1) Given the following waveform:

\[ f(t) \]

Express \( f(t) \) as a Fourier Series. Then use MATLAB to construct the signal from the Fourier series you derived to verify your result.

a) For the waveform shown, by providing enough justification, circle the following statements that are true:

i) \( f(t) \) can represent a voltage across an inductor.
ii) \( f(t) \) can represent a current through an inductor.
iii) \( f(t) \) can represent a current through a capacitor.
iv) \( f(t) \) can represent a voltage across a capacitor.

2) In the converter of Fig. 1, the switches operate synchronously, each is in position 1 for \( 0 \leq t \leq DT_s \), and in position 2 for \( DT_s \leq t \leq T_s \). Derive an expression for the voltage conversion ratio \( M(D) = \frac{V}{V_g} \). Sketch \( M(D) \) vs. \( D \) and compare with that of a buck converter.

3) The converter of Fig. 2 operates with an input voltage \( V_{in} = 10V \). The output voltage is \( V_{out} = 24V \) and the switching frequency is \( f_{sw} = 250kHz \). All elements are ideal, and the converter operates in steady state.

a) What is the duty cycle?

b) Sketch the waveform of the MOSFET drain-to-source voltage. Label the numerical values of all relevant times and voltages.

c) Find the dc component of the voltage waveform of part (b).

d) Sketch capacitor current, capacitor voltage, and diode current.
4) Assume that the MOSFET of the converter of Fig. 2 is not ideal and has a fixed voltage drop of $v_0$ during conduction. Derive the ratio between average input and average output voltage for a boost converter. Plot the waveforms for all components for this non-ideal boost converter. Assume CCM operation.