(50) 1. Consider the three-phase full-bridge rectifier.

Let $e_{as} = E\cos\theta_e$, $e_{bs} = E\cos\left(\theta_e - \frac{2\pi}{3}\right)$, $e_{cs} = E\cos\left(\theta_e + \frac{2\pi}{3}\right)$ where $\theta_e = \omega_e t$. Consider the interval where valves 1, 2 and 3 are conducting (i.e. the 1-2-3 interval), which begins at $\theta_e = \frac{\pi}{3}$ and $i_{as} = I_d$.

(a) Derive an explicit expression for $i_{as}(\theta_e)$ during this interval.

(b) Derive an explicit expression for $v_{dc}(\theta_e)$ during this interval.

(c) What determines the angle $\theta_e$ at which valve 1 turns off? An implicit relationship for this angle is sufficient.

(50) 2. Consider the full-bridge inverter connected to a balanced resistive load.

(a) The switching signals for $S_1$, $S_2$, and $S_3$ are sketched below. The switching signals for $S_4$, $S_5$, and $S_6$ are, respectively, the logical compliments of $S_1$, $S_2$, and $S_3$. Evaluate
the values of $v_{ng}$ (voltage from node $n$ to node $g$) and $v_{an}$ for intervals I and II. Assume all devices are ideal. Express answers in terms of $V_{dc}$ and/or $R$.

(b) If the conducting transistor and diode voltage drops are 1-V each, re-evaluate $v_{ng}$ and $v_{an}$ for interval II only.