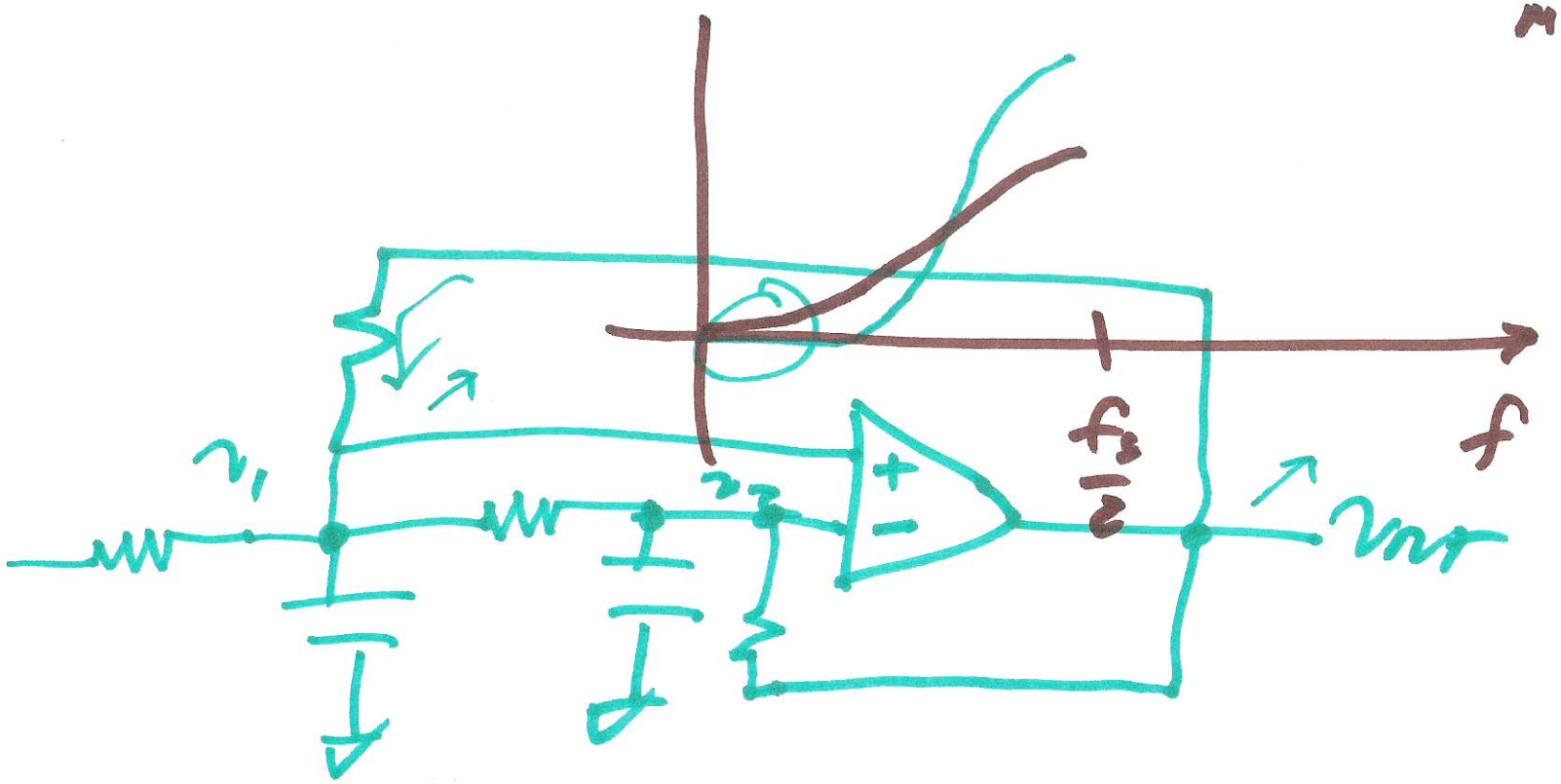
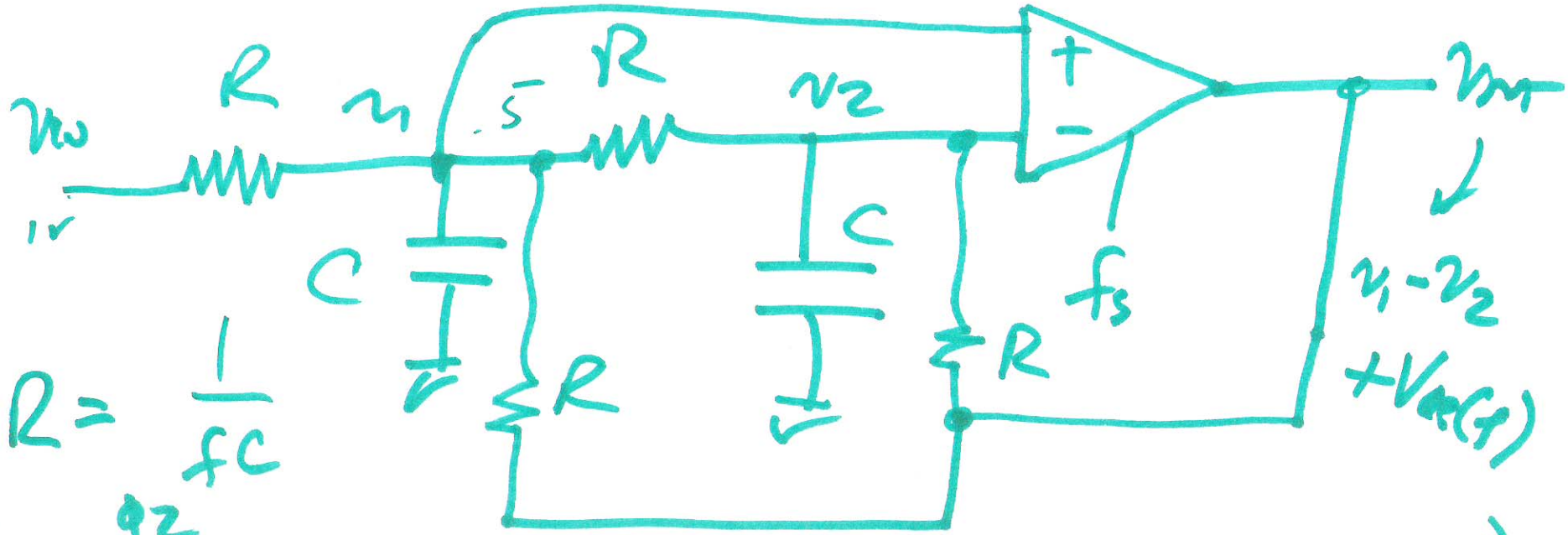
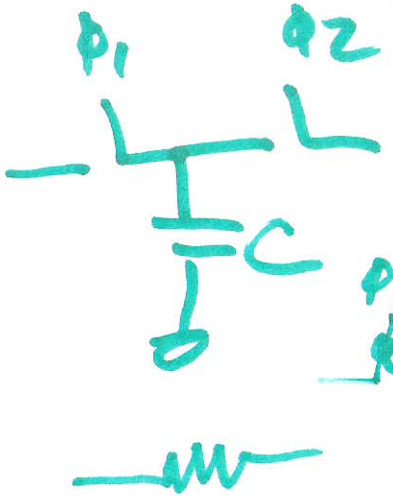
Second-order passive noise-shaping

$$V_{out}(z) = V_{in}(z) \cdot z^{-1} + \underbrace{(1 - z^{-1})^2 V_{quant}(z)}_{\text{modulation}}$$



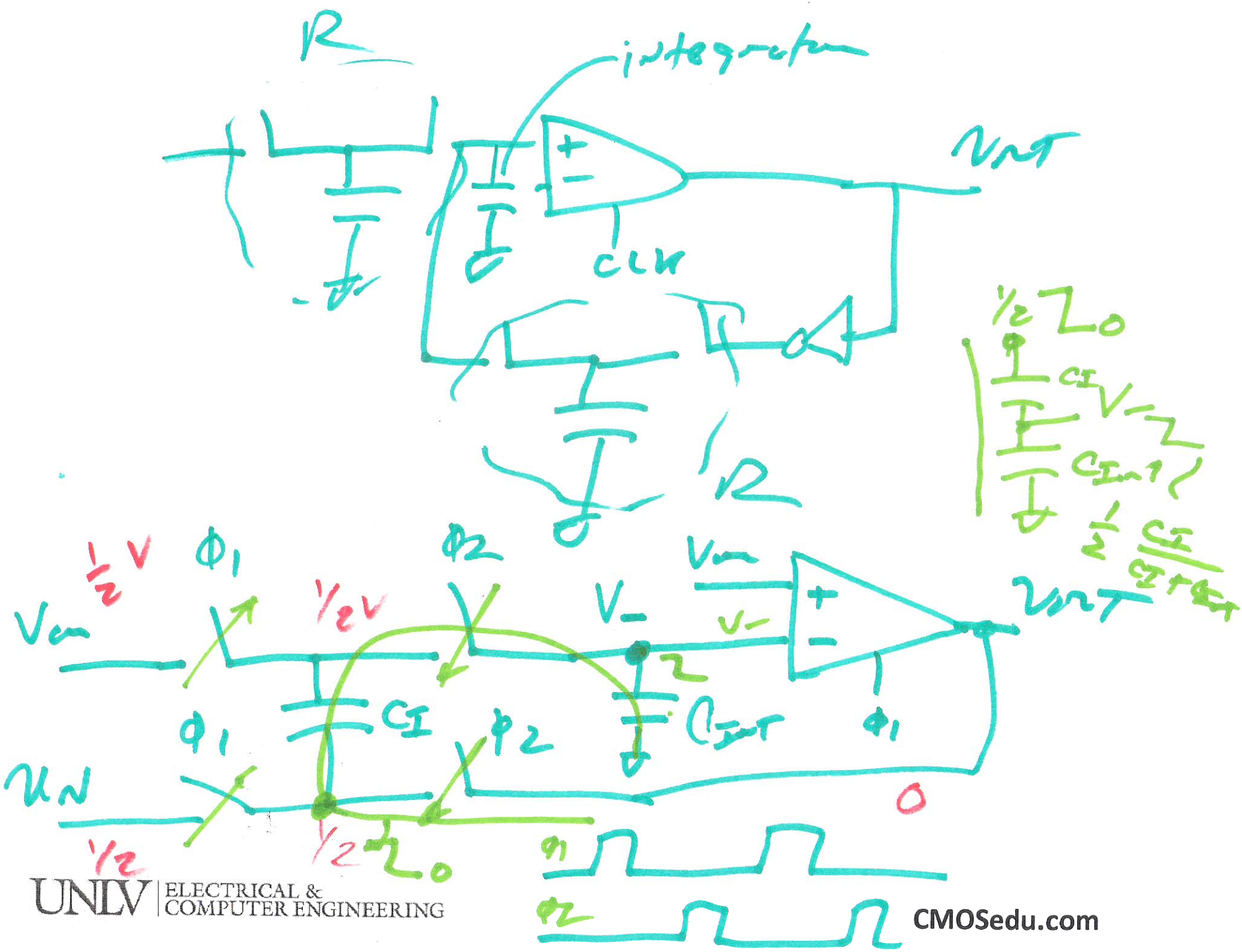


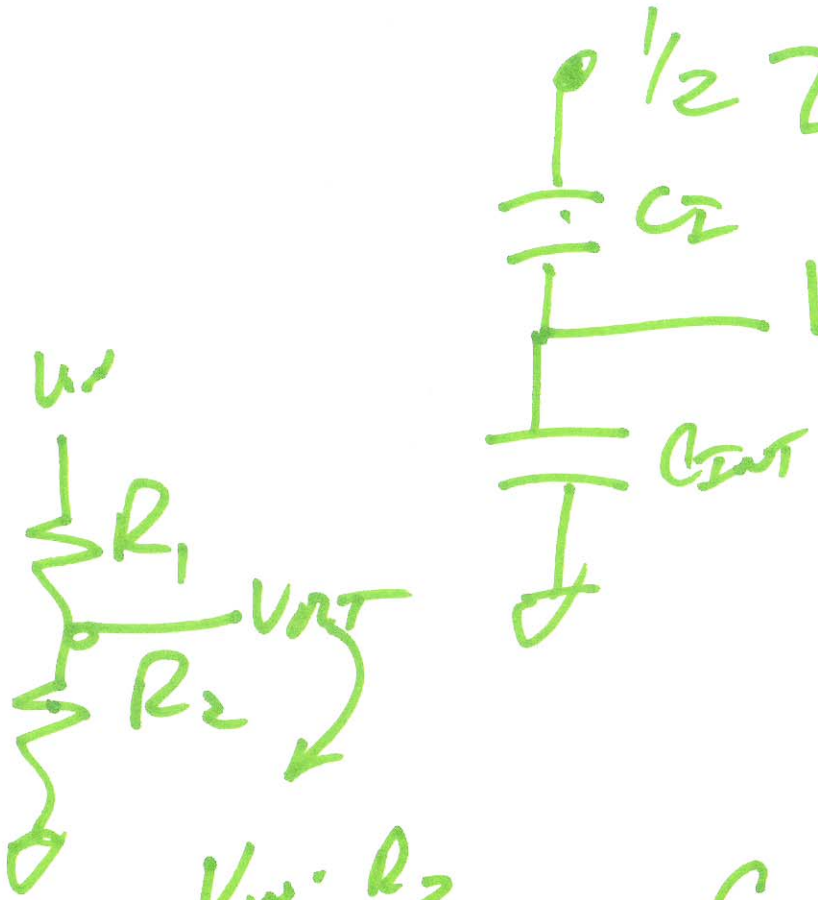
$$R = \frac{1}{fC}$$



$$v_1 = \left(\frac{v_{in} - v_1}{R} + \frac{v_{out} - v_1}{R} + \frac{v_2 - v_1}{R} \right) \cdot \frac{1}{j\omega C}$$

$$v_2 = \left(\frac{v_1 - v_2}{R} + \frac{v_{out} - v_2}{R} \right) \cdot \frac{1}{j\omega C}$$


R
integrator
CLK
V_{out}
$\frac{1}{2}V$
ϕ_1
ϕ_2
V_{cm}
V_-
C_I
C_{int}
V_{IN}
0



$$V_{in} \cdot \frac{R_2}{R_1+R_2}$$

$$(\Delta V_{in} - \Delta V_-) C_I = (\Delta V_- - 0) C_{INT}$$

$$C_I \cdot \Delta V_{in} = (C_{INT} + C_I) \Delta V_-$$

$$\Delta V_- = \Delta V_{in} \cdot \frac{C_I}{C_{INT} + C_I}$$

$$C_I\left(V_{os} - \left(V_{in}\left((N-1)T\right) + V_{os}\right)\right) =$$

$$\left(C_I + C_{INT}\right)\left(V_-\left(\left(N-\tfrac{1}{2}\right)T\right) + V_{os}\right.$$

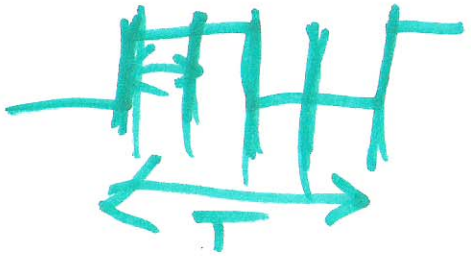
$$\left. - \left(V_{OUT}\left((N-1)T\right) + V_{os}\right)\right)$$

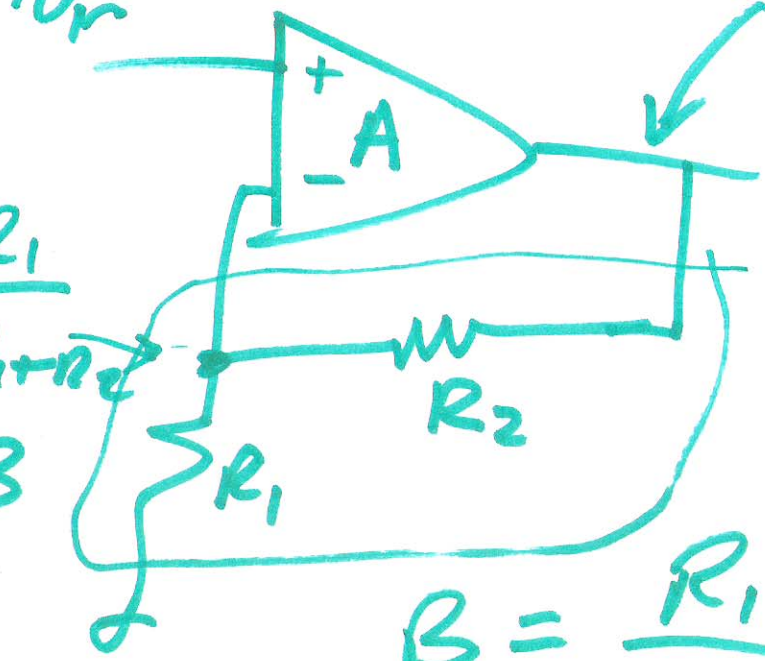
$$-C_I z^{-1} V_{in}(z) = \left(C_I + C_{INT}\right)\left(V_-(z)\, z^{-1/2}\right.$$

$$\left. - V_{OUT}(z)\, z^{-1}\right)$$

$$V_{OUT}(z) = \frac{V_{in} \cdot z^{-1} \cdot C_I}{z^{-1}\left(C_I + C_{INT}\right)} + \frac{V_- z^{-1/2} C_{INT}}{C_I + C_{INT}}$$

$4f_s = \frac{1}{4}$





$V_{OUT} = A(V_{in} - V_f)$

$V_f = V_{OUT} \cdot \frac{R_1}{R_1+R_2}$

$V_f = V_{OUT} \cdot \beta$

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

$\frac{R_1+R_2}{R_1} = \frac{R_1}{R_1} + \frac{R_2}{R_1} = 1 + \frac{R_2}{R_1}$

$V_{OUT} = A(V_{in} - V_{OUT} \cdot \beta)$

$V_{OUT}(1 + A\beta) = A V_{in}$

$\frac{V_{OUT}}{V_{in}} = \frac{A}{1+\beta A} = \frac{1}{\frac{1}{A}+\beta} \approx \frac{1}{\beta}$

$A \to \beta s$

2.5.25

$X_1 + X_2 + X_3 + X_4 + X_5 + X_6 + X_7 + X_8$