# EE595S
# Fall 2001
# Exam 1

Problem 1 (20 pts)

Consider a three phase bridge inverter feeding a asymmetrical (non-balanced) wye-connected three-phase load. At a given instant of time the upper semiconductors of the a- and b- phases are gated on and the lower semiconductor of the c-phase is gated on. At the same instant, the a-phase current is 5 A (out of the inverter) and the b-phase current is – 2 A (out of the inverter) and the DC rail voltage is 25 V. If the voltage drop across a switch is 2 V, and the voltage drop across a forward biased diode is 1 V, compute the instantaneous value of the q- and d-axis voltage in the stationary reference frame.

Problem 2 (20 pts)

The flux linkage equations of a certain class of permanent magnet synchronous machine is described by

$$\lambda_{qd0} = \begin{bmatrix} 0.2 & 0 & 0 \\ 0 & 0.2 & 0 \\ 0 & 0 & 0.1 \end{bmatrix} i_{qd0} + \begin{bmatrix} 0.15 \\ 0 \\ 0 \end{bmatrix}$$

Set forth the flux linkage equations in terms of abc variables.

Problem 3 (20 pts)

Consider a brushless dc machine with the following parameters: $v_{dc} = 200\,\text{V}$, $\phi_v = \pi/4$, $r_s = 2\Omega$, $L_q = 12\,\text{mH}$, $L_d = 8\,\text{mH}$, $\lambda_m = 0.2\,\text{Vs}$, $P = 4$. If the mechanical rotor speed is 1000 rpm, and the modulation strategy is 180 degree operation, find the electromagnetic torque.

Problem 4 (20 pts)

Consider an inverter operating at a dc link voltage of 200 V. It is desired that the fast average of the q- and d-axis voltages be 50 V and 25 V, respectively. Assume that the modulation strategy is sine triangle with third harmonic injection. Express $d_a$ (the a-phase duty cycle) as a function of $\theta_r$ and literals.

Problem 5 (20 pts)

An inverter feeds a wye-connected RL load with a per phase resistance of 5 Ohms and a per phase inductance of 10 mH (non-coupled). The inverter is controlled with a space vector modulator (you may consider the modulator inputs to be commanded q- and d- axis voltages). Design a regulator that will ensure that the currents are exactly tracked, that decouples the q- and d-axis, and that has gains such that the q- and d-axis transfer functions have poles at s=-1000 and s=-5000. Include a block diagram and numerical values for gains.