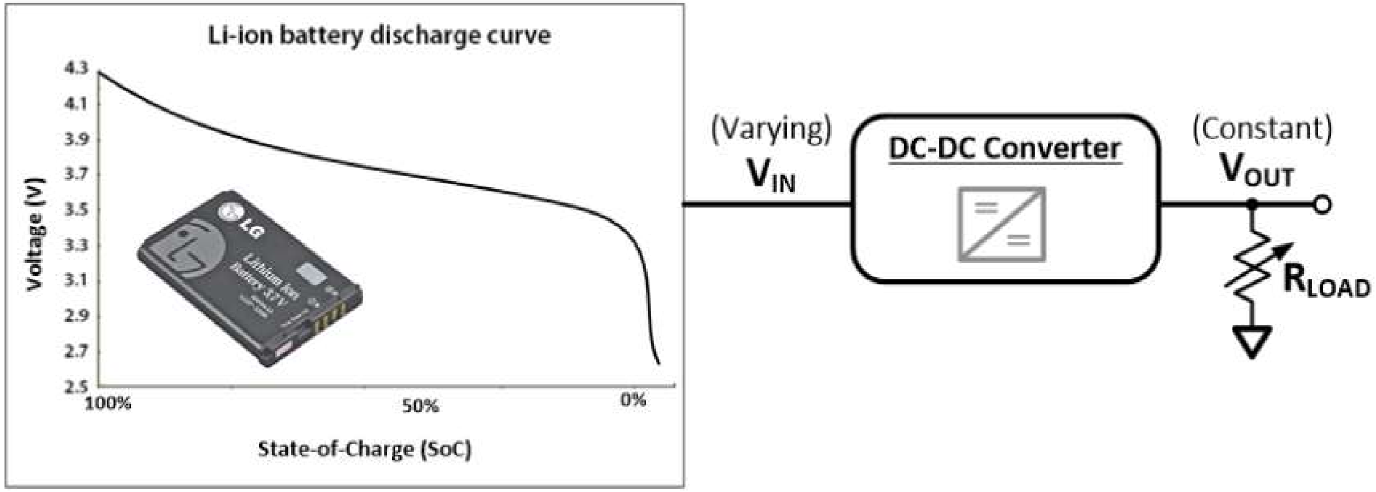
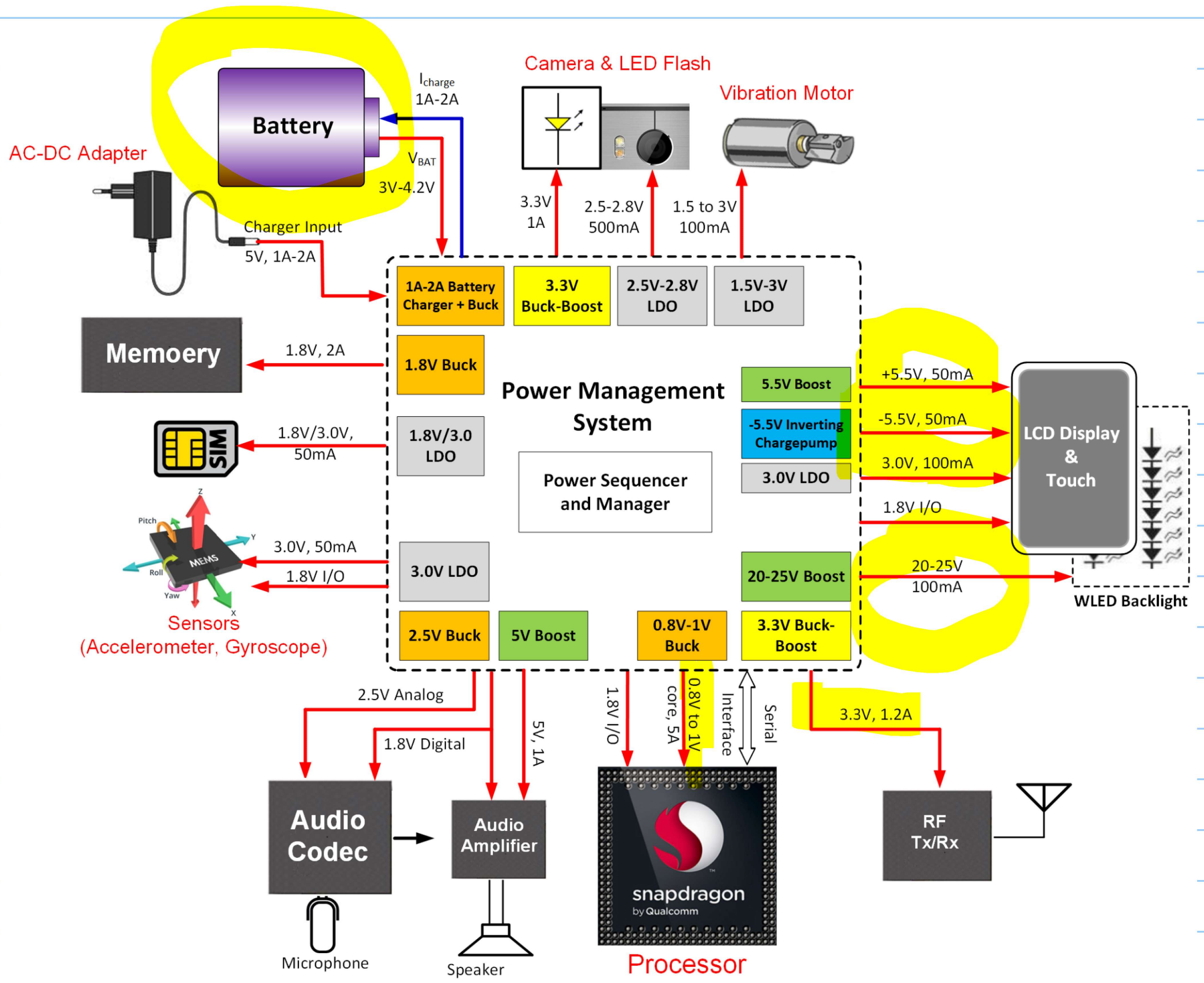
EE2019

Note Title 3/8/2019



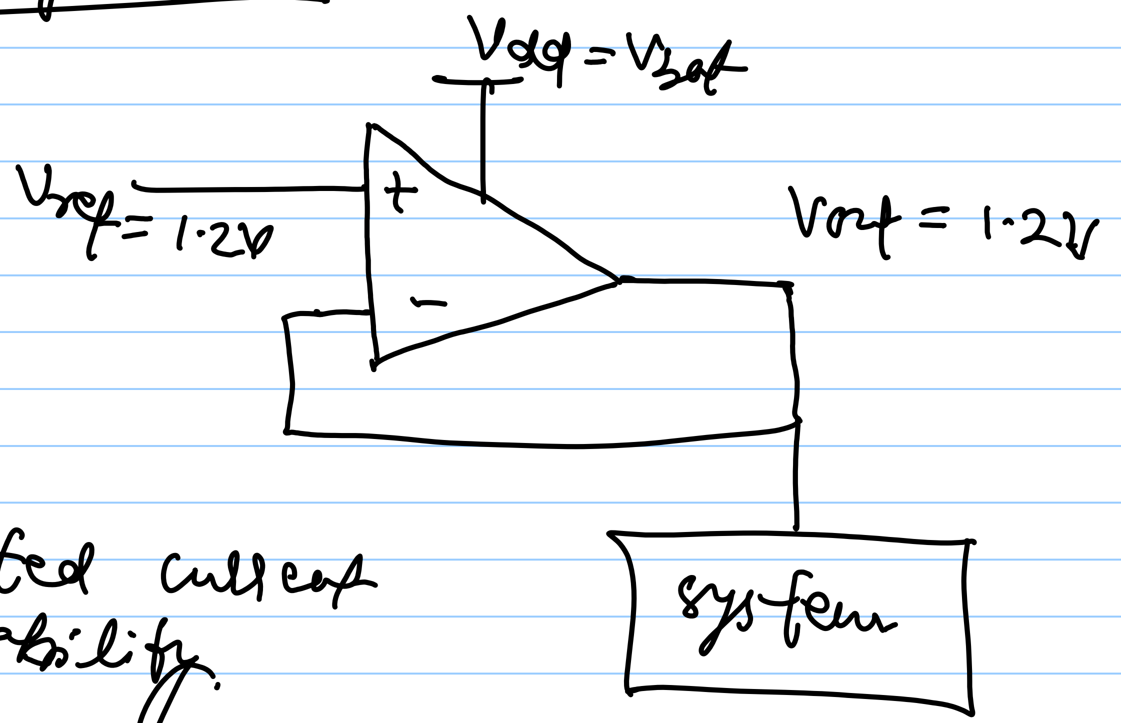


Battery
Icharge 1A-2A
VBAT 3V-4.2V
AC-DC Adapter
Charger Input 5V, 1A-2A
Camera & LED Flash
Vibration Motor
3.3V 1A
2.5-2.8V 500mA
1.5 to 3V 100mA
1A-2A Battery Charger + Buck
3.3V Buck-Boost
2.5V-2.8V LDO
1.5V-3V LDO
Memoery
1.8V, 2A
1.8V Buck
Power Management System
Power Sequencer and Manager
5.5V Boost
-5.5V Inverting Chargepump
3.0V LDO
+5.5V, 50mA
-5.5V, 50mA
3.0V, 100mA
1.8V I/O
LCD Display & Touch
SIM
1.8V/3.0V, 50mA
1.8V/3.0 LDO
3.0V, 50mA
1.8V I/O
3.0V LDO
20-25V Boost
20-25V 100mA
WLED Backlight
Sensors (Accelerometer, Gyroscope)
2.5V Buck
5V Boost
0.8V-1V Buck
3.3V Buck-Boost
2.5V Analog
1.8V Digital
5V, 1A
1.8V I/O
core, 5A
0.8V to 1V
Interface
Serial
3.3V, 1.2A
Audio Codec
Audio Amplifier
snapdragon by Qualcomm
RF Tx/Rx
Microphone
Speaker
Processor

Types of Voltage Regulators

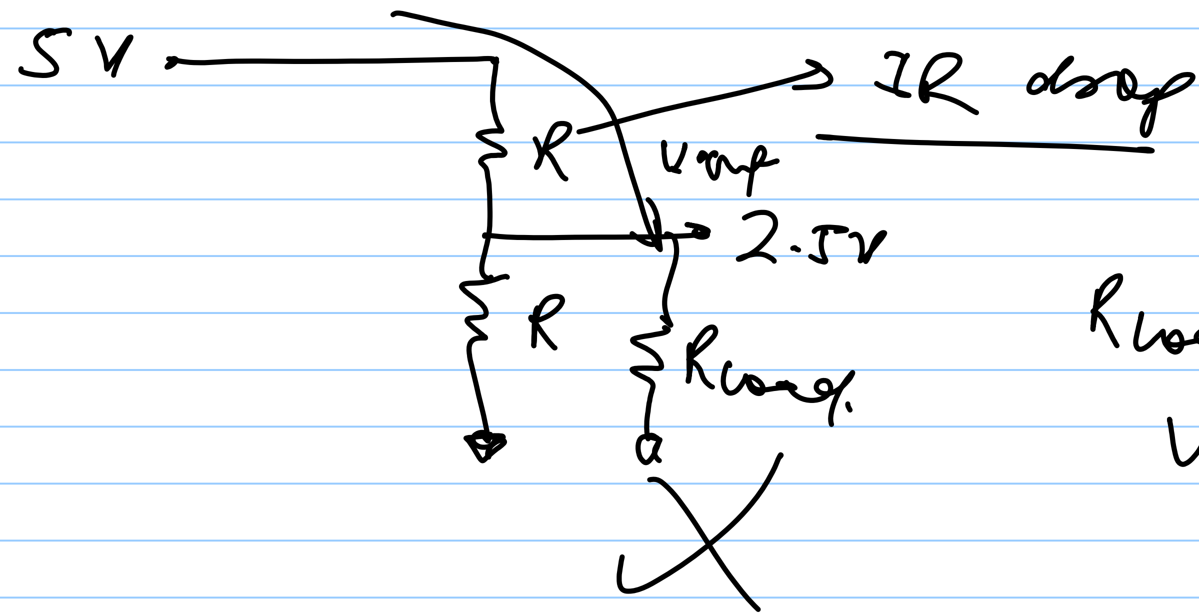
- Voltage Regulator
  - Linear Regulator
  - Switching Regulator

Linear Regulator:

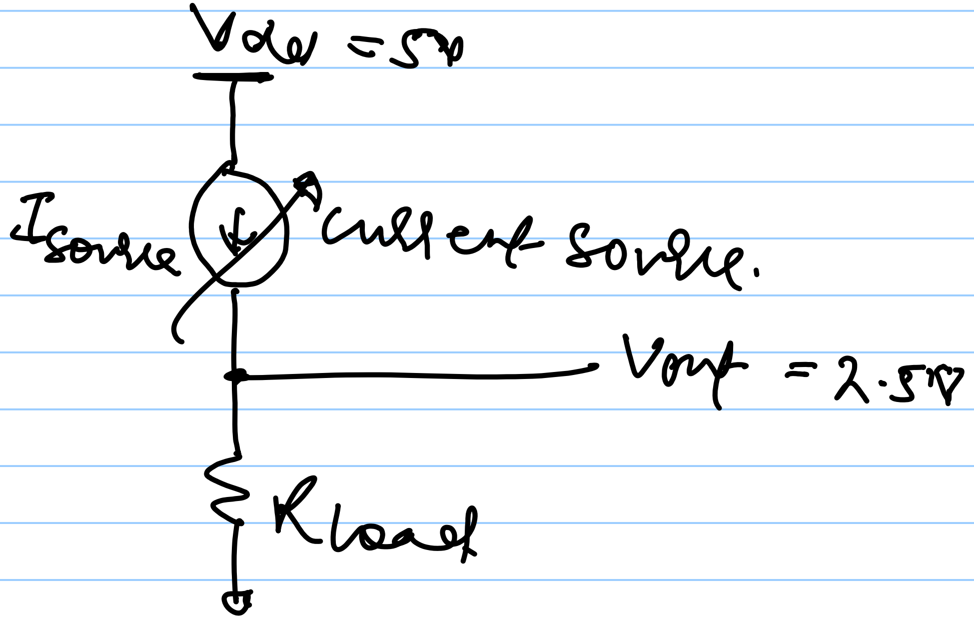


Limited current capability.

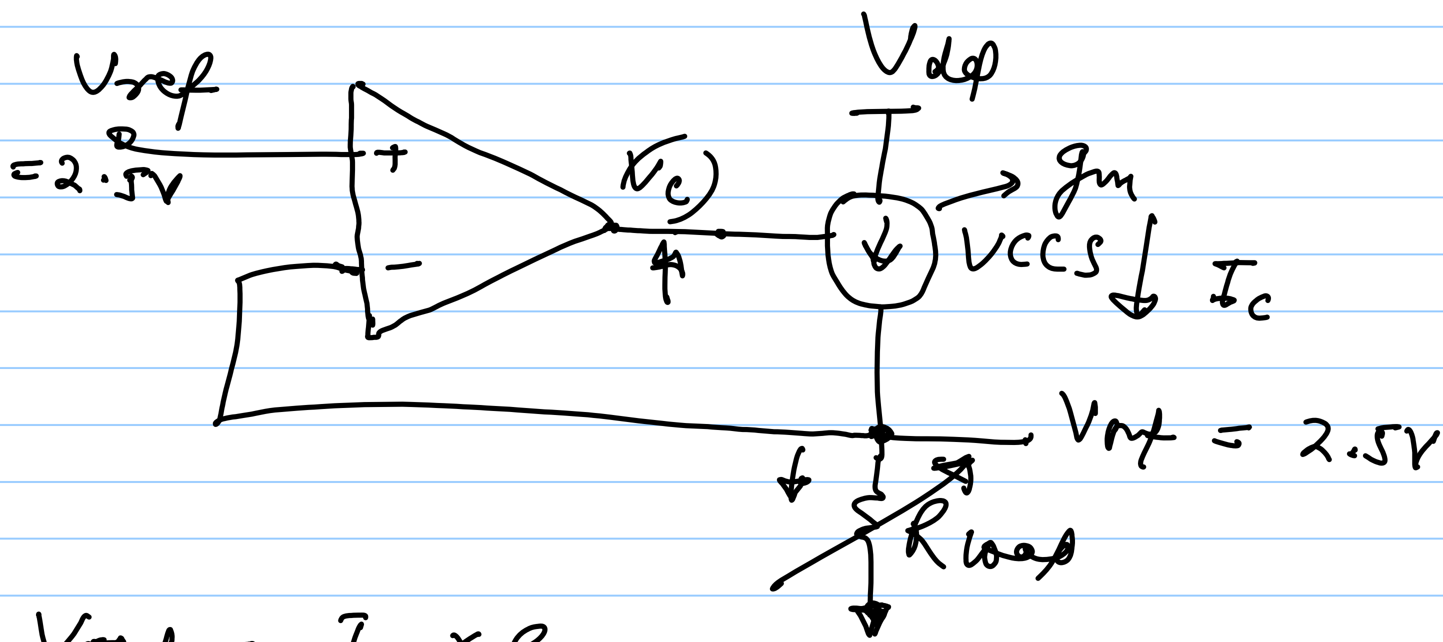
$V_{in} = 5\,V$, $V_{out} = 2.5\,V$



R_{load} is varying so
V_{out} is not constant

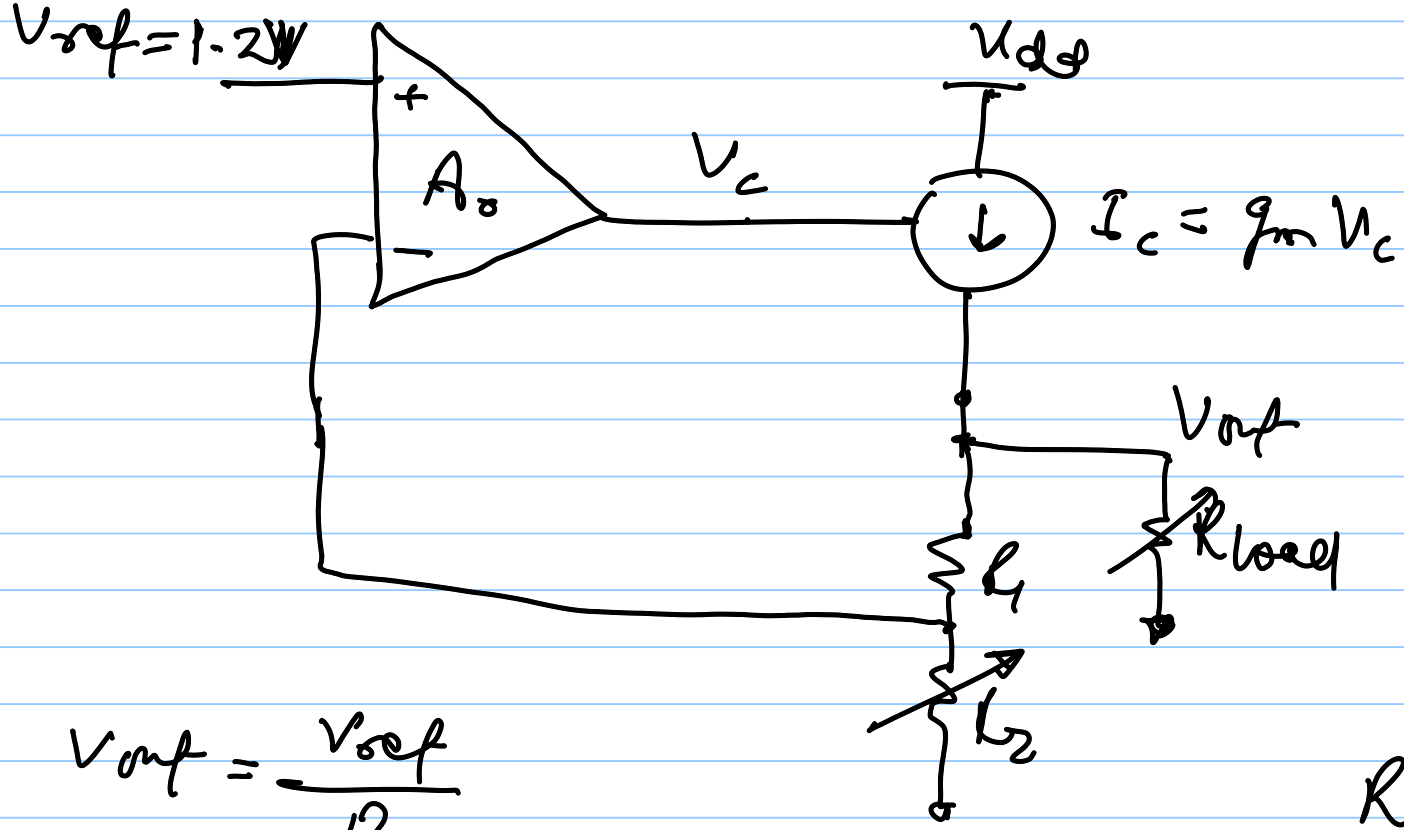


$V_{out} = I_{source}\uparrow \times R_{load}\downarrow = 2.5V$



$V_{out} = I_c \times R_{load} = V_c \uparrow \cdot g_m \cdot R_{load} \uparrow$

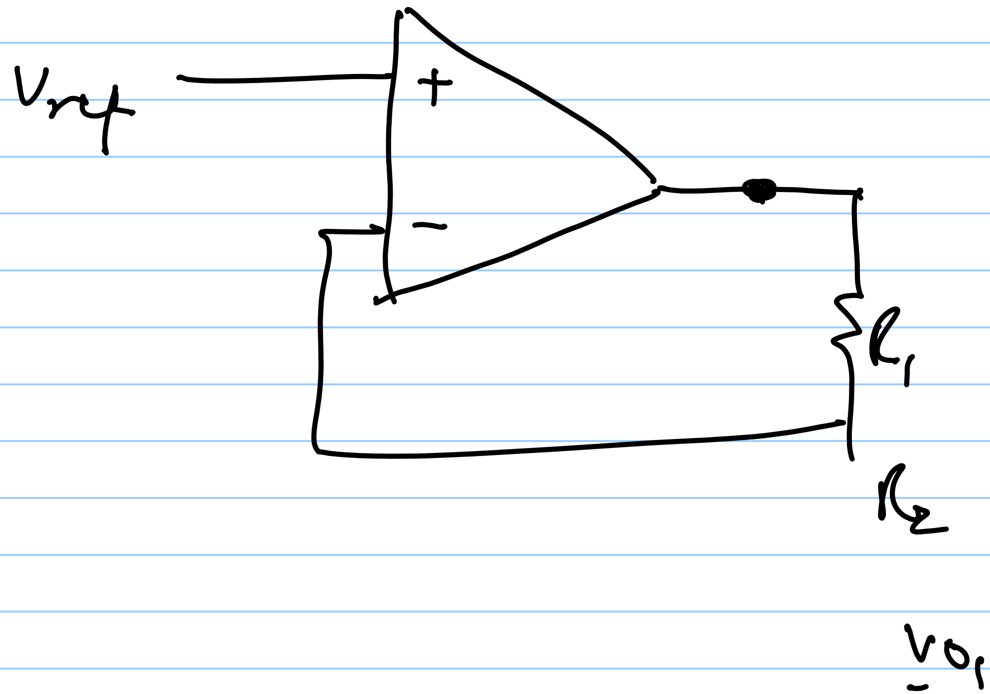
Vout is regulated by negative feedback when V_c is varied based load current requirement.



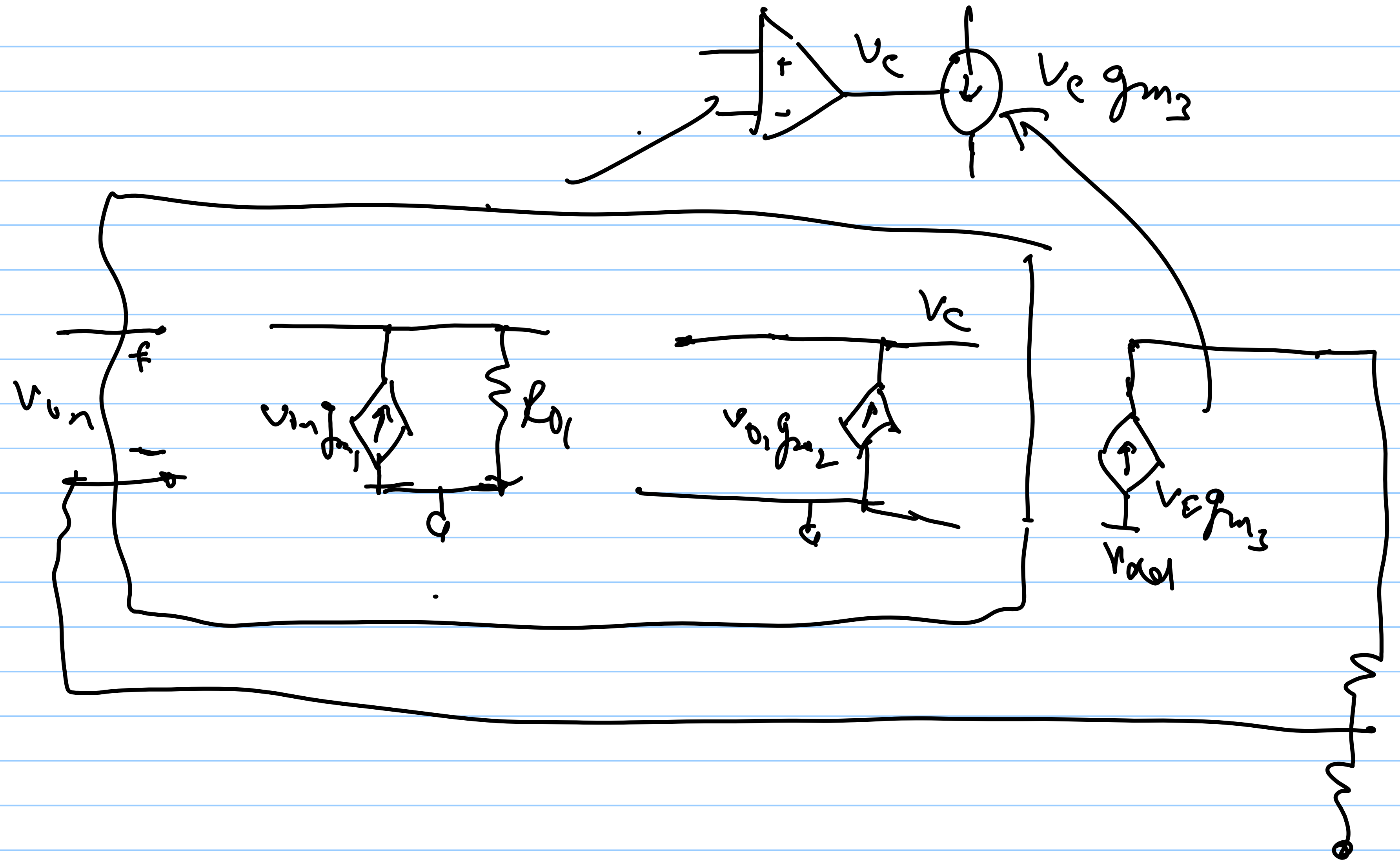
$$V_{out} = \frac{V_{ref}}{\beta}$$

$$\beta = \frac{R_2}{R_1 + R_2}$$

V_{out} can be controlled by changing β.



vref
+
−
R1
R2
vo1



v_{in}
+
−
$v_{in}\,g_{m_1}$
R_{o_1}
$v_{o_1}\,g_{m_2}$
v_c
+
−
v_c
$v_c\,g_{m_3}$
$v_c\,g_{m_3}$
r_{od}

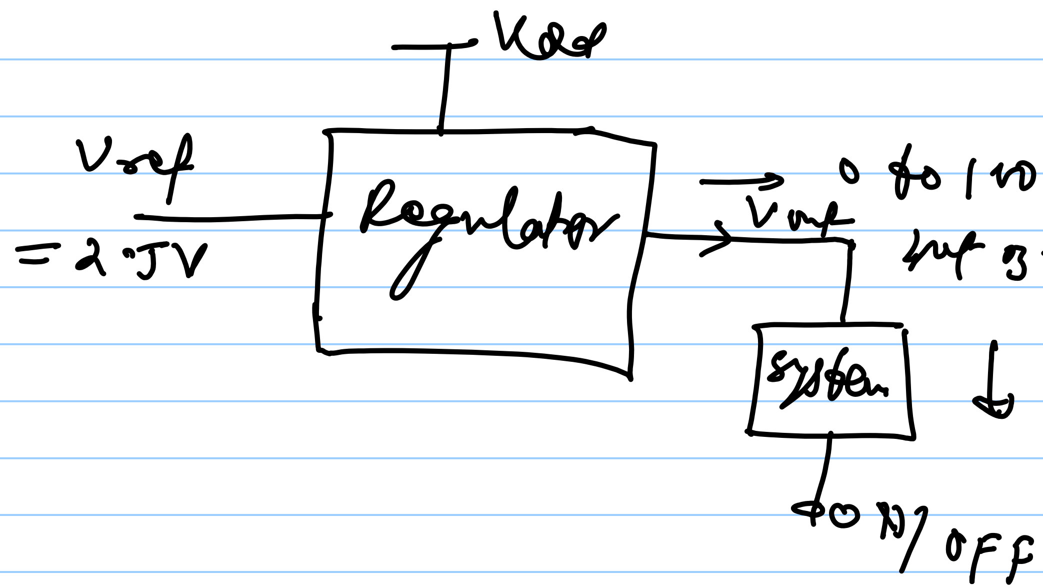
Line Regulation :- is change in V_{out} w.r.t. V_{in} or V_{dd}

$$\text{Line Regulation} = \frac{\Delta V_{out}}{\Delta V_{dd}}$$

Load Regulation :- change output voltage (V_{out}) w.r.t. Load current

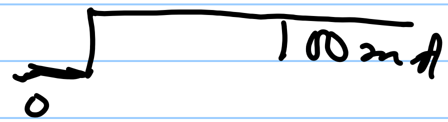
$$\text{Load Regulation} = \frac{\Delta V_{out}}{\Delta I_{Load}}$$

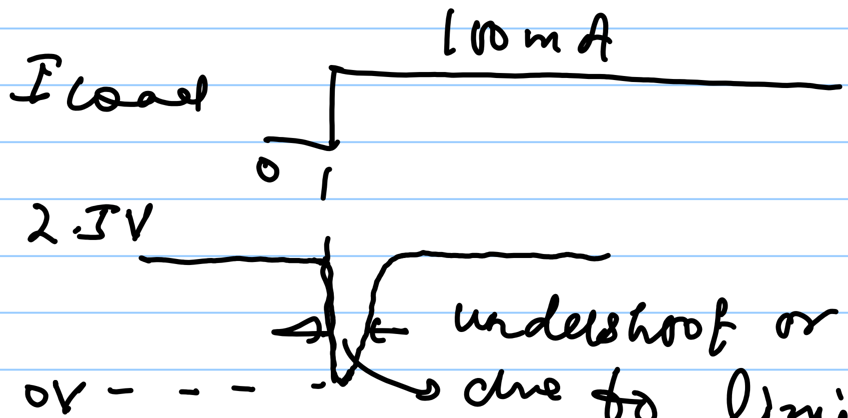
Load Transient : Transient change in V_{out} w.r.t Load step → step response w.r.t Load



0 to 100mA quickly.
but BW will limit the effect.

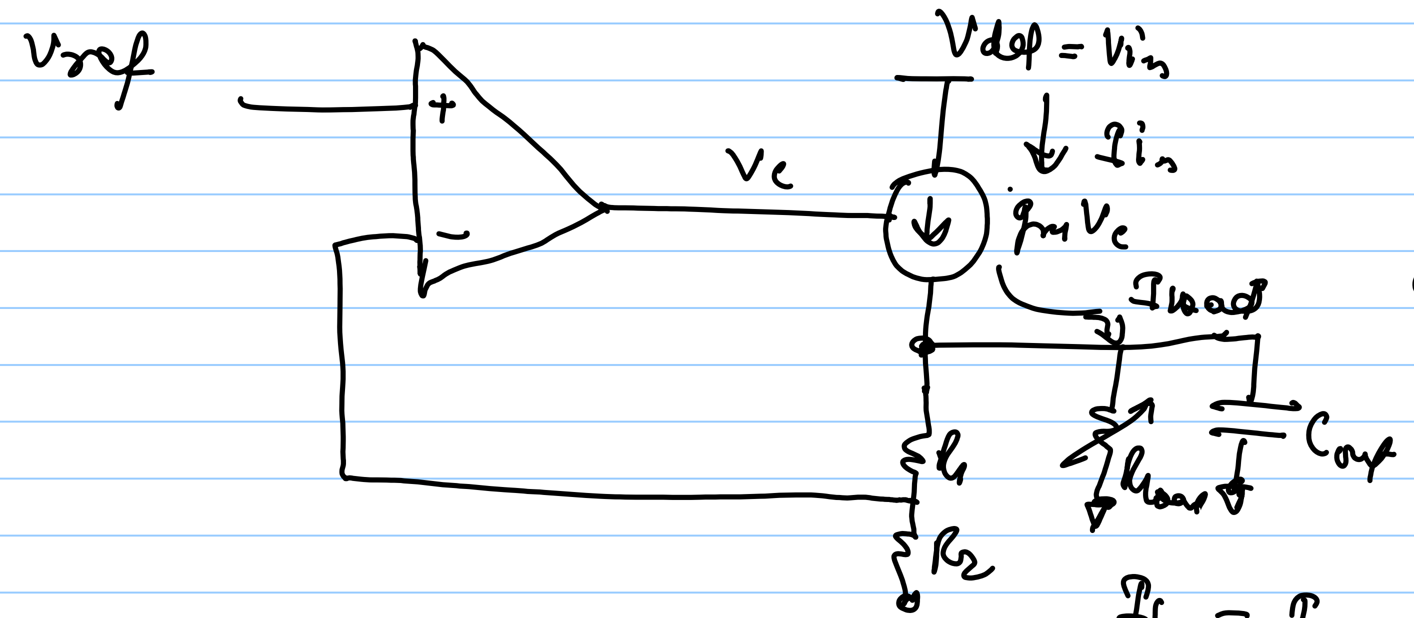
↓ Iload = 0 to 100mA





undershoot or voltage droop
due to limited op-amp BW.

undershoot can be reduced by adding capacitor at V_{out}



$I_{in} = I_{load}$

$i = C\,dV/dt$

$dV = \frac{i_{load}}{C_{out}} \times dt$

BW dependent.

Efficiency of Linear Regulator.

$$\eta = \frac{\text{output power}}{\text{Input power}}$$

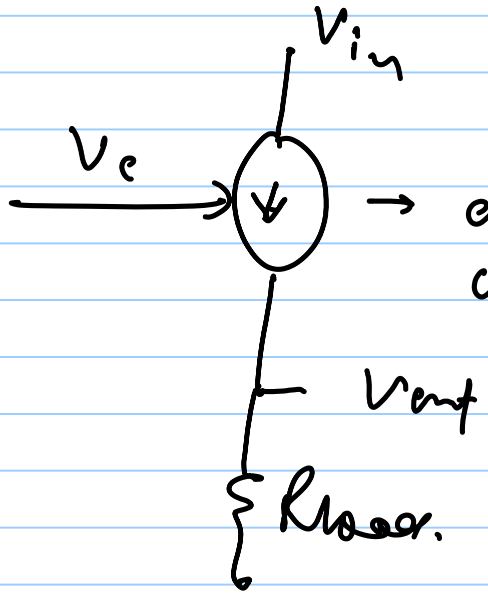
$V_{in} \rightarrow$ Input supply $I_{in} \rightarrow$ current drawn from V_{in}

$V_{out} \rightarrow$ Output Voltage $I_{out} \rightarrow I_{load}$.

$$\eta = \frac{V_{out} \times \cancel{I_{load}}}{V_{in} \times \cancel{I_{in}}} = \frac{V_{out}}{V_{in}}$$

$V_{in} = 5V$, $V_{out} = 2.5$

$$\eta = \frac{2.5}{5} = \frac{1}{2} \rightarrow 50\%$$



→ drop $= V_{in} - V_{out}$

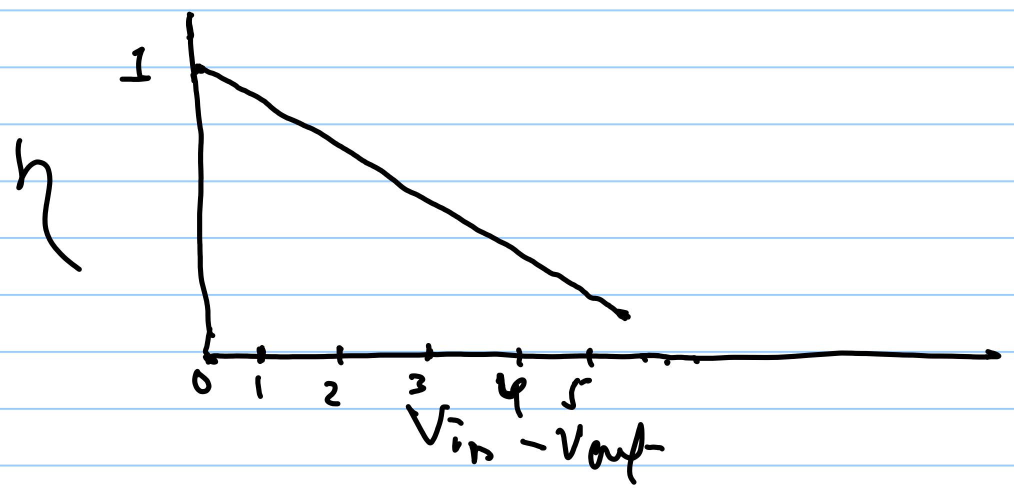
current $= I_{in}$

Power loss

$= (V_{in} - V_{out}) I_{load}$

↓

drop out voltage.



Linear Regulator has poor efficiency if drop-out voltage is large ($V_{in} - V_{out}$ is large).