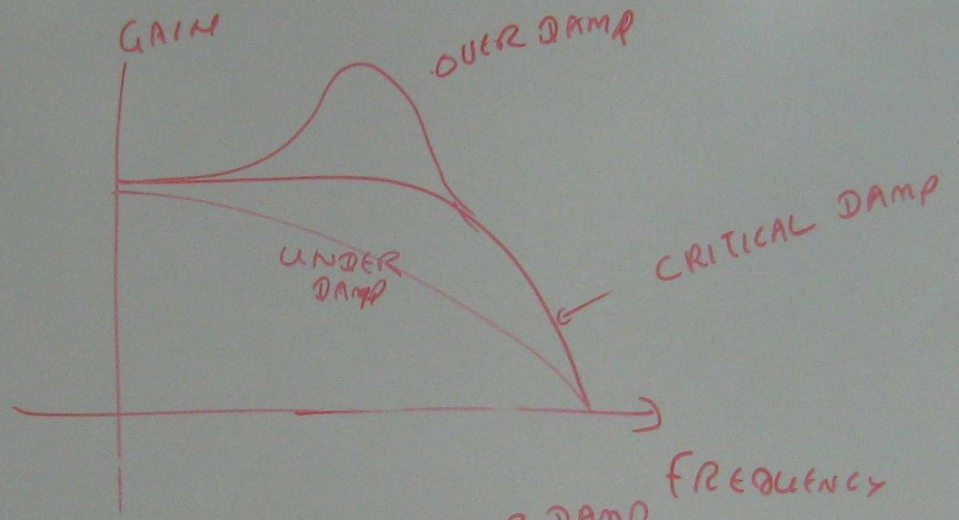
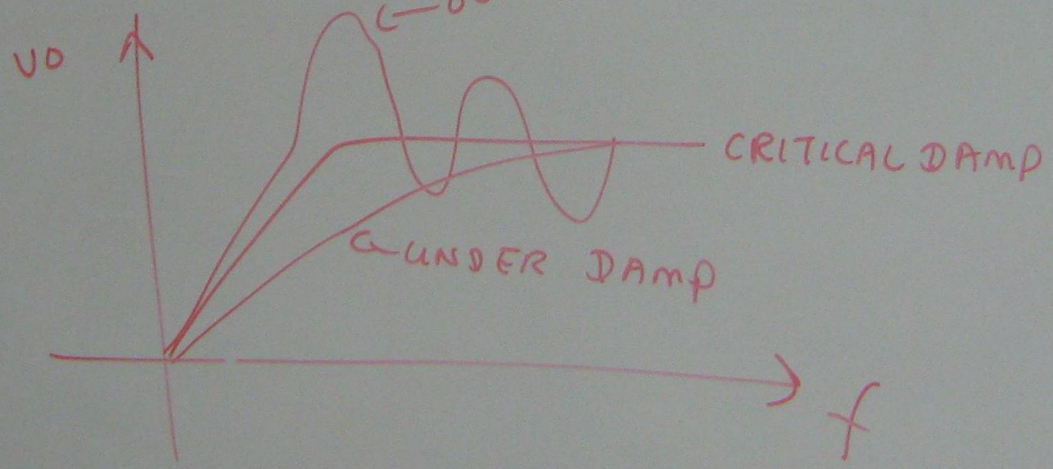
FREQUENCY COMPENSATION





FREQUENCY COMPENSATION IS TO BE APPLIED FOR OVER DAMP AND UNDER DAMP CIRCUITS TO ATTAIN THE CRITICAL DAMP FUNCTION

CAUSE OF DAMPING

PHASE MARGIN 45° ⟶ CRITICAL DAMPING

PHASE MARGIN $> 45^\circ$ ⟶ OVER DAMPING

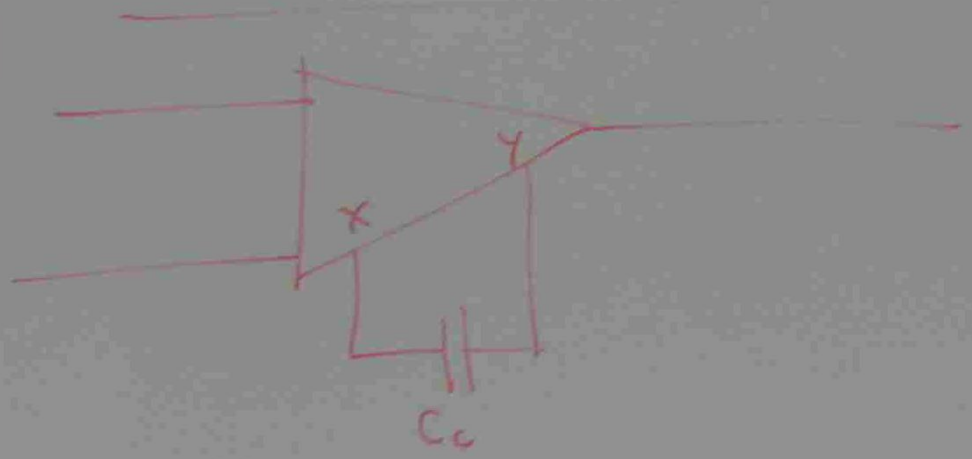
PHASE MARGIN $< 45^\circ$ ⟶ UNDER DAMPING

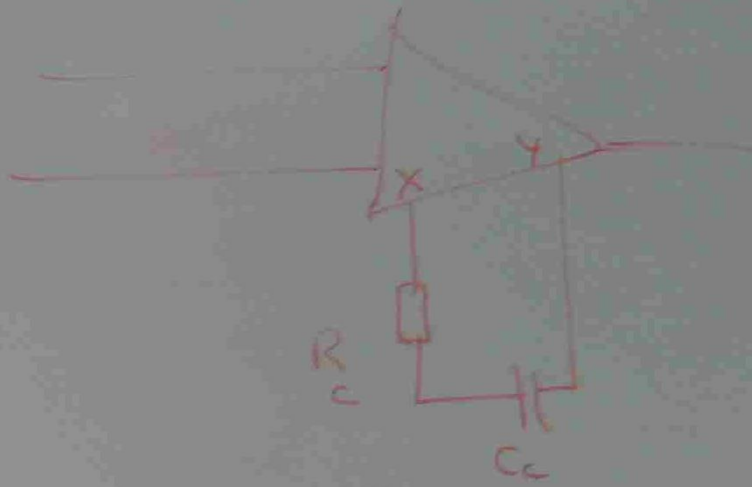
INTERNAL AND EXTERNAL COMPENSATION

IC 741, LF351, 714 ⟵ INTERNALLY COMPENSATED

LM301, NE5534 ⟵ EXTERNALLY COMPENSATED

CONNECTION of COMPENSATION CAPACITOR





SELECTION OF CAPACITOR

C_c = {REQUIRED COMPENSATION CAPACITOR

REQUIRED COMPENSATION CAPACITOR $= \frac{1}{A C_L \text{ (CLOSED LOOP GAIN)}}$

C_c

$$\text{OPTIMAL } C_C = \frac{\text{REQUIRED } C_C}{A_{CL}}$$

BANDWIDTH AND SLEW RATE ARE EFFECTED BY OPTIMAL CAPACITOR VALUE

$$BW\ (\text{BANDWIDTH}) = \text{GAIN BANDWIDTH PRODUCT (GBWP)} \times \frac{\text{REQUIRED } C_C}{\text{ACTUAL } C_C} \times \frac{1}{A_{CL}}$$

$$BW = GBWP \times \frac{\text{REQ } C_C}{\text{ACT } C_C} \times \frac{1}{A_{CL}}$$

$$\text{NEW SLEW RATE} = \text{GIVEN SLEW RATE} \times \frac{C_C}{\text{ACTUAL } C_C}$$

P9 / THE LM 301 OP-AMP REQUIRES A 30 PF COMPENSATION CAPACITOR FOR USE AS VOLTAGE FOLLOWER. ITS SLEW RATE IS 0.5 V/μs AND GAIN BANDWIDTH PRODUCT IS 1 MHz. THIS OP-AMP IS USED TO MAKE A NON-INVERTING FEEDBACK AMPLIFIER WITH $A_{CL} = 10$.

(a) WHAT IS THE OPTIMAL VALUE OF C_c ?

(b) IF C_c OF 10 PF IS ACTUALLY USED, WHAT IS THE BANDWIDTH OF THE CKT AND SLEW RATE

(a) $\text{OPTIMAL } C_c = \dfrac{\text{REQUIRED } C_c}{A_{CL}} = \dfrac{30\text{ PF}}{10} = 3\text{ PF}$

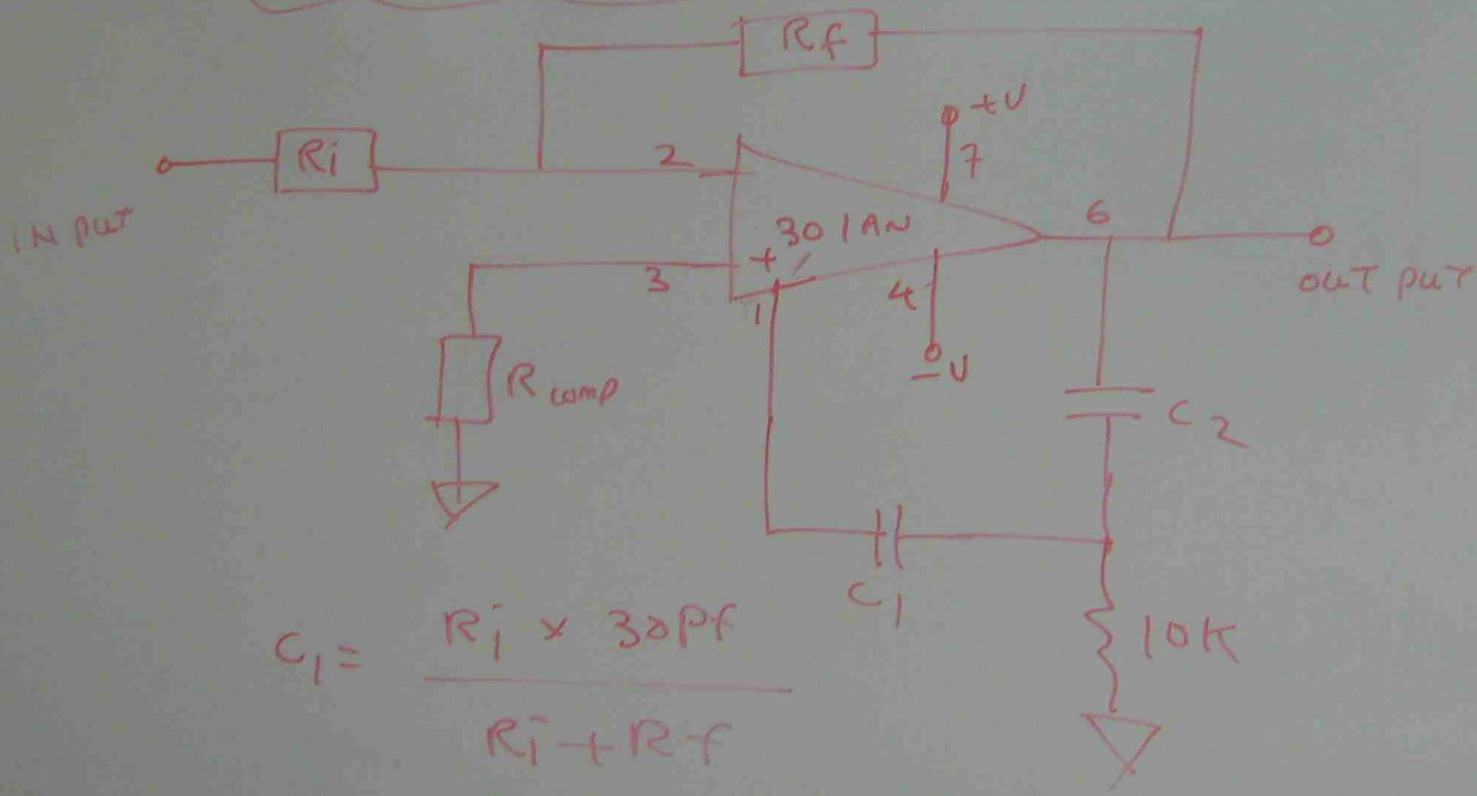
(b) $BW = GBWP \times \dfrac{\text{REQ. } C_c}{\text{ACT } C_c} \times \dfrac{1}{A_{CL}}$

$= 1\text{ MHz} \times \dfrac{30\text{ PF}}{10\text{ PF}} \times \dfrac{1}{10} = \dfrac{1000\text{ KHz} \times 3}{10} = 300\text{ KHz}$

$\text{NEW SLEW RATE} = \text{GIVEN SLEW RATE} \times \dfrac{C_c}{\text{ACT } C_c} = 0.5 \times \dfrac{30}{10} = 1.5\text{ V/}\mu\text{s}$

CONNECTION METHODS of COMPENSATION

(1) TWO CAPACITOR COMPENSATION



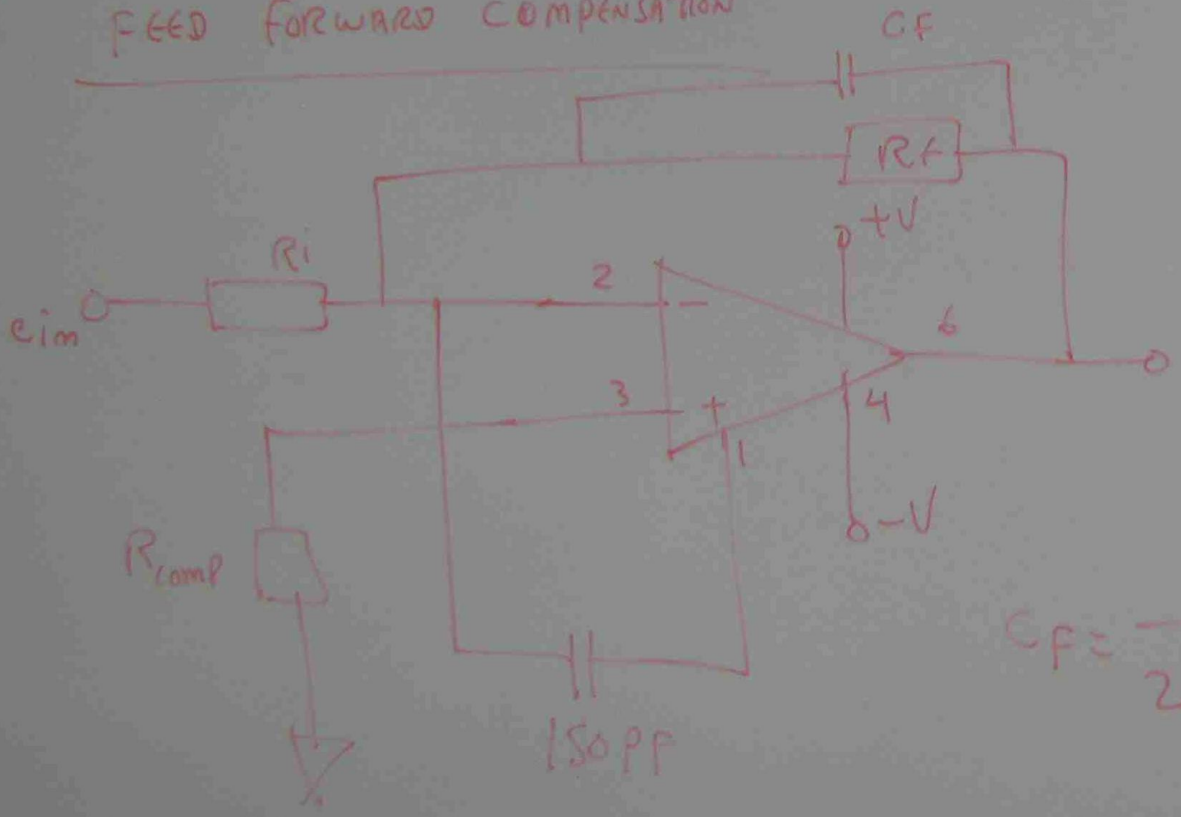
$$C_1 = \frac{R_i \times 30pf}{R_i + R_f}$$

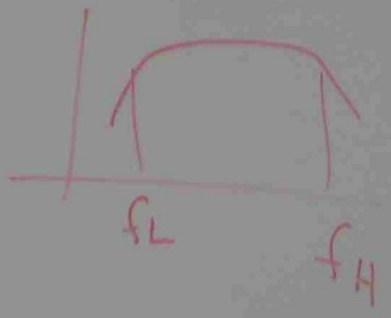
$$C_2 = 10\, C_1$$

CHARACTERISTICS

- REDUCTION IN HIGH FREQUENCY GAIN WHICH IS NEEDED FOR STABILITY
- HIGHER SLEW RATE FOR A GIVEN GAIN BANDWIDTH PRODUCT

FEED FORWARD COMPENSATION





$$C_F = \frac{1}{2\pi f_H R_F}$$

IN MANY OP-AMP, THE INVERTING SIGNAL HAS TO PASS THROUGH SOME SLOW BIASING TRANSISTORS WHICH INTRODUCE LARGE NEGATIVE PHASE SHIFT.

IN FEED FORWARD COMPENSATION, THE PHASE SHIFTING TRANSISTORS ARE BY PASSED BY A CAPACITOR.

C_F WORKS ONLY FOR INVERTING AMPLIFIERS

IT CAN PROVIDE HIGH SLEW RATE.