ECE 281, supplemental Carry vs Overflow
- **Carry: Occurs any time the MSB operation results in a carry bit**
- **Overflow: Occurs any time the addition results in a value exceeding the range of values for the bit width and type (unsigned, 2's complement)**

Overflow and Carry can occur independent of one another in 2's compliment. However, for unsigned binary values when the MSB results in a carry, it will be an overflow as it exceeds the range of the available bits.

Examples (**all assume 4-bit 2's complement numbers**). Any result exceeding the range of [-8_d to 7_d] will be an overflow regardless of carry:

No overflow or carry, MSB matches for both operands and for the result. The result of 7_d is within range of 4-bit 2's compliment.

$\quad 3_d \quad\quad\quad\quad 0011_b$
$+4_d \quad\quad\quad\quad +0100_b$
$\quad 7_d \quad\quad\quad\quad 0\ 0111_b$

Carry Bit

No overflow but there is a carry, MSB matches for both operands, the result, and the carry. The result of -7_d is within range of 4-bit 2's compliment. The carry bit is discarded.

$\quad -3_d \quad\quad\quad\quad 1101_b$
$+(-4_d) \quad\quad\quad +1100_b$
$\quad -7_d \quad\quad\quad\quad 1\ 1001_b$

No overflow but there is a carry, MSB differs for the two operands indicating they are of different sign. In a situation where the values have different sign, there will never be an overflow. The result of 0 is within range of 4-bit 2's compliment. The carry bit is discarded.

$\quad 7_d \quad\quad\quad\quad 0111_b$
$+(-7_d) \quad\quad\quad +1001_b$
$\quad 0_d \quad\quad\quad\quad 1\ 0000_b$

Overflow but no carry, MSB is the same for the two operands indicating they are the same sign. However, the MSB for the result does not match the operands, indicating the result has a different sign which is not possible when the two operands have the same sign. The result of 11_d exceeds the range of 4-bit 2's compliment.

$\quad 7_d \quad\quad\quad\quad 0111_b$
$+\ 4_d \quad\quad\quad\quad +0100_b$
$\quad 11_d \quad\quad\quad\quad 0\ 1011_b \quad$ This result, in 4-bit 2's complement, is -5_d. This is not correct for 7_d+4_d.

Overflow and carry, MSB is the same for the two operands indicating they are the same sign. However, the MSB for the result does not match the operands, indicating the result has a different sign which is not possible when the two operands have the same sign. The result of -9_d exceeds the range of 4-bit 2's compliment.

$\quad -7_d \quad\quad\quad\quad 1001_b$
$+\ (-2_d) \quad\quad\quad +1110_b$
$\quad -9_d \quad\quad\quad\quad 1\ 0111_b \quad$ This result, in 4-bit 2's complement, is 7_d. This is not correct for $-7_d+(-2_d)$.