210 Review Session Q&A

RC circuit

Q: What is steady state and zero state? What is the transient solution in terms of zero-input and zero-state?

A: The steady state of an RC circuit is its behavior when time approaches infinity. The capacitor will either charge or discharge.

The transient solution is part of the overall response that is initially present but vanishes when time approaches infinity. It has a zero-input component and a zero-state component. The zero-input response will always be transient, and the zero-state response will have a transient part and a steady state part.

Example 3.13 and 3.14 (pg. 95) from the book

Q: How do you get = 2V

A: is the capacitor voltage in DC state, before the switch is flipped. The capacitor can be treated as an open circuit, so its voltage drop is equal to the voltage drop across the 1 resistor. 1.

Steady-State Circuit question

Q: How do you get ?

A: The capacitor is an open circuit before the switch is flipped open. You can simplify the circuit by combining the 8 resistors at the bottom to be 4 . Using voltage division. The capacitor is 6V.

Q: How to get Vs = 12V, capacitor voltage at t = infinity?

A: At t infinity, the capacitor is an open circuit. Therefore, the resistor connected in series with the capacitor will not have a voltage drop. In order to satisfy KVL at the outter-most loop, the voltage of the capacitor has to match the voltage source 12V.

Q: How to find voltage on capacitor in the DC circuit?

A: Treat the capacitor as an open circuit. The open circuit voltage is the capacitor voltage in DC circuit.

Q: How do you find the current ?

A: Use IV relation of the capacitor and take the derivative of the voltage equation.

Q: How do you find the power dissipated through the resistor?

A: The power dissipated through the resistor is .

Q: How to determine Thevenin resistance?

A: When you have all independent sources, find the open circuit voltage and short circuit current. Use Ohm’s Law . When you have a dependent source, you have to use test signal. Suppress all independent sources and inject a 1A current source. Write KVL and KCL equations to solve for the voltage drop across the 1A current source. Using Ohm’s Law R = V/1A, the voltage drop will have the same value as the Thevenin resistance.

Q: Derive steady state/transient and zero-input/zero-state given differential equation.

A: To get the zero-input response, solve the differential equation with f(t) set to 0 (and hence the name). To get the zero-state response, include f(t) but ignore the initial condition at the end. The overall response can be found by combining these terms.

To find the steady state, extract terms that do not go to 0 when t infinity, for example, the constant(DC) or sinusoidal components in the equation. To get the transient state, extract terms that vanish to 0 as t infinity, usually all the exponential terms. (see example 3.19 from the book).

Note that the zero-input response is always transient, since physically, this means that if there is some residual signals left in the LTI system at the start of the time of interest, it will eventually disappear if the system does not have any input. The zero-state response can contain both a steady state and transient solution.

Q: How do you get and current flowing through the resistors?

A: How to find Thevenin resistance in dependent source circuits using test signal?

Suppress all independent sources. Inject an independent current or voltage source with 1A or 1V. Use KVL or KCL to find the voltage / current across the arbitrary input source. or . (see more examples on pg. 56 – 60 of the book)

Q: Is there a Thevenin / Norton example problem?

A: We can add an example to our future slides like the one below.



