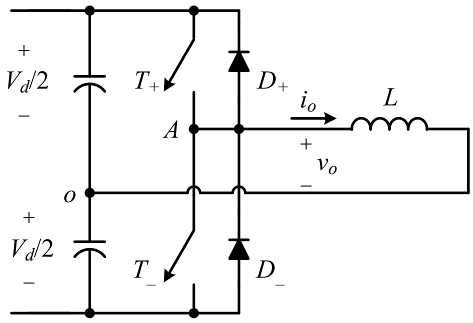
EE4532, Part II
Tutorial 4, DC-AC Single-Phase Inverters

1. A half-bridge single-phase inverter is modulated by the sinusoidal pulse-width modulation (SPWM) and its input DC bus voltage is 300V. The amplitude of the carrier waveform is 3V, while the amplitude of the control signal is 2V with a frequency of 50Hz. Determine,

   a. Amplitude modulation index. **[0.667]**
   b. Fundamental output voltage, **[100V amplitude]**
   c. Frequency modulation ratio if the carrier frequency is 25kHz. **[500]**
   d. Describe the over-modulation and its effect on the inverter output voltage.

2. A single-phase half-bridge inverter is used to power an inductive load of 100mH as shown in the figure below. The inverter is supplied from a DC source of 600V, and is operated at a frequency of 50Hz using the square wave modulation. It can be assumed that in the steady state, no DC component exists at the AC output side of the inverter.

   a. Sketch the load voltage and current with all relevant values indicated on the plots.
   b. Determine the RMS output voltage, the RMS fundamental output voltage, and the total harmonic distortion (THD) of the output voltage. **[300V, 270V, 48.3%]**
   c. Determine the RMS fundamental output current and the RMS value of the 3rd order harmonic current. **[8.59A, 0.95A]**



3. Repeat all the sub questions in 2 with the half-bridge inverter replaced by a full-bridge inverter with all other parameters kept the same. The full-bridge inverter is controlled using the square wave modulation with a phase displacement β of 120° set between its two half-bridges.

   You may need to use the following trigonometric identity,
   $$\cos\alpha - \cos\beta = -2\sin\frac{\alpha+\beta}{2}\sin\frac{\alpha-\beta}{2}.$$

   a. –
   b. **[489.9V, 467.8V, 31.08%]**
   c. **[14.89A, 0]**

EE4532, Part II
Tutorial 5, DC-AC Three-Phase Inverters

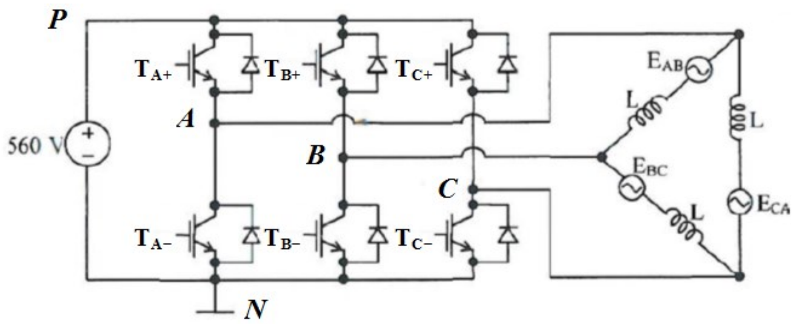
1. A three-phase inverter is used to supply a constant AC output voltage across a sensitive load that will malfunction if the voltage across it dips by 5%. The inverter is connected to a DC source whose terminal voltage varies from 295V to 325V. Based on the described scenario, what is the maximum fundamental voltage that the inverter can continuously supply across the sensitive load if the sinusoidal pulse-width modulation is used? In addition, state the variation range of the amplitude modulation ratio to continuously maintain this maximum voltage. **[104.3V phase RMS, [0.908,1]]**

2. The figure below shows a three-phase inverter powered by a 560V DC source. The inverter is designed to supply a delta-connected load with each phase having a 20mH inductor and a 400Vrms, 50Hz back-EMF connected in series. To reduce its switching loss, the inverter is square-wave modulated at a fundamental frequency of 50Hz.

   a. Calculate the RMS voltage applied across each phase of the load. **[457.2V]**

   b. Calculate the RMS voltage applied across the load after it is reconfigured as a wye-connected circuit. **[264V]**

   c. Calculate the RMS fundamental, fifth and seventh harmonic current components flowing through one phase of the load assuming that the back-EMF is lagging the inverter fundamental voltage by a phase angle of 10°. **[13A, 2.78A, 1.42A]**



3. A three-phase square-wave-modulated inverter is used to supply a balanced wye-connected resistive load with a neutral star-point labelled as *n*. Draw the circuit connection, the phase *A* line-to-neutral voltage, and the phase *A* output current.

4. Repeat question 2 with the resistive load replaced by a purely inductive load. It is assumed that the load current has no DC component.