 V_{RMS} / 50 Hz
- Switching Frequency (F_{sw}) = 20 kHz
- Output Current (I_o) = 10 A_{RMS}

a) Select the corresponding topology and justify.
b) Calculate the required modulation index (m_a) to achieve the desired output voltage.
c) Select the value of the load resistor (R_L) to obtain the desired output current.
d) Find the value of the filter inductor (L) and capacitor (C) for a characteristic impedance (Z_o) of 5 Ω and cut-off frequency (F_o) of 600 Hz.
e) Simulate the designed converter in PSIM. Analyze the obtained results and include relevant waveforms.
f) Redesign the output filter (L & C) for:
   i. $F_o = 1200\ Hz, Z_o = 5\ \Omega$
   ii. $F_o = 300\ Hz, Z_o = 5\ \Omega$

   By using the FFT tool in PSIM, explain the effects of the filter cut-off frequency in the obtained output voltage.

2. Design a DC/DC **isolated** power supply using a full-bridge converter with the following specifications:

- DC Input Voltage (V_{dc}) = 170 V
- DC Output Voltage (V_o) = 5 V
- Output Voltage Ripple (ΔV_o) = +/- 1%
- Maximum Output Current (I_o) = 75 A
- Inductor Current Ripple (Δi_L) = 3%
- Switching Frequency (F_{sw}) = 150 kHz

a) Derive the converter's gain equation $\left(\frac{V_o}{V_{in}}\right)$ and find the corresponding duty cycle (D) for this design.
b) Select the value of the load resistor (R_L) to obtain the maximum output current.
c) Select the value of the filter inductor (L) and capacitor (C) to obtain the desired current and voltage ripples.
d) Simulate the designed converter using PSIM. Include relevant waveforms and comments.
e) Find the value of the load resistor to operate the converter in the boundary of discontinuous conduction mode. Simulate the converter under this operating mode and include relevant waveforms.