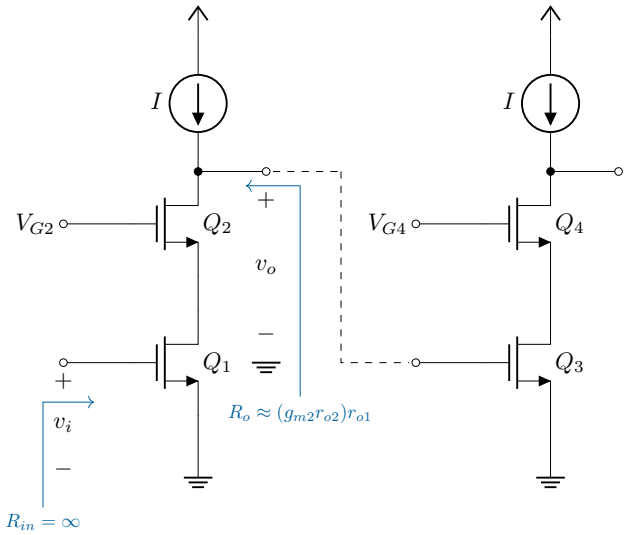
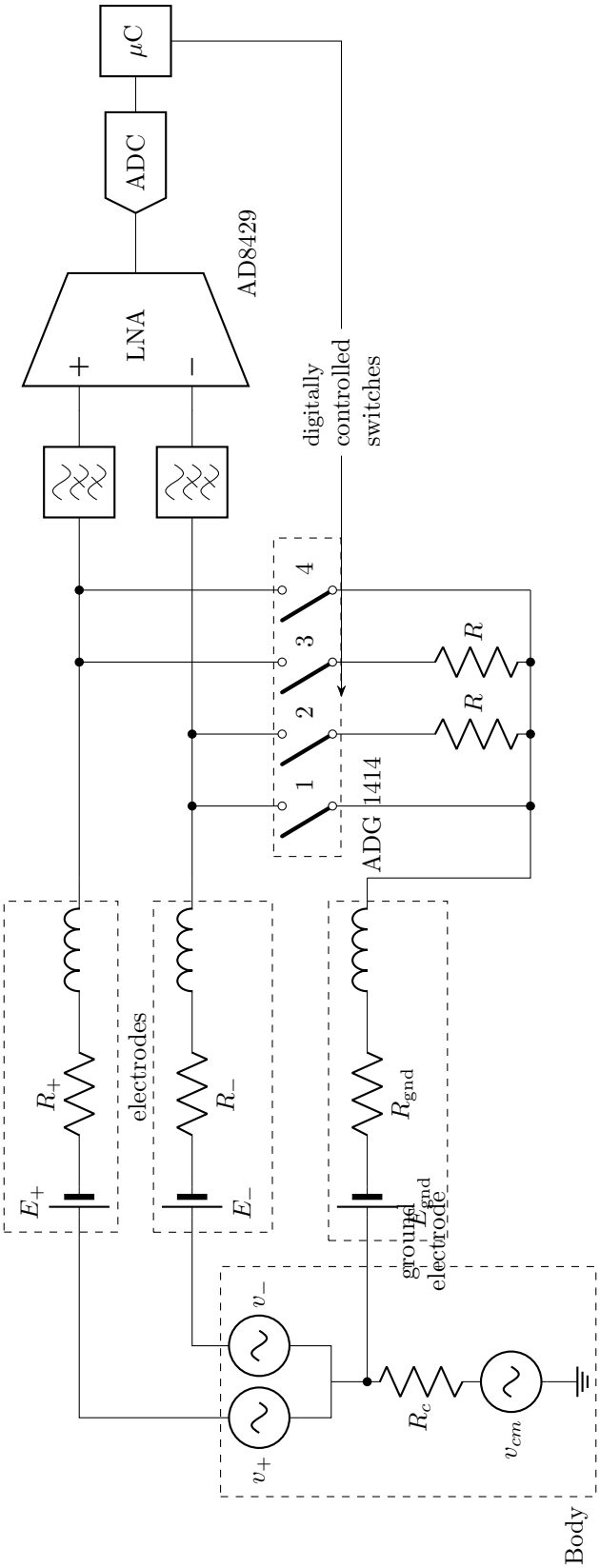
Example 1 + Answer




```
\ctikzset{tripoles/mos style/arrows}
\ctikzset{transistors/arrow pos=end}
\definecolor{highlight}{rgb}{0,0.3843,0.6078}

% Define the start coordinate
\path (0,0) coordinate(IN);

% Draw the main components
\draw (IN) to[short, o-] ++(1,0) node[nmos, anchor=G](Q1){$Q_1$};
\draw (Q1.S) to[short] ++(0, -0.5) node[ground](GND){};

\draw (Q1.D) to[short] ++(0, 0.5) node[nmos, anchor=S](Q2){$Q_2$};
\draw (Q2.G) to[short, -o] (IN |- Q2.G) node[left]{$V_{G2}$};
\draw (Q2.D) to[short, *-o] ++(1, 0) coordinate(OUT);
\draw (Q2.D) to[isource, invert, l=$I$] ++(0, 2) node[vdd]{};

% Draw voltage labels (using CircuiTikZ)
\draw (IN) to[open, v=$v_i$] (IN |- GND.south);
\draw (OUT) to[open, v=$v_o$] (OUT |- Q1) node[tlground]{};

% Draw regular labels (using _just_ TikZ)
\draw[->, color=highlight] (IN |- GND.south) ++(-0.3,-0.3)
node[below, scale=0.8]{$R_{in} = \infty$} -- ++(0,1.55) -- ++(0.75,0);
\draw[->, color=highlight] (OUT |- Q1) ++(0.5,-0.5)
node[below, scale=0.8]{$R_{o} \approx (g_{m2} r_{o2})r_{o1}$} -- ++(0,3.1) -- ++(-0.8,0);

% Oh, wait, let's draw another stage!
\draw[dashed] (OUT) ++(0.1,0) -- ++(1,0) coordinate(tmp);
\draw[dashed] (tmp) -- (tmp |- IN) -- ++(1,0) ++(0.1,0) coordinate(IN);

\draw (IN) to[short, o-] ++(1,0) node[nmos, anchor=G](Q1){$Q_3$};
\draw (Q1.S) to[short] ++(0, -0.5) node[ground](){};
\draw (Q1.D) to[short] ++(0, 0.5) node[nmos, anchor=S](Q2){$Q_4$};
\draw (Q2.G) to[short, -o] (IN |- Q2.G) node[left]{$V_{G4}$};
\draw (Q2.D) to[short, *-o] ++(1, 0) coordinate(OUT);
\draw (Q2.D) to[isource, invert, l=$I$] ++(0, 2) node[vdd]{};
```

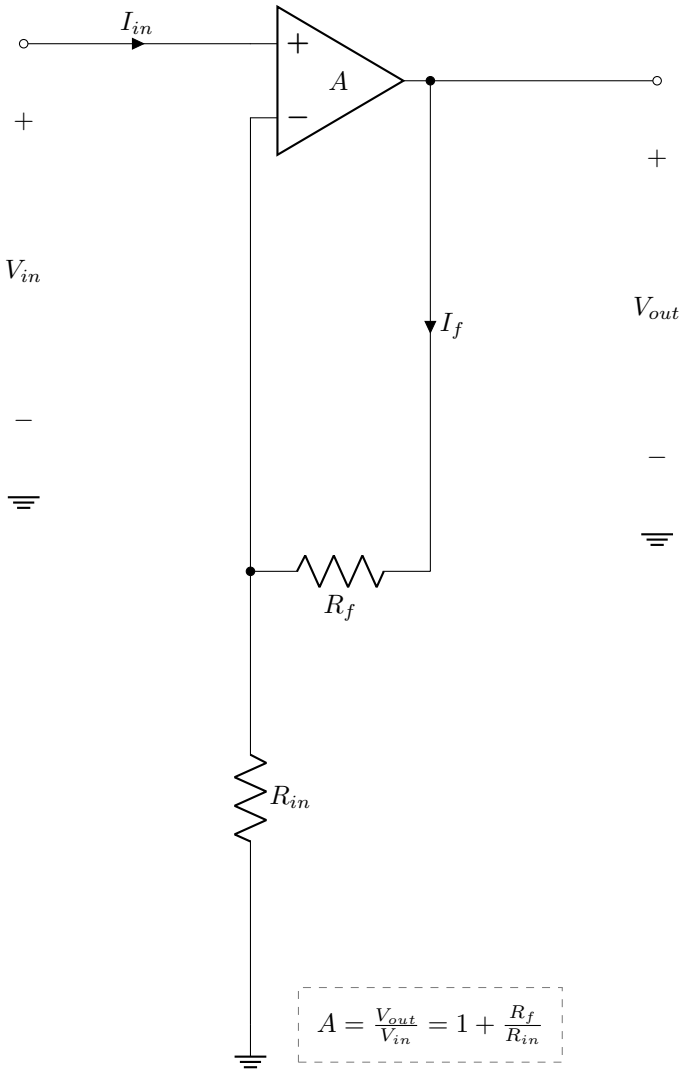
Example 2


μC
ADC
AD8429
LNA
+
−
digitally controlled switches
4
3
2
1
ADG 1414
R
R
electrodes
R_+
R_-
R_{gnd}
E_+
E_-
E_{gnd}
ground electrode
v_-
v_+
R_c
v_{cm}
Body

Example 2 Answer

```
\ctikzset{bipoles/cuteswitch/thickness=0.5}

% Draw the source upto the split
\draw (0,0) node[ground](GND0){} to[sV, l=$v_{cm}$] ++(0,1) to [R, l=$R_c$, -*] ++(0,1.5) coordinate(vcm);
\draw (vcm) -- ++(0,0.5) coordinate(diffc);

% Draw the upper/+ path including the LNA
\draw (diffc) -- ++(-0.5, 0) -- ++(0, 0.5) to[sV, l=$v_+$, name=vplus] ++(0,1)
    -- ++(0, 2) -- ++(2.5, 0) coordinate(skin+ a);
\draw (skin+ a) to[battery2, l=$E_+$, name=eplus] ++(1,0) to[R=$R_+$, name=rplus] ++(2,0) to[L, name=lplus] ++(2
\draw (skin+ b) -- ++(0.5,0) -- ++(4,0) coordinate(hpin+);
\draw (hpin+) to[highpass] ++(2,0) node[inst amp, anchor=+, noinv input up, circuitikz/amplifiers/scale=1.6,

% Define the coordinate to align the -/lower path.
\coordinate (skin- a) at (LNA.- -| skin+ a);

% Draw the lower path
\draw (diffc) -| ++(0.5,0.5) to[sV,l_=$v_-$, name=vminus] ++(0, 1) |- (skin- a);
\draw (skin- a) to[battery2, l_=$E_-$, name=eminus] ++(1,0) to[R, l_=$R_-$, name=rminus] ++(2,0) to[L, name=lmin

% Define the ground coordinate to align the lowest path
\coordinate (gnd a) at (vcm -| skin+ a);
\draw (vcm) -- (gnd a) to[battery2, l_=$E_\mathrm{gnd}$, name=egnd] ++(1,0) to[R, l_=$R_\mathrm{gnd}$, name=rgnd

% switch set
\def\swdown{-3.2}
\draw (skin- b) ++(1,0) coordinate(sw1);
\draw (sw1) to[cosw, invert, mirror, l=1, *-, name=s1] ++(0,\swdown) to[short, -*] ++(0, -1.5);
\draw (sw1) ++(1,0) coordinate(sw2);
\draw (sw2) to[cosw, invert, mirror, l=2, *-] ++(0,\swdown) to[R=$R$, -*] ++(0, -1.5);
\draw (sw2|-skin+ b) ++(1,0) coordinate(sw3);
\draw (sw3) to[short, *-] (sw3|-sw2) to[cosw, invert, mirror, l=3,] ++(0,\swdown) to[R=$R$, -*] ++(0, -1.5);
\draw (sw3) ++(1,0) coordinate(sw4);
\draw (sw4) to[short, *-] (sw4|-sw2) to[cosw, invert, mirror, l=4, name=s4] ++(0,\swdown) to[short] ++(0, -1.5)
\draw (gnd b) |- (endsw);

% boxes (use fit library from TikZ)
\node[rectangle, draw, dashed, fit=(GND0) (vplus) (vpluslabel) (vminuslabel)](body) {};
\node[anchor=south east, align=center] at (body.south east) {Body};

\node[rectangle, draw, dashed, fit=(rplus) (eplus) (epluslabel) (rpluslabel) (lplus)](top) {};
\node[rectangle, draw, dashed, fit=(eminus) (rminus) (eminuslabel) (rminuslabel) (lminus)](bot){};

\node[anchor=center, align=center] at ($(top.south)!0.5!(bot.north)$) {electrodes};
\node[rectangle, draw, dashed, fit=(egnd) (rgnd) (egndlabel) (rgndlabel) (lgnd)](gnd){};

\node[below, align=center] at (gnd.south) {ground\\ electrode} ;
\node[rectangle, draw, dashed, fit=(s1) (s4label), inner ysep=8pt](switches){};

% ADC and micro
\draw (LNA.out) -- ++(0.5,0) node[msport,circuitikz/RF/scale=2](ADC){ADC};
\draw (ADC.right) -- ++(0.5,0) node[twoportshape, anchor=left, t=$\mu$C](uC){};
\draw (uC.south) -- (uC.south |- switches.east) -- ++(-4,0) node[align=left, anchor=east](DCS){\small digitally\
\draw[-Stealth] (DCS.west) -- (switches.east);

\node [anchor=north west] at ([xshift=-10pt, yshift=-5pt]switches.south east) {ADG 1414};
\node [anchor=north west] at ([yshift=-5pt]LNA.refv down) {AD8429};
```

Challenge



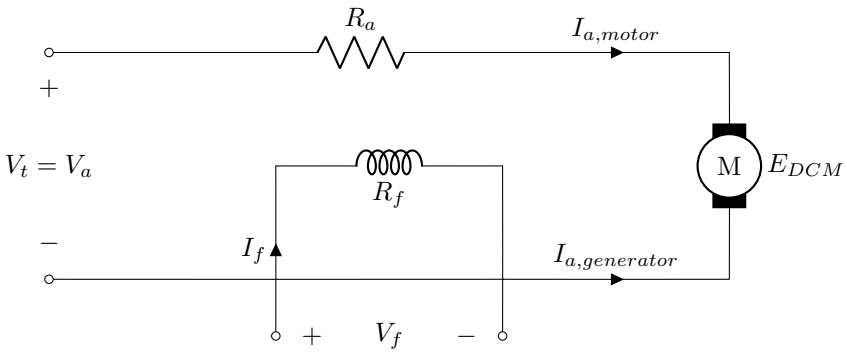
Challenge Answer

```
\path (0,0) coordinate(IN);

\draw (IN) to[short, o-, i=$I_{in}$] ++(1,0) node[op amp, noinv input up, anchor=+](opamp){$A$};
\draw (opamp.-) to[short, -*] ++(0,-2) coordinate(c) to[R, l=$R_{in}$] ++(0,-2) node[ground](g){};
\draw (c) to[R, l_=$R_f$] (opamp.out |- c) (opamp.out) to[short, *-, i=$I_f$] (opamp.out |- c);
\draw (opamp.out) to[short, -o] ++(1,0) to[open, v=$V_{out}$] ++(0,-2) node[tlground](){};
\draw (IN) to[open, v=$V_{in}$] ++(0,-2) node[tlground](){};

\draw (opamp.out |- g) node[](t){$A = \frac{V_{out}}{V_{in}} = 1 + \frac{R_f}{R_{in}}$};

\node[rectangle, draw, dashed, color=gray, fit=(t)]{};
```

EE BSC specific

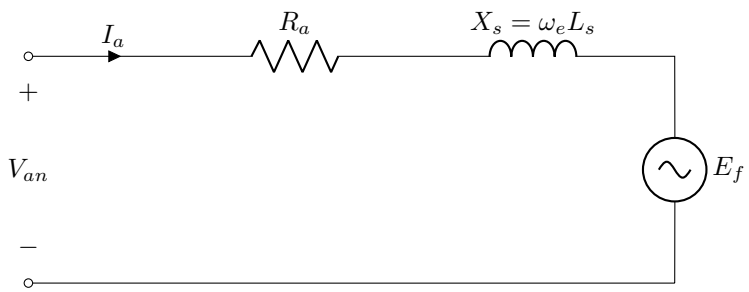
By $\sqrt{KS}$

DCM



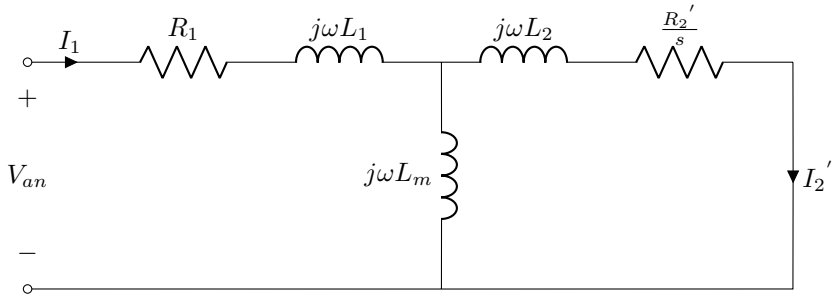

```
% Defining the input node
\coordinate (IN) at (0,0);
\coordinate (FCircuit) at (2,-2.5);
\draw
(IN) to [short, o-] ++(1.5,0)

% Drawing resistor
to[R, l=$R_a$] (4,0)

% Drawing motor current
to[short, -, i^={$I_{a, motor}$}] ++(2,0)
to[sV, color=white, name=M1, l=$E_{DCM}$] ++(0,-2)

% Drawing OC at input
(IN) to [open, v^>={$V_{t}=V_{a}$}] ++(0,-2)
to[short, o-] ++(4,0)
to[short, i^={$I_{a, generator}$} ] ++(2, 0)

++(0,1) node[elmech](motor){M} ++(0, -1)

(FCircuit) to[short, i^={$I_f$}, o-] ++(0,1.5)
to[short, -] ++(0.5,0)
to[L, l_=$R_f$] ++(1,0)

to[short, -] ++(0.5,0)
to[short, -o] ++(0,-1.5)
(FCircuit) to [open, v^>={$V_{f}$}] ++(2,0);
```

PMSM




```
\centering
% Input node
\coordinate (IN) at (0,0);
\draw
(IN) to [short,o-,i^=$I_a$] ++(1.5,0)

% Resistor
to[R, l=$R_a$] ++(1.7,0)

% Inductor
to[american inductor, l={$X_{s}=\omega_e L_{s}$}] ++(2.5,0)

% Wire and source
to [sV, l=$E_f$] ++(0,-2) coordinate(E_f_out)

% Horizontal wire bottom
(0, -2) to[short,o-] (E_f_out)
(IN) to [open, v^>={$V_{an}$}] (0,-2);
```

IM




```
\coordinate (IN) at (0,0);

\draw
% Resistor and terminal 1
(IN) to [short,o-,i^= $I_1$] ++(0.75,0)
to[R, l=$R_1$] ++(1.25,0)
to[american inductor, l^={$j\omega L_1$}] ++(1.5,0)

% Resistor and terminal 1
(3.5,0) to [short,-] ++(0.25,0)

to[american inductor, l=$j\omega L_2$] ++(1.25,0)
to[R, l^=$\frac{ {R_2}^{'} }{s}$] ++(1.5,0)
to [short,-] ++(0.25,0)

% Vertical traces
(6.75,0) to [short,-,i^=${I_2}^{'}$] (6.75,-2)
to [short,-o] (0,-2)

(3.65,0) to[american inductor, l_=$j\omega L_m$] ++(0,-2)

(IN) to [open, v^>={$V_{an}$}] (0,-2);
```