Simulation Homework

1. Implement a 3-phase inverter in Simulation (Plexim preferred, otherwise plain Simulink) to produce 3-phase sinusoidal output.
   Specs:

400V DC link (200+200)
10kHz switching frequency
Use ideal MOSFETs/IGBT models
The modulation index should be variable through a user input (knob)
The model should be parameterized, i.e. most parameters should be in one parameter file somewhere.
Connect an RL load on each phase, from the inverter pole to the DC midpoint.
Take the R/L value to be such that τ>10*T_{sw} and peak current is about 2.5A

The model should be in Fixed-time steps; step time of ~1us

Submission via MATLAB/GitHub
You may work in pairs, but each student must submit individually.

2. Simulate and implement a Converter system in simulation software to analyze the performance of both single-phase and three-phase rectifiers under the following specifications:
   a. Single-Phase PFC Boost Converter:
   - Input Voltage: 230V RMS, 50 Hz
   - Load Power: 3.3 kW
   - DC-Link Voltage: 400V (nominal)
   - Ripple Specification: Maintain a ripple of 5% at the DC-link output.
   - Capacitance Calculation: Determine the required DC-link capacitance to meet the ripple constraint.

   b. Three-Phase PFC Boost Converter:
   - Input Voltage: 400V Line-to-Line RMS, 50 Hz
   - Load Power: 3.3 kW
   - DC-Link Voltage: 400V (nominal)
   - Ripple Specification: Maintain a ripple of 5% at the DC-link output.
   - Capacitance Calculation: Determine the required DC-link capacitance to meet the ripple constraint.

3. Based on the given specifications, design and simulate a Synchronous BUCK converter. Calculate the maximum allowable inductor value L and determine the required capacitance C to achieve the desired performance. Perform the simulation in MATLAB/Simulink.
   - Input Voltage (V_{in}): 12V
   - Output Voltage (V_o): 5V
   - Switching Frequency (F_{sw}): 300 kHz
   - Maximum Output Power (P_{o_max}): 60W
   - Desired Negative Inductor Current (I_{L_neg}): 2.5A
   - Soft Switching Delay Time: 2% of T_{sw}
   - Capacitance Calculation: Find the value of C needed (neglecting Coss).

4. Design and simulate a Phase-Shifted Full-Bridge (PSFB) Converter to achieve soft switching under specified conditions. Perform necessary calculations and implement the design in MATLAB/Simulink. Provide a reference for the methodology used in design and calculation.
   - Input Voltage (V_{in}): 120V
   - Output Voltage (V_o): 50V
   - Switching Frequency (F_{sw}): 200 kHz
   - Maximum Output Power (P_{o_max}): 60W