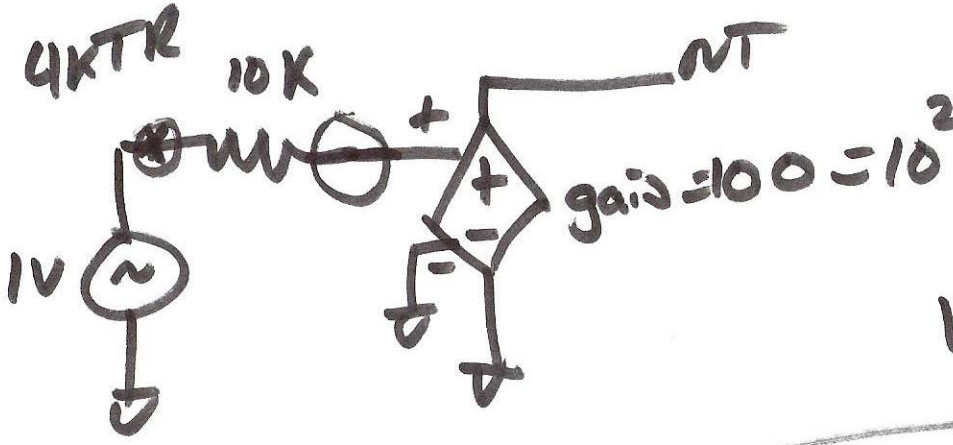
ECE 614 Advanced Analog IC Design

BOISE STATE UNIVERSITY

Sept. 27, Lecture 11

A8.4a



$$\frac{4KT}{R} = 1.66 \times 10^{-24} \frac{A^2}{Hz}$$

(300K / 10K)

$$V_{o,noise}^2(f) = 10^4 \cdot 1.66 \times 10^{-18} \frac{V^2}{Hz}$$

$$= 166 \times 10^{-12} \frac{V^2}{Hz}$$

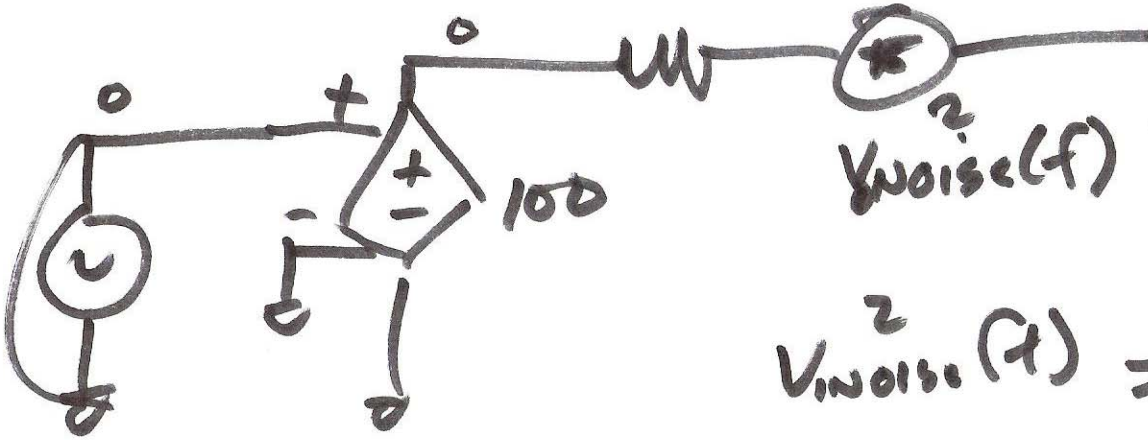
$$V_{i,nc}^2(f) = 4KTR = 1.66 \times 10^{-20} \frac{A^2}{Hz}$$

$$\cdot 10^8$$

$$V_{o,noise}^2(f) = 1.66 \times 10^{-12} \frac{V^2}{Hz} = 1.66 \times 10^{-18} \frac{V^2}{Hz}$$

$$V_{i,noise}^2(f) = 1.66 \times 10^{-18} \frac{V^2}{Hz}$$

1)



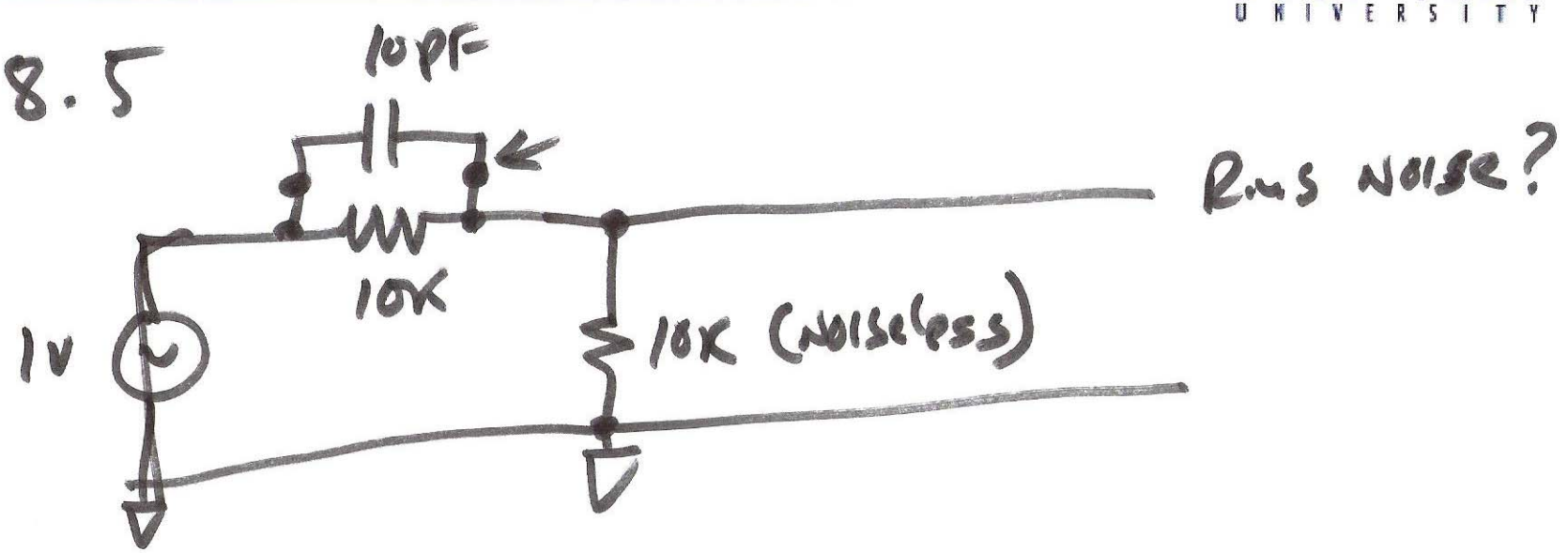
$$V^2_{noise}(f) = 1.66 \times 10^{-16} \frac{V^2}{Hz}$$

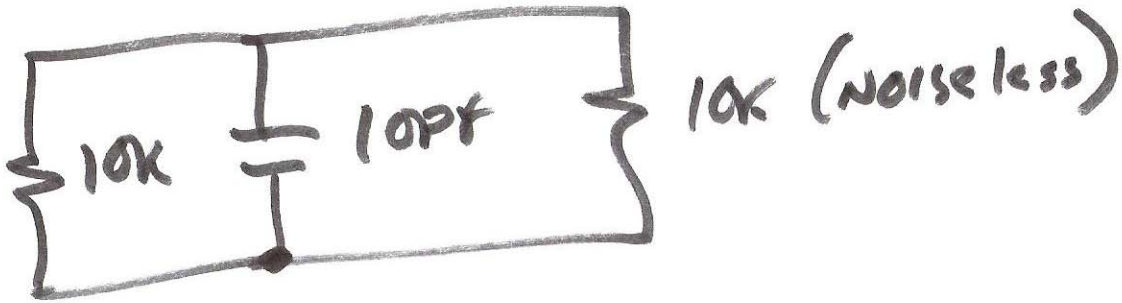
$$V^2_{inoise}(f) = \frac{1.66 \times 10^{-16} \frac{V^2}{Hz}}{10^4}$$

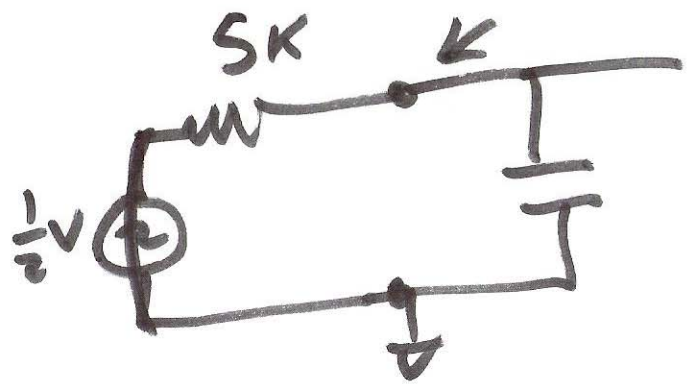
$$= 1.66 \times 10^{-20} \frac{V^2}{Hz}$$

2)

A8.5



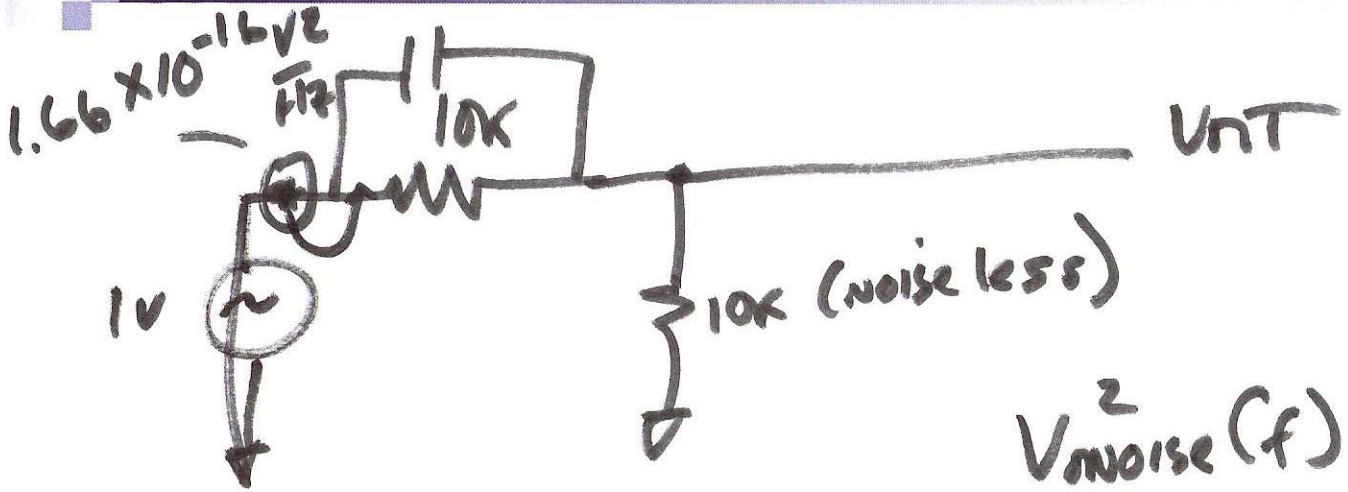




$$\text{Rms noise} = \sqrt{\frac{kT}{C}}$$

$C = 10\,pF$

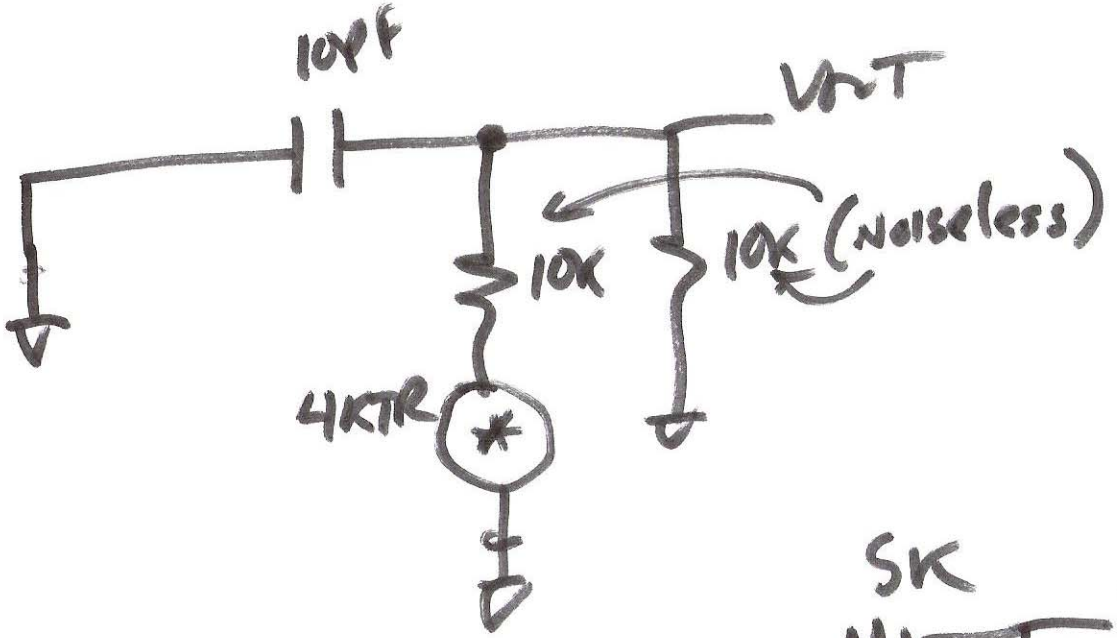
$V_{rms} = 20\,\mu V$

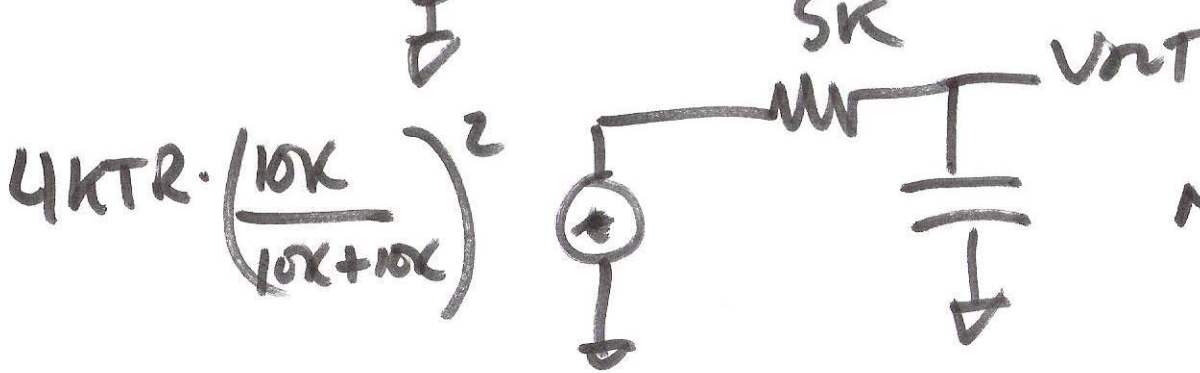


$$V^2_{noise}(f) = 1.66 \times 10^{-16} \cdot \left(\frac{10K}{10K+10K}\right)^2$$

$$= .4 \times 10^{-16}$$

$$= 40 \times 10^{-18} \frac{V^2}{Hz}$$





$$f_{3dB} = \frac{1}{2\pi \cdot 5K \cdot 10pF} \approx 3.18MHz$$

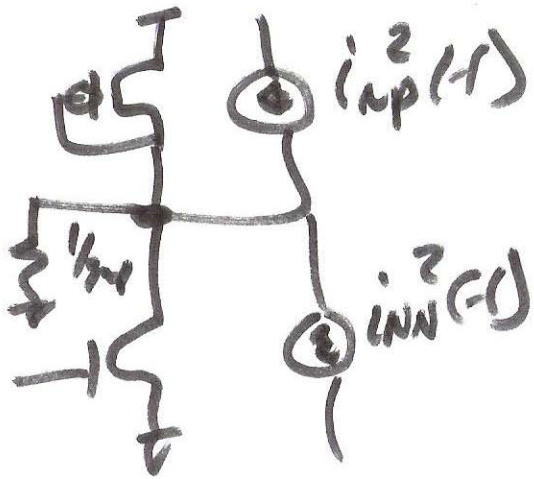
$$NEB = \frac{\pi}{2} \cdot f_{3dB} \approx 3MHz$$

4)

$$V_{rms} = \sqrt{40 \cdot 10^{-18} \cdot (5 \cdot 10^6)^2}$$

$$= 20 \cdot 10^{-9} \cdot \sqrt{5 \cdot 10^6}$$

$$= [redacted] \cdot [redacted] \quad \underline{14.14\,\mu V} \quad 20\,\mu V$$



NMOS
$$i_{nn}^2(f) = 2.67 \times 10^{-24} \frac{A^2}{Hz}$$

PMOS
$$i_{np}^2(f) = \frac{2.4}{(6.5\times)^2} \times 10^{-24} \frac{A^2}{Hz}$$

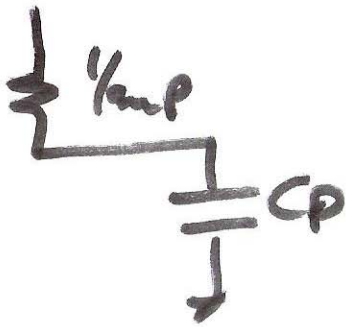
$$V_{onoise}^2(f) = \left(\frac{1}{g_m}\right)^2 \cdot (2.4 + 2.67) \cdot 10^{-24} \frac{A^2}{Hz}$$

$$40 \cdot 5 \cdot 10^6 \cdot 10^{-24} \frac{V^2}{Hz}$$

5) → $200 \cdot 10^{-18}\ V^2/Hz$

$$\text{Therm} = 1.5 \times 10^{-16} \frac{V^2}{Hz}$$

$$\text{flicker} = \frac{10^{-10} V^2}{f}$$



$B = 1\,GHz$

$$\text{M.S. Noise} = 1.5 \cdot 10^{-16} \cdot 10^{9} + 49 \cdot 10^{-10}$$

$$= 1.5 \cdot 10^{-7} + 49 \cdot 10^{-10}$$

$$150 \cdot 10^{-9} \qquad 4.90 \cdot 10^{-9}$$

$$\text{Rms} = \sqrt{155 \cdot 10^{-9}}$$

$$= 3.8 \cdot 10^{-4} = 380\,\mu V$$

6)

With B.W. limitations ($C_L = 10pF$)

$$\text{M.S. NOISE} = \underbrace{1.5 \cdot 10^{-16}}_{\frac{V^2}{Hz}} \cdot \underbrace{5 \cdot 10^{6}}_{\text{NEB, Hz}} + 49 \cdot \underbrace{10^{-10}}_{F_{NN}}$$

$$= 7.5 \cdot 10^{-10} + 49 \cdot 10^{-10}$$

$$= 56.5 \cdot 10^{-10}$$

$$= 5.65 \cdot 10^{-9}$$

$$\text{RMS value} = 7.5 \cdot 10^{-5}$$

$$\underline{\underline{75\ \mu V}}$$