Solution to lecture 5 exercises

5-100

The step-down converter in exercise 22-13 is based on a MOSFET switch according to Figure 1. The switching response is defined in 22-13 related to a wave shape as shown in Figure 2.

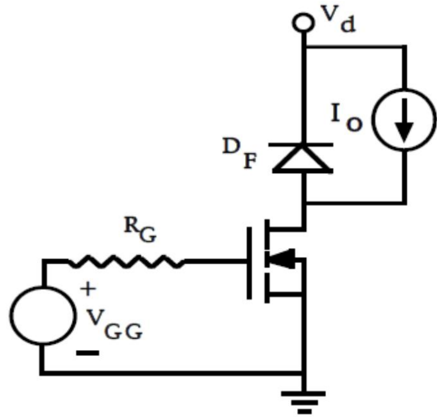

Figure 1

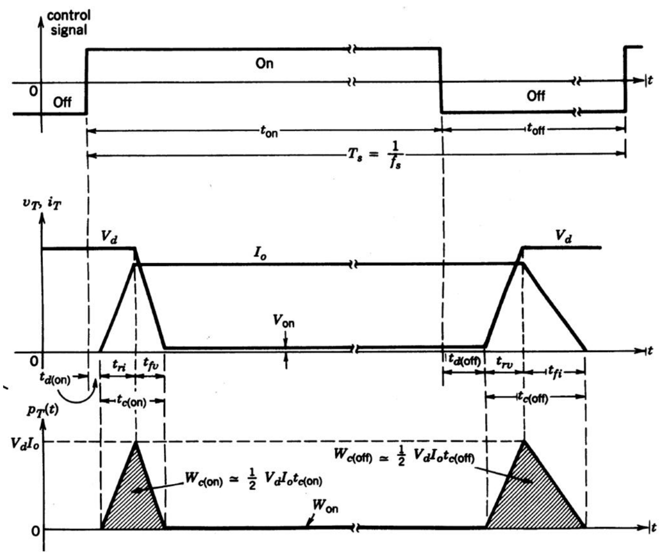

Figure 2

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The task is to determine the gate resistor which gives the turn-on dV/dt according to the given data. The dynamics of the MOSFET can during turn-on be modelled as:

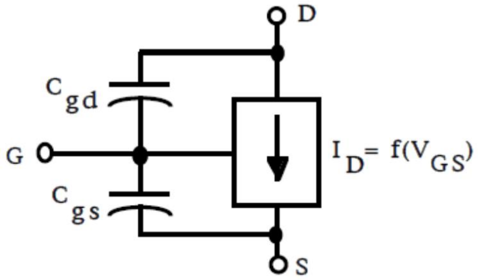

Figure 3

During turn-on the dV/dt between of the drain voltage will discharge the gate-drain capacitance C_{gd} giving a current defined as:

$$I_{gd} = C_{gd}\frac{dV_d}{dt} = 120pF\frac{100}{200ns} = 60mA$$

Specifically related to the Miller plateau where the gate-source voltage is constant during the collapse of the drain voltage, all current from the gate of the MOSFET will go through the gate-drain capacitance according to Figure 4.

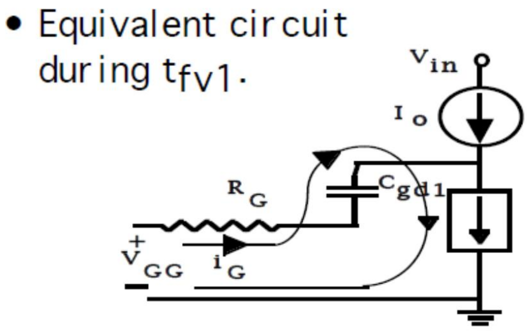

Figure 4

Consequently the gate current is defined by the gate drain capacitance and the dV/dt.

$I_g = I_{gd}$.

Related to the gate drive the following equation applies for the gate current when the gate-source voltage is defined by the Miller plateau voltage, V_{GP}.

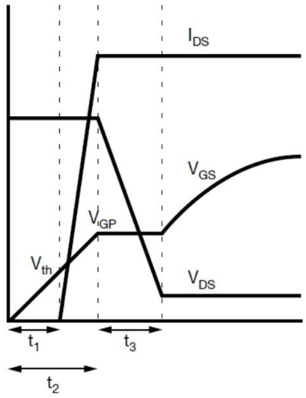

Figure 5

$$R_G = \frac{V_{GG} - V_{GP}}{I_g} = \frac{10 - 4}{60mA} = 100ohm$$