emech.transmod Modeling with transducers

1 We now develop both linear graph and state-space models of systems that include transducers. Linear graphs of two-port ideal transducer elements are drawn as shown in Figure transmod.1. Once again, we use the sign convention that power into an element is positive. Often, the edges are drawn toward ground nodes, which are always different when the transducer acts between different energy domains. Transducers may or may not be sufficiently modeled by ideal transducers. For instance, we may need to consider the moment of inertia associated with a gear. When this is the case, additional elements can be connected in parallel and in series with the two-port element nodes. DC motors—another example—are typically not modeled with an ideal transducer, alone, because the windings have both resistance and inductance.

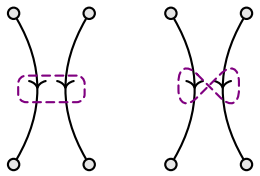

Figure transmod.1: two-port ideal linear graph elements of a transformer (left) and a gyrator (right).

State-space modeling with transducers

2 We present a method for constructing a state-space model of systems containing transducer elements. This procedure begins, as before, with the construction of the normal tree. The following rules must be respected.

- R1. There can be no loops.
- R2. Every node must be connected.
- R3. Of a transformer's two edges, exactly one is included.
- R4. Of a gyrator's two edges, either both are or neither is included.

3 Form a normal tree with the following steps.

1. Include all nodes.
2. Include all across-variable sources.
3. Include as many as possible A-type elements.[2]

2. Inclusion of an A-type at this step may result in a violation of R3 or R4 in the next, which implies the A-type is a dependent energy storage element and that it should be excluded from the normal tree.

4. Include transducer edges, minimizing the number of T-types in the tree.
5. Include as many as possible D-type elements.
6. Include as many as possible T-type elements.

4 The state and output equations can be derived as before, but with the following caveat: each two-port element requires two elemental equations.