This LM311 comparator is being used in a PWM circuit:

```
(+5V) 

+15V

VM(t) -> LM311  

Vr(t)       

---

-15V

1k

R_PULL_DOWN

Q

V(t)  

(output)
```

(7 points) Given the input voltage signals VM(t) and Vr(t), sketch the output Vo(t) on the graph below:

![Graph of VM, Vm(t), Vr(t), and Vo(t)]

(3 points) Express the duty cycle of Vo(t) as a function of Vm(t) and VM.

\[
D(t) = 1 - \frac{V_m(t)}{VM}
\]

For a comparator (like an LM311 with an open collector output):

- If \( V^+ > V^- \), \( Q \) is off
- If \( V^+ < V^- \), \( Q \) is on

With a pull down resistor, the output goes low when \( V^+ > V^- \) and vice versa.