ME242 – MECHANICAL ENGINEERING SYSTEMS

LECTURE 25:

- Intermediate Modeling – Simple Circuits 4.1

INTERMEDIATE MODELING

Start second pass of modeling process

- Bond graphs with many bonds and junctions
- Include multiple transformers and gyrators
- More bond graph reduction, model equivalences

SIMPLE CIRCUITS

Creation of simple multi-element bond graphs

Key Concepts:

- Each element has two sides
- Elements interconnect by simple junctions
- Graph simplified by removal of ground
- Remove two ported multiports

Slight Differences:

- Electrical and Fluid very similar
- Mechanical slightly different

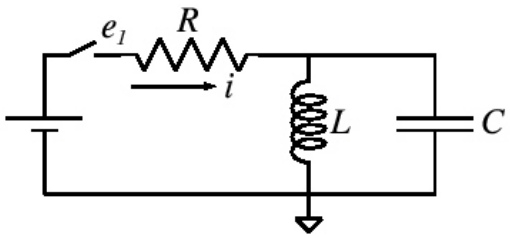
ELECTRIC CIRCUITS

Identify all nodes and all elements
(*there are two nodes for each element*)

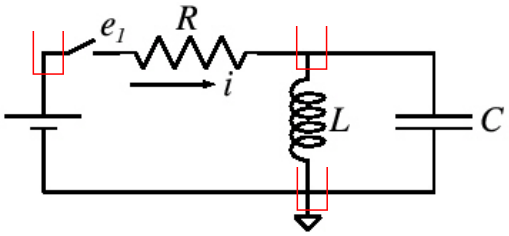
1. Represent each electrical junction (node) with a 0 junction
   - Represent each element with I, R or C
     (*each element gets a bond to it*)
2. Connect each element's bond to a 1 junction
   - Connect each 1 junction to 2 0 junctions
3. Discard all bonds for $e = 0$ (ground) and $i = 0$
4. Eliminate all junctions with only two bonds

ELECTRIC CIRCUITS

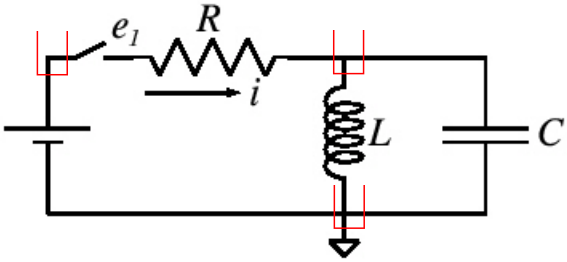
Example:



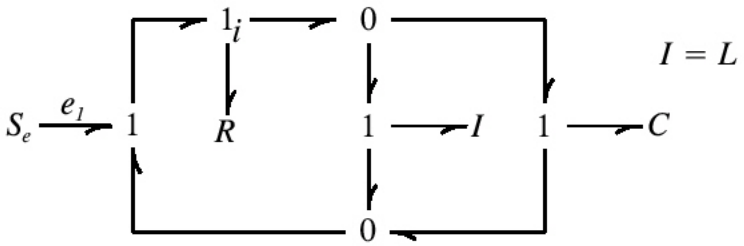
Identify elements and nodes



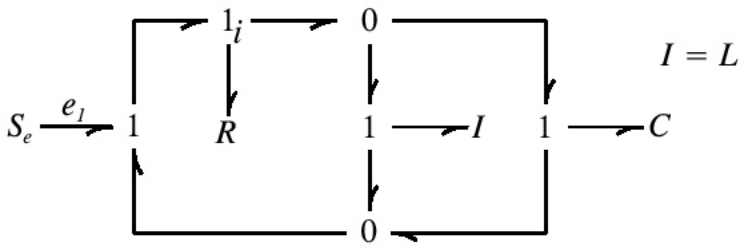
ELECTRIC CIRCUITS



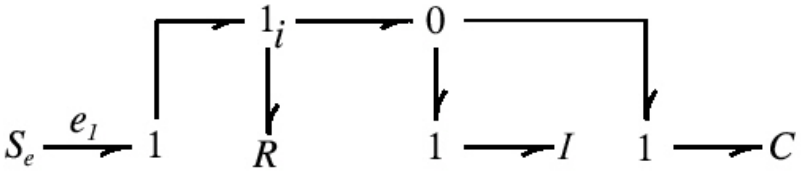
Add junctions



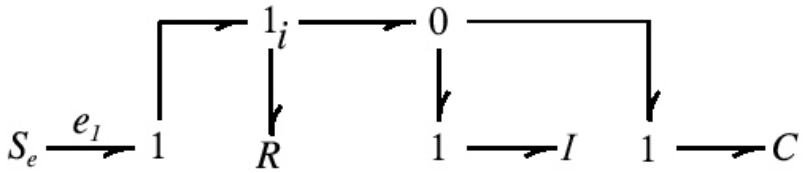
ELECTRIC CIRCUITS



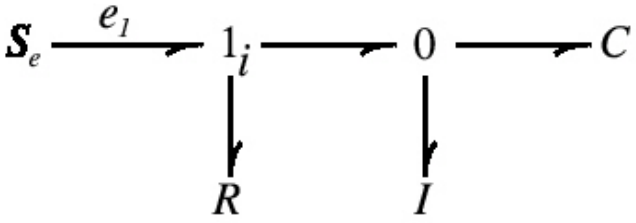
Remove $e = 0,\ i = 0$ bonds $\Downarrow$



ELECTRIC CIRCUITS



Remove 2 ported multiports $\Downarrow$



With practice can draw final graph in one step.

ELECTRIC CIRCUITS

Identify all nodes and all elements
(*there are two nodes for each element*)

1. Represent each electrical junction (node) with a 0 junction
   - Represent each element with I, R or C
     (*each element gets a bond to it*)
2. Connect each element's bond to a 1 junction
   - Connect each 1 junction to 2 0 junctions
3. Discard all bonds for $e = 0$ (ground) and $i = 0$
4. Eliminate all junctions with only two bonds

FLUID CIRCUITS

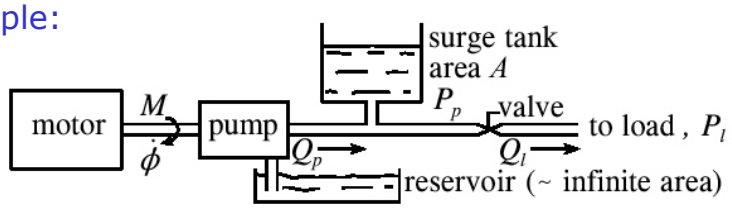
Identify all nodes and all elements
(*there are two nodes for each element*)

1. Represent each node with a 0 junction
   - Represent each element with I, R or C
     (*each element gets a bond to it*)
2. Connect each element's bond to a 1 junction
   - Connect each 1 junction to 2 0 junctions
3. Discard all bonds for $e = 0$ (ground) and $i = 0$
4. Eliminate all junctions with only two bonds

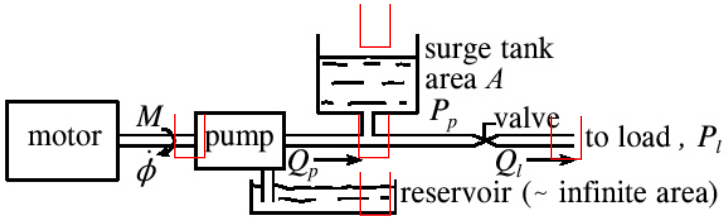
Just like electrical circuits!

FLUID CIRCUITS

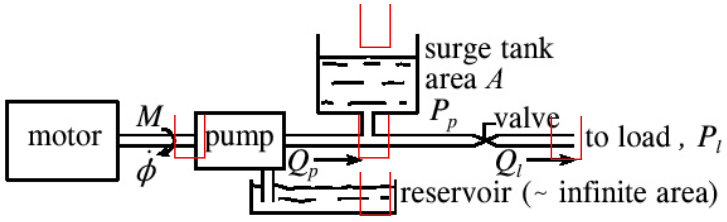
Example:



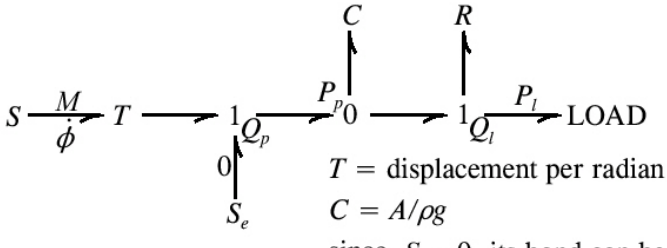
Identify elements and nodes ⇓



FLUID CIRCUITS



⇓



T = displacement per radian

$C = A/\rho g$

since $S_e = 0$, its bond can be dropped

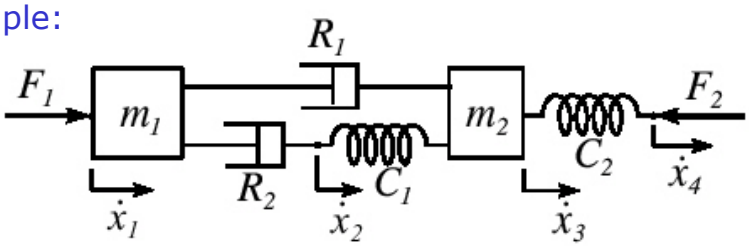
MECHANICAL CIRCUITS

Identify all nodes and all elements
(*there are two nodes for each element*)

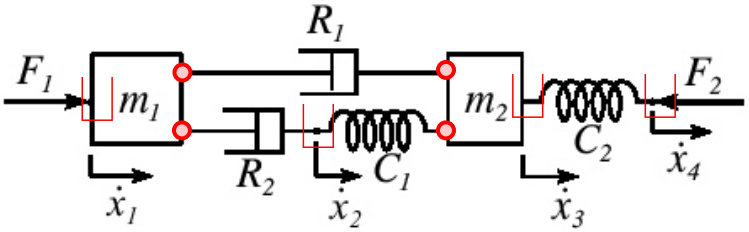
1. Represent each mech. junction with a 1 junction
   - **Place all I's on 1 junctions**
2. Connect each R, C elements on a 0 junction
   - Connect each 0 junction to 2 1 junctions
3. Coalesce bonded junctions of same type
4. Add in S, S_e S_f as needed.
5. Discard all bonds for $e = 0$ (ground) and $f = 0$
6. Eliminate all junctions with only two bonds

MECHANICAL CIRCUITS

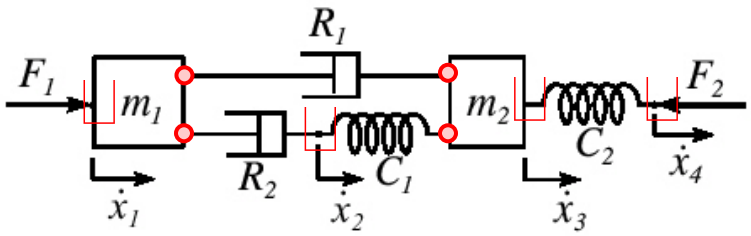
Example:



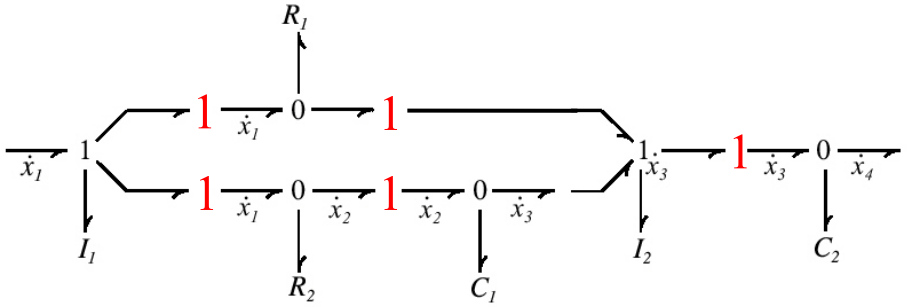
Identify elements and junctions ⇓



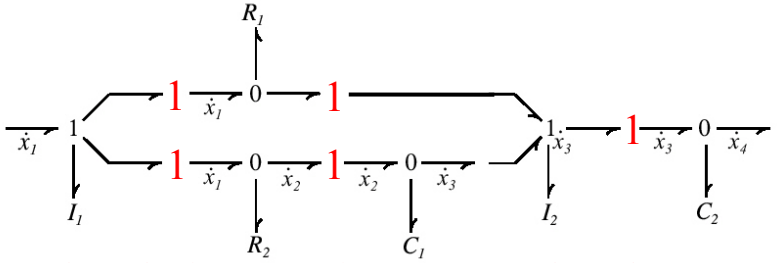
MECHANICAL CIRCUITS



I's to 1's, C's and R's to 0 and 1's for junctions ⇓



MECHANICAL CIRCUITS



Delete bonds for e=0, f=0, 2 ported multports, add S's ⇓