1. Research Objective

- Analog IC requires
  - Operation in wide temperature range
  - One voltage reference

Proposal of a reference voltage generator
- Insensitive to temperature
- Simple and small
- Only standard CMOS FETs
- Based on MOS temperature characteristics

2. Point of Our Work

- **ID-VGS** characteristic of M1
  - When $I_1 > I_p$, $V_{GS}$ increases.
  - When $I_2 < I_p$, $V_{GS}$ decreases.

3. Proposed Circuit

- P1, P2, P3, P4, M1, M2, M3 compose a constant current source
- M2, M3 adjust input current
- M4, M5, M6 compensate for temperature sensitivity of $V_{ref}$
- M7, M8 suppress variation of $V_{ref}$ from supply voltage

$v_{ref} = V_{GS4} + V_{GS5}$

4. SPICE Simulation Result

- **Small temperature coefficient**
- **Supply voltage = 3V**
- **$\Delta V = 0.0045V, 0.41\%$ over 140°C variation**

5. Conclusion

- Small reference voltage deviation
  - 0.0045V from -20°C to 120°C
  - for supply voltage of 3V.

- Next step: focus on supply voltage
- Make reference voltage insensitive to power supply voltage.

References
