EECS192 Mechatronic Design Laboratory

Worksheet 2 Solutions: MOSFET and Motor

Ducky

General 1

Given the parameters, the circuit can be simplified into a +7.2v source, a 0.12Ω resistor (combining the motor and battery resistances), and a MOSFET in series. Because the motor is not spinning (stalled), there is no back EMF to worry about.

2 Problem 1

At $V_{DS} = 0$, the combined 0.12 Ω resistor sees the full 7.2V, leading to $\frac{7.2V}{0.12\Omega} = 60A$ through the motor (or circuit).

The power through the motor is then $P = I^2 R_{MOT} = (60A)^2 \times 0.06\Omega = 216W$.

Since R_{BAT} and R_{MOT} forms a resistive divider, the voltage at the battery terminals is halved, so the battery voltage is 3.6V.

The power supplied by the battery is the combined power dissipation of the circuit, which is $P = I^2(R_{MOT} +$ $R_{BAT}) = (60A)^2 \times 0.12\Omega = 432W.$

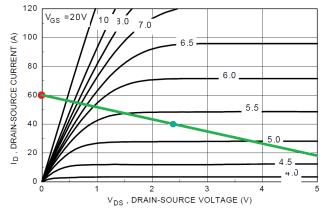
Problem 2 3

At $V_{DS} = 2.4V$, the equivalent resistors sees an effective voltage difference of 7.2V - 2.4V = 4.8V. The current is then $\frac{4.8V}{0.12\Omega} = 40A$ through the motor (or circuit). The power dissipated in the motor is then $P = I^2 \times R_{MOT} = (40A)^2 \times 0.06\Omega = 96W$.

The power dissipated in the MOSFET is then $P = V_{DS} \times I = 2.4V \times 40A = 96W$

Problem 3 4

From the problems above, we can plot the points $V_{DS} = 0, I = 60A$ (red point) and $V_{DS} = 2.4, I = 40A$ (blue point) on the on-characteristics chart. If we then draw a line through both points (in green), we get the load-line chart.



Looking at the I_D vs. V_{DS} curve for $V_{GS} = 5.5V$, the intersection is at around $V_{DS} = 1.5$, $I_D = 50A$. Using the same strategy as above, we have $P = I^2 \times R_{MOT} = (50A)^2 \times 0.06\Omega = 150W$ from the motor and $P = V_{DS} \times I = 1.5V \times 50A = 75W$ from the MOSFET.

5 Problem 4

The intersection for $V_G S = 20V$ is at around $V_{DS} = 0.5$, $I_D = 54A$. Using the same strategy as above, we have $P = I^2 \times R_{MOT} = (55A)^2 \times 0.06\Omega = 181.5W$ from the motor and $P = V_{DS} \times I = 0.5V \times 55A = 27.5W$ from the MOSFET.