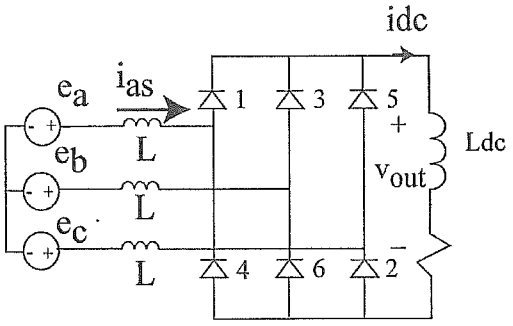
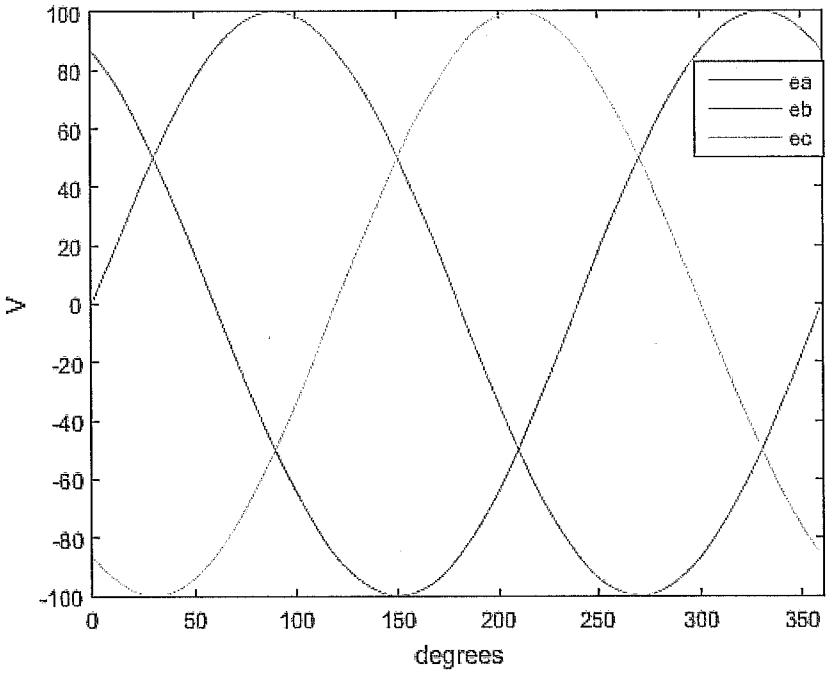
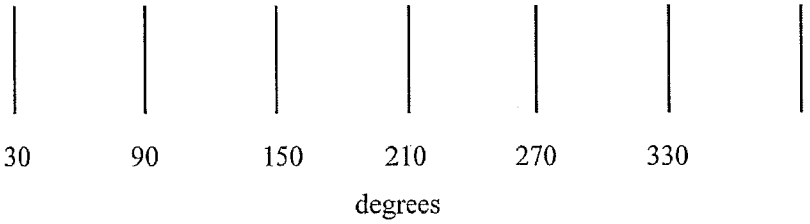
1. Given the following system. (40 pts)

$e_a = 100\sin(\theta + 120^\circ)$, $e_b = 100\sin(\theta)$, $e_c = 100\sin(\theta - 120^\circ)$, $\omega = 1000$ rad/s.





a. Assuming Ldc is large, label the diodes that conduct on the figure below for the situations in which the inverter is operating in 2-3 mode. Use diode numbering from the figure. You will need to insert subintervals to indicate commutation.

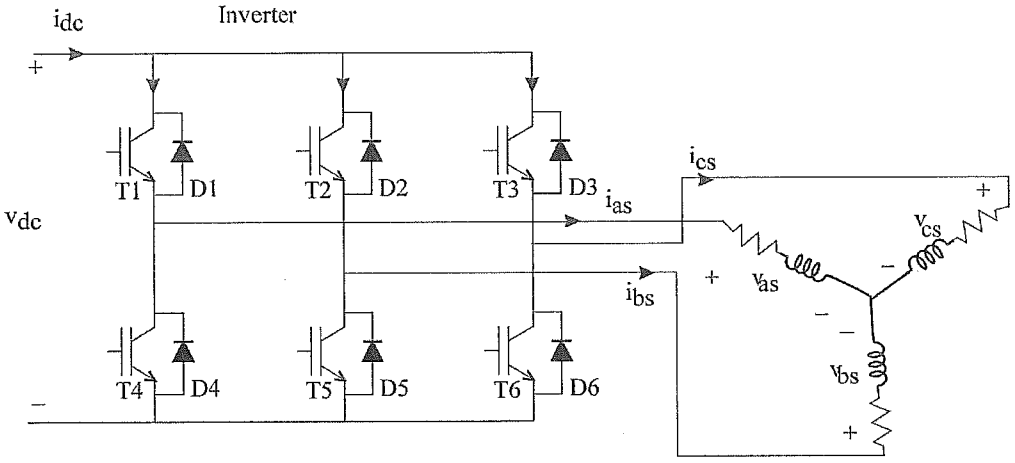


b. Assume L = 1 mH, Ldc=large, 2-3 mode operation, and that the derivative of the short term average of the output current is zero. Derive the expression

$$\hat{v}_{out} = \frac{300\sqrt{3}}{\pi} - \frac{3}{\pi}\hat{i}_{dc}$$

Show all steps and state assumptions made.

2. Given the 3-phase inverter. v_{dc} = 100 v. Each phase of the load has an inductance L = 10 mH, and r = 0 (negligible value). There is no coupling between phases. (35 pts)



a) Derive the expression $\hat{v}_{as} = 0.5 d_a v_{dc}$, where d_a is the phase-a duty cycle. State any assumptions used in the derivation.

b) Assuming the inverter is operating under sine-triangle modulation (no 3rd harmonic injection) and you need phase-currents of the form:
$i_{as} = I_p \cos(100t), i_{bs} = I_p \cos(100t - 120°), i_{cs} = I_p \cos(100t + 120°)$.
Determine the maximum value of I_p that can be obtained if you cannot tolerate harmonics in your current. For this value express d_a. Then, determine the maximum value of I_p and a corresponding d_a for the case in which you can tolerate harmonics in the current. Note that the d_a for this case is not unique.

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3. For the given DC chopper circuit system and armature current shown below. Plot the diode currents and source current. Assuming $k_v\omega_r = 100$ V, $L_{AA} = 1$ mH, T = 1 ms, determine the duty cycle k, and the source voltage v_S. State any assumptions made in your analysis. (25 pts)