

303 d11.

Exam 303 dec 4 Daniel Eren

1. $K = 1.3806 \times 10^{-23}$ $T = 298.15$ $R = 1000$

$$e_n^2 = 4kTR \quad \therefore e_n = \sqrt{4 \times 1.3806 \times 10^{-23} \times 298.15 \times 1000}$$

$$= 4.0578 \times 10^{-9} \frac{V}{\sqrt{Hz}}$$

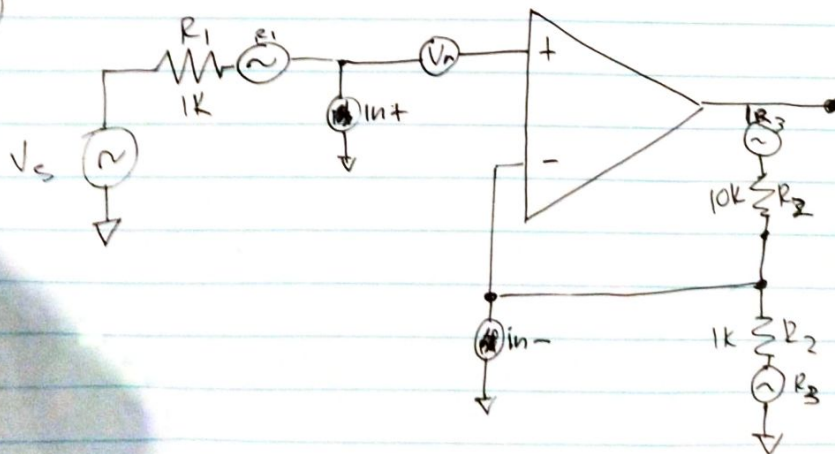
$= 4.06 \text{ nV}/\sqrt{Hz}$ ✓

2. i) S/N_{in} , $V_s = 100 \mu V_{rms}$

$V_n = \frac{4 \text{ nV}}{\sqrt{Hz}} (B = 4 \text{ kHz}) = 4 \times \sqrt{4} = 0.253 \mu$

$S/NR = \frac{100 \mu}{0.253} = 395.26$ $20 \log(SNR) = 2 + 5.9 \text{ dB}$
 $S/NR = \frac{100}{0.253} = 395.26$ $20 \log(400) = 52 (51.937)$

ii)



$A_{V+} = 1 + \frac{R_2}{R_1} = 11$

$A_{V-} = -\frac{R_2}{R} = -10$

$$\text{III) } R_1: 4 \text{ nV}/\sqrt{\text{Hz}} \cdot 11 = 44 \text{ nV}/\sqrt{\text{Hz}}$$

$$R_3: 4 \text{ nV}/\sqrt{\text{Hz}} \cdot 10 = 40 \text{ nV}/\sqrt{\text{Hz}}$$

$$R_2: R=10\text{k} \Rightarrow \sqrt{4kTR} = 12.8 \text{ nV}/\sqrt{\text{Hz}}$$

$$1.8 \text{ nV} \cdot 11 = 19.8 \text{ nV}$$

$$m+ \Rightarrow 1.2 \text{ pA}/\sqrt{\text{Hz}} \cdot 1\text{k} \cdot 11 = 13.2 \text{ nV}/\sqrt{\text{Hz}}$$

$$m- \Rightarrow 1.2 \text{ pA}/\sqrt{\text{Hz}} \cdot 10\text{k} = 12 \text{ nV}/\sqrt{\text{Hz}}$$

Total noise spec density:

$$= \sqrt{44^2 + 40^2 + 12.8^2 + 19.8^2 + 13.2^2 + 12^2}$$

$$= 66.4 \text{ nV}/\sqrt{\text{Hz}}, \quad B = 4\text{kHz}$$

$$V_{\text{off}} = 66.4 \text{ nV}/\sqrt{\text{Hz}} \cdot \sqrt{4\text{k}} = 4.1995 \mu\text{V}$$

IV) S/N out:

$$\text{noise} = 4.2 \mu\text{V}$$

$$\text{signal} = 100 \mu\text{V} \cdot 11 = 1.1 \text{ mV}$$

$$S/N = \frac{1.1}{4.2} = 261.9 \Rightarrow \underline{\underline{48.36}}$$

$$N \text{ factor} = \frac{S/N_{\text{in}}}{S/N_{\text{out}}} = \frac{395.26}{261.9} = \underline{\underline{1.51}}$$

$$N \text{ figur} = 20 \log(1.51) = \underline{\underline{3.575 \text{ dB}}}$$

- Improvements:
- Add filtering to reduce input noise.
 - Restrict bandwidth as small as necessary
 - Keep circuit cool.