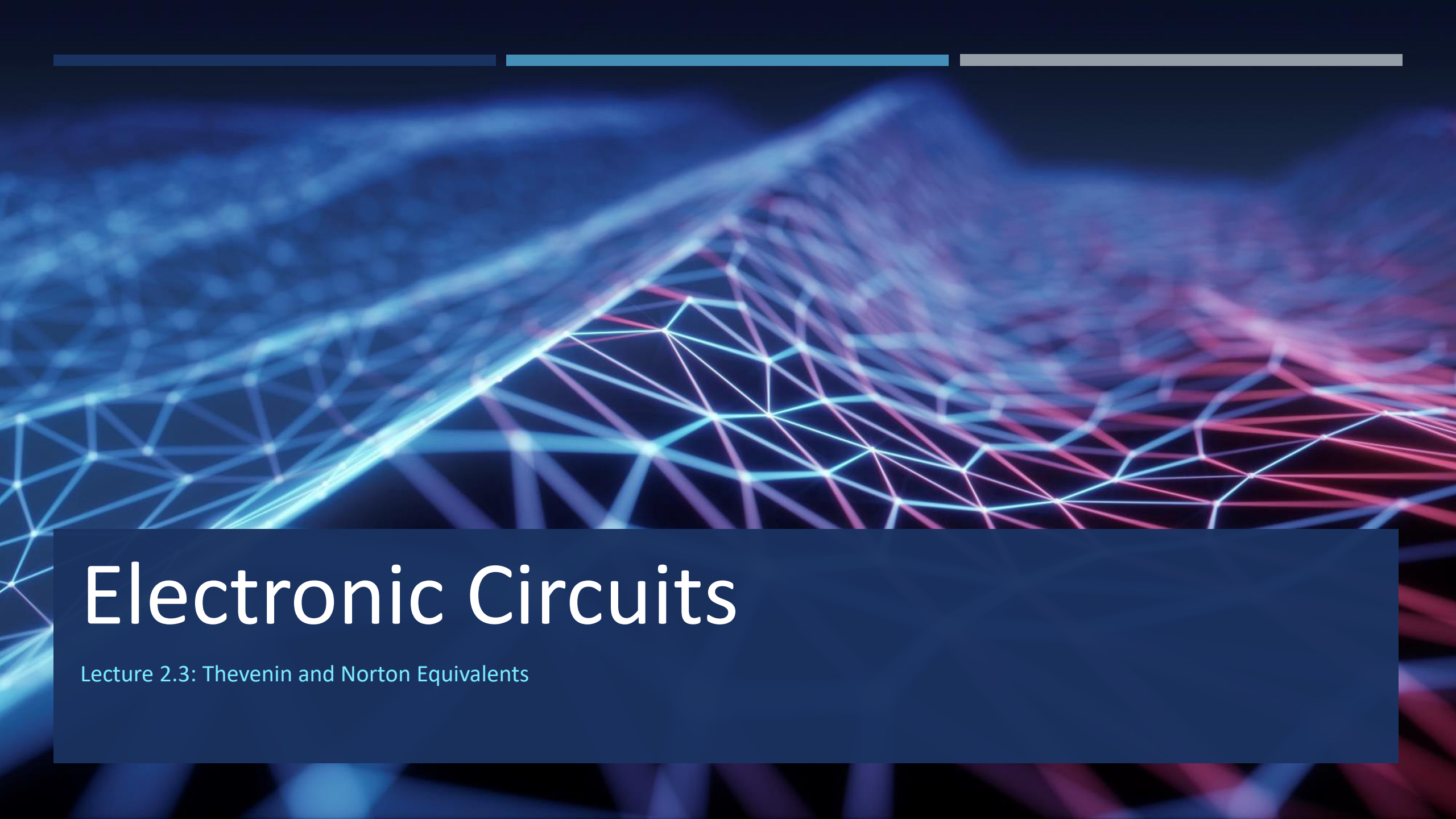
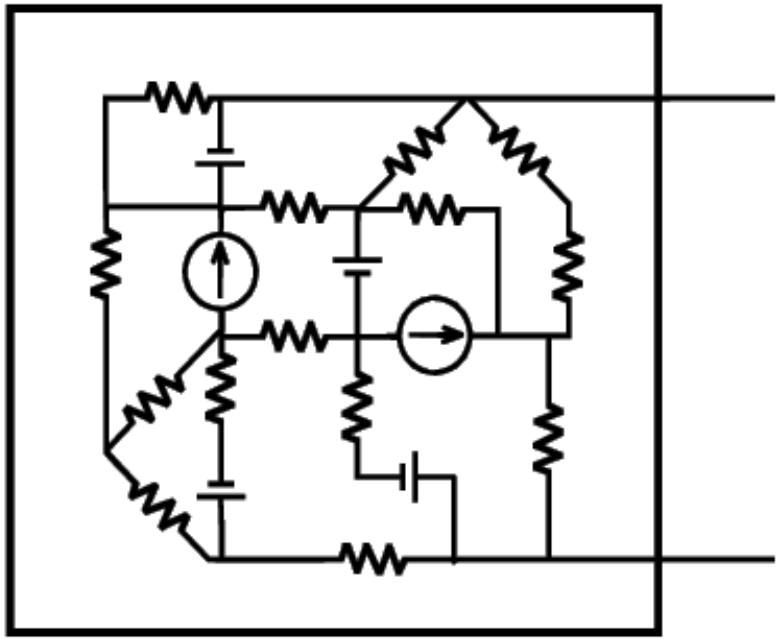


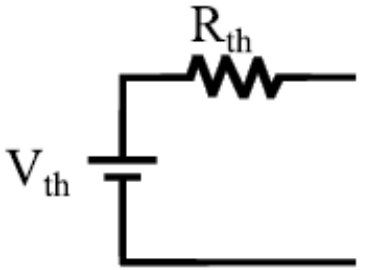
Electronic Circuits

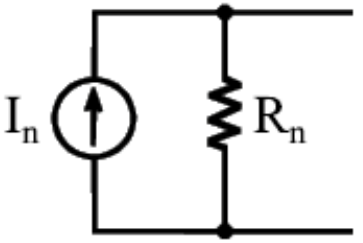
Lecture 2.3: Thevenin and Norton Equivalents

Circuit Reduction

- Consider a box with two external leads. Inside the box is any number of elements and linear sources connected in any way.
- When this box is connected into a circuit, and assuming appropriate values are chosen for Vth, Rth, In, and Rn, the circuit will behave the same if either the Thevenin or Norton equivalent is used instead.
- The Thevenin and Norton equivalents are used, for example, to analyze or better understand a circuit by reduction.

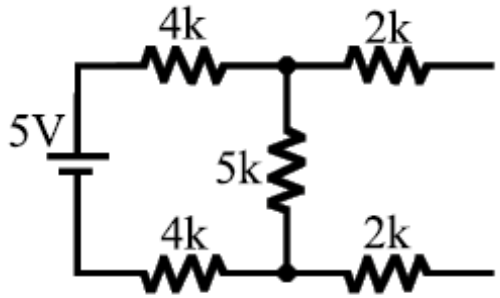


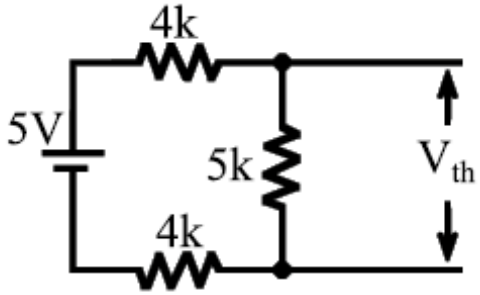


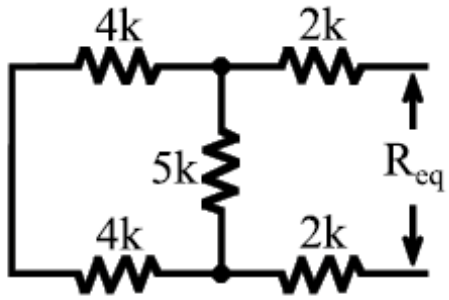


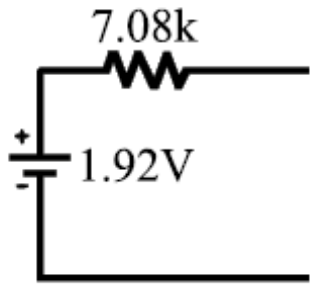
Determining the Thevenin Parameters

- Vth = Open-circuit voltage
- In = Short-circuit current
- Rth = Req



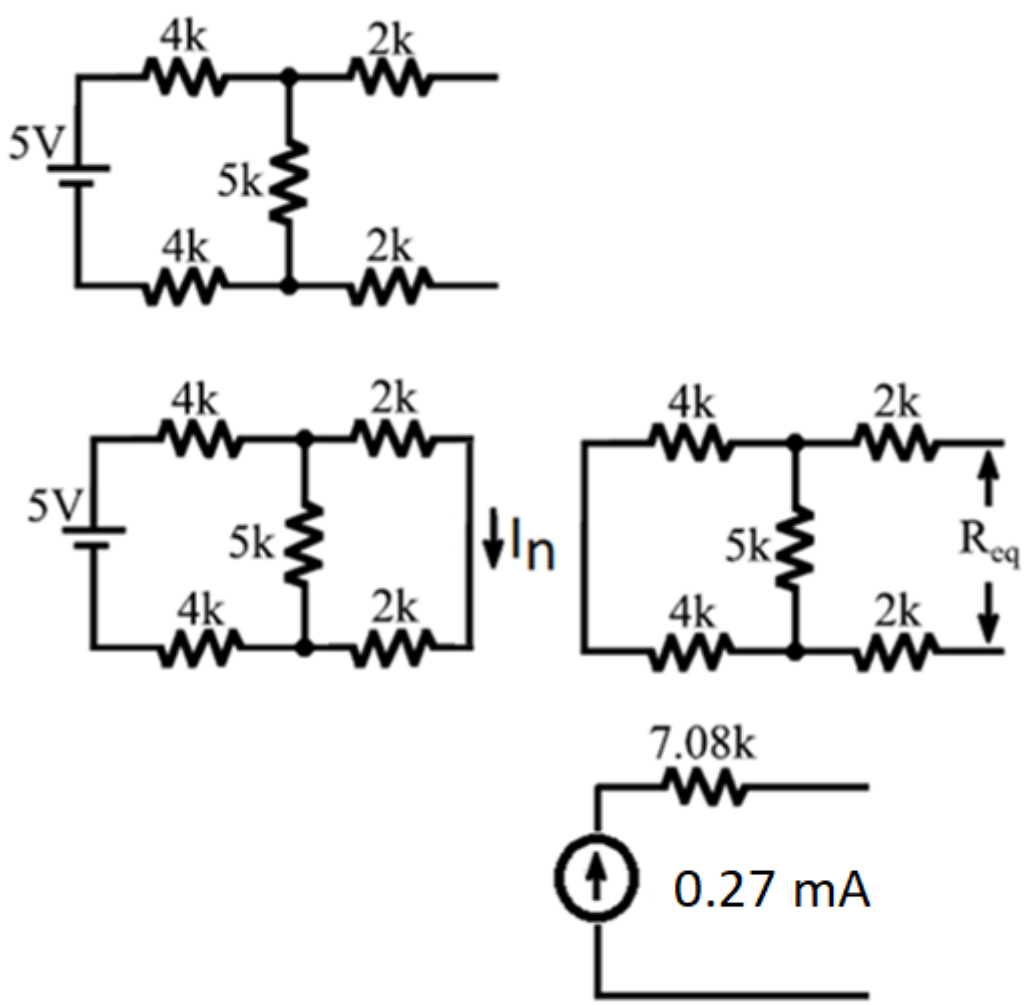






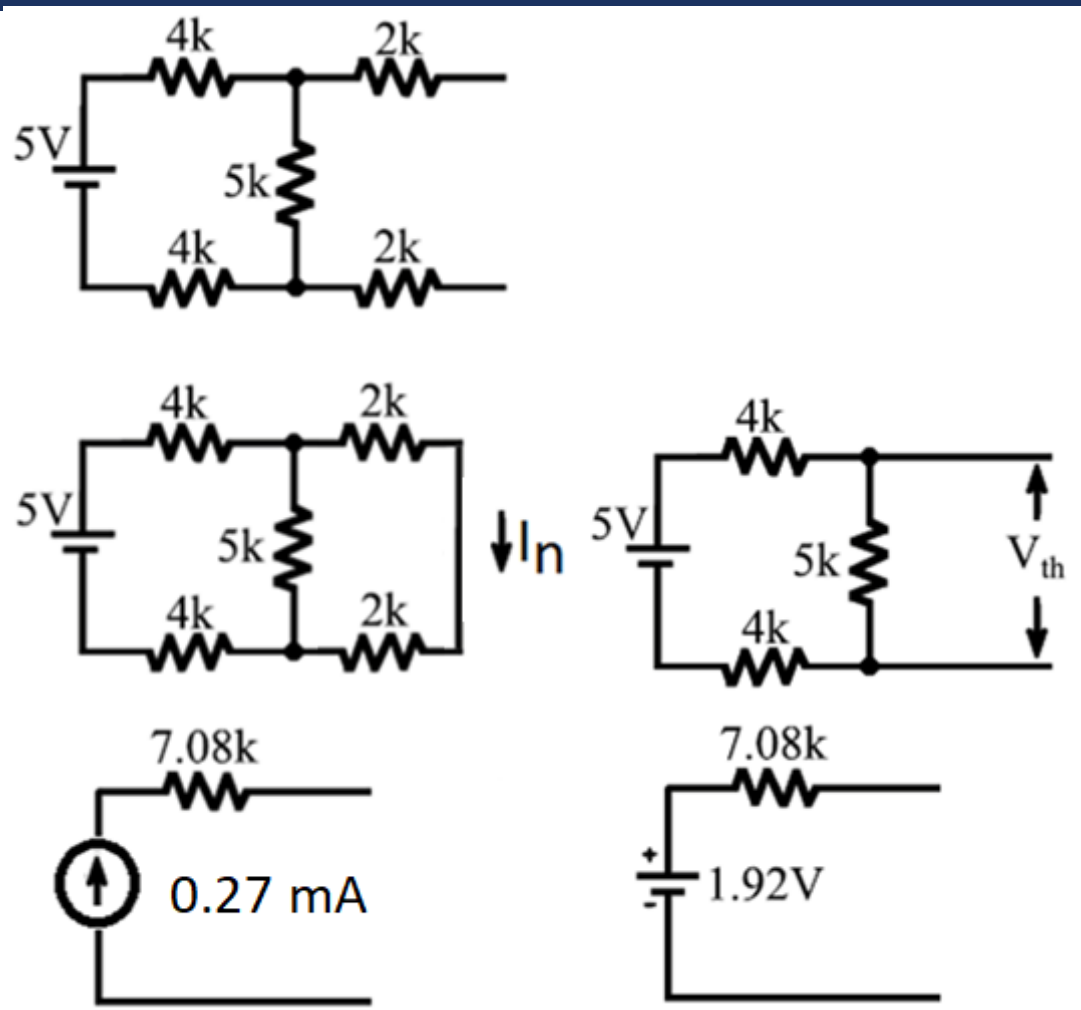
Determining the Norton Parameters

- Vth = Open-circuit voltage
- In = Short-circuit current
- Rn = Req

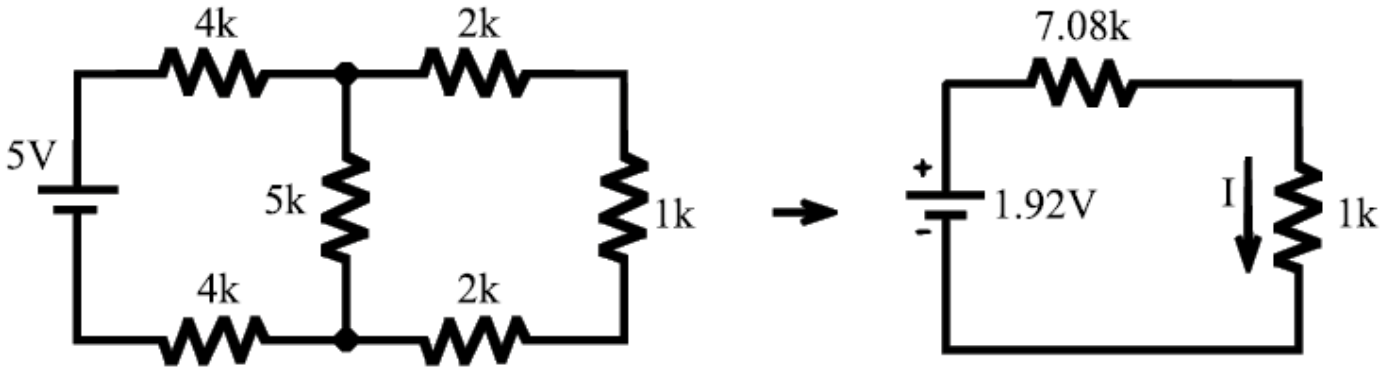


Determining the Equivalent Circuit Parameters

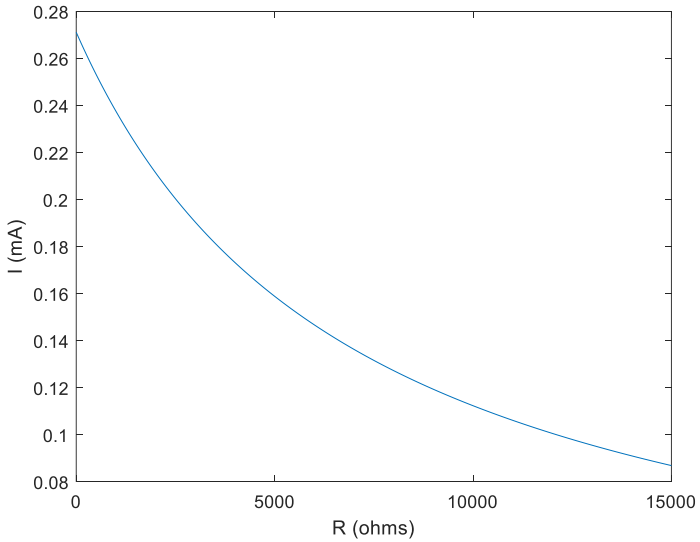
- Vth = Open-circuit voltage
- In = Short-circuit current
- Req = Rn = Rth = Vth / In



Use of Equivalent Circuit (1): Calculate One Use Multiple

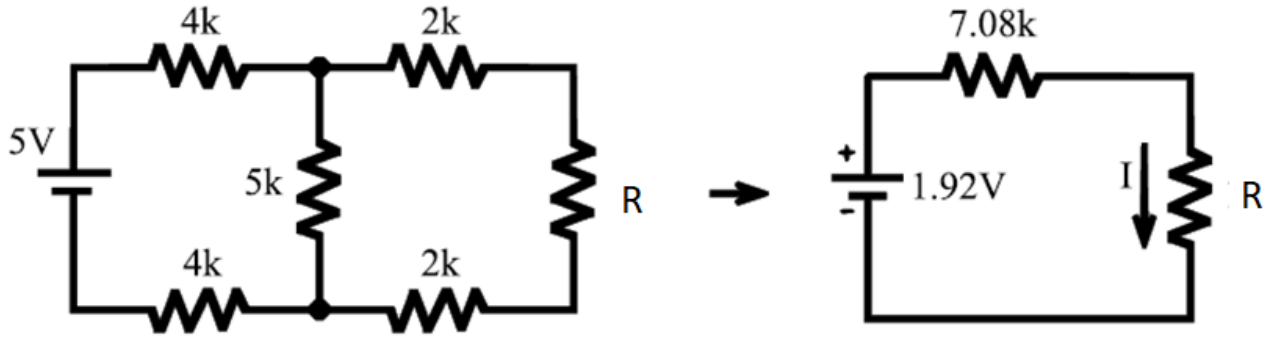


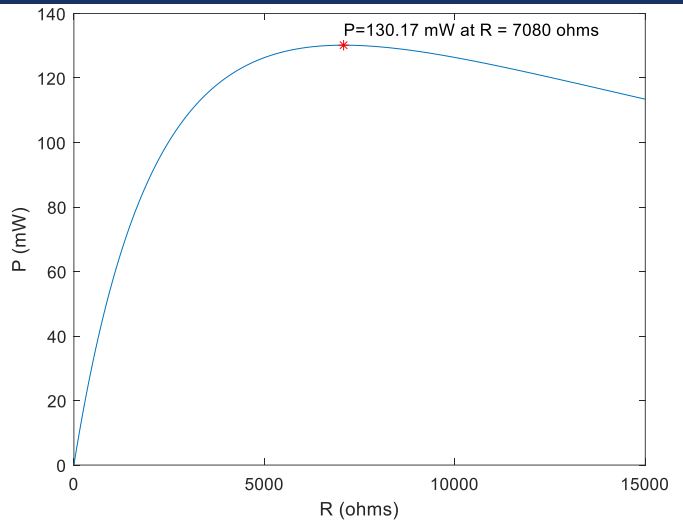

```
R = 0:10:15000;
I = 1.92./(7080+R) * 1000;
P = I.^2 .* R;

figure, plot(R,I)
xlabel("R (ohms)")
ylabel("I (mA)")
```



- $I = \frac{1.92}{7080+R} = \frac{1.92}{7080+1000} = 0.24\ mA$
- After finding the equivalent circuit, you can easily calculate the effect of any resistor connected instead of 1k load.

Use of Equivalent Circuit (2): Maximum Power Transfer Theorem

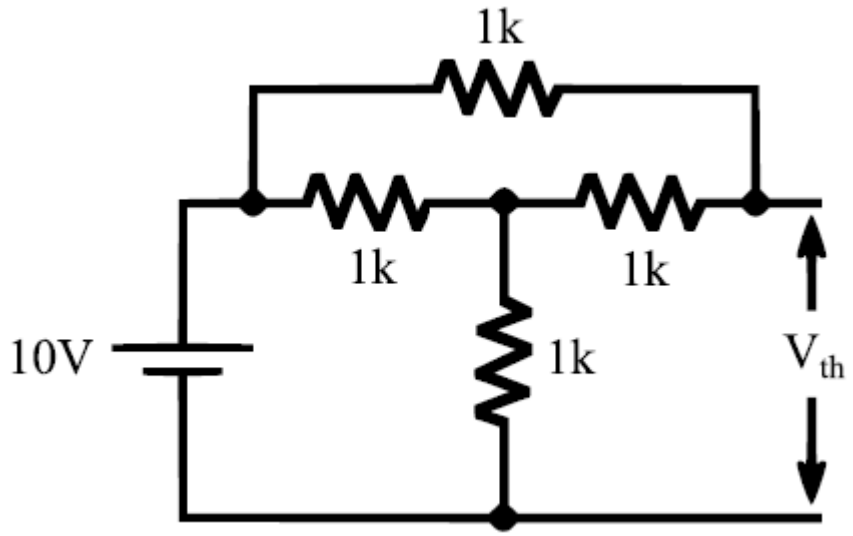




- In order to transfer maximum power to the load (R), what value should R take?
- Maximum Power Transfer Theorem: If the load equals to the equivalent resistor, than the maximum power will transferred from circuit to the load !!!

```
R = 0:10:15000;
I = 1.92./(7080+R) * 1000;
P = I.^2 .* R;

figure, plot(R,P)
xlabel("R (ohms)")
ylabel("P (mW)")
hold on
[M,I] = max(P)
plot(R(I),P(I),'*r')
S = sprintf("P=%3.2f mW at R = %d ohms",M,R(I))
text(R(I)+1,P(I)+5,S)
```

LTS: Left To Students (Not homework, try yourself)



- What is the Thevenin equivalent for the circuit?
- What is the Norton equivalent for the circuit?
- Which value of a load resistor should be connected for the maximum power transfer to the load?

Thanks for listening ☺

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Assoc. Prof.