EE115A Analog Circuits

Homework 2

Due date: 10/14/2025

Note:

- Please provide enough calculation process to get full marks.
- Please submit your homework to Gradescope (code **J62G3D**) in PDF version.
- It's highly recommended to write every exercise on a single sheet of page.
- Late submissions will have points deducted according to the penalty policy.
- Please use English only to complete the assignment, solutions in Chinese are not allowed.
- Plagiarizer will get zero points.
- The full score of this assignment is 100 points.

Exercise 1. (15pt)

An op amp wired in the inverting configuration with the input grounded, having $R_2 = 20k\Omega$ and $R_1 = 2k\Omega$, has an output dc voltage of $-40\ mV$. If the input bias current is known to be very small, find the input offset voltage.

Exercise 2. (15pt)

Measurements of the open-loop gain of a compensated op amp intended for high-frequency operation indicate that the gain is 4×10^3 at $100\ kHz$ and 8×10^2 at $1MHz$. Estimate its 3-dB frequency, its unity-gain frequency, and its dc gain.

Exercise 3. (25pt)

Note: This question requires simulation. Please note that you need to use Multisim for simulation and provide the simulation circuit and simulation results in your answer.

Consider an op amp connected in the inverting configuration to realize a closed-loop gain of $-100\ V/V$ utilizing resistors of $1\ k\Omega$ and $100\ k\Omega$. A load resistance R_L is connected from the output to ground, and a low-frequency sine-wave signal of peak amplitude V_p is applied to the input. Let the op

amp be ideal except that its output voltage saturates at $\pm 10\ V$ and its output current is limited to the range $\pm 10\ mA$. This is the case for an ADA4077 op amp operating from $\pm 11 - V$ supplies.

(a) For $R_L = 2\ k\Omega$, what is the maximum possible value of V_p while an undistorted output sinusoid is obtained?

(b) Repeat (a) for $R_L = 200\ \Omega$.

(c) If it is desired to obtain an output sinusoid of 10-V peak amplitude, what minimum value of R_L is allowed?

Exercise 4. (15pt)

For a silicon crystal doped with phosphorus, what must N_D be if at $T = 300\,K$ the hole concentration drops below the intrinsic level by a factor of 10^8 ?

Exercise 5. (15pt)

Find the length of a silicon bar having a 5-μm × 4-μm cross section and having free-electron and hole densities of $10^4/cm^3$ and $10^{16}/cm^3$, respectively, so that $0.2\ mA$ current flows when $1\ V$ is applied end-to-end. Use $\mu_n = 1200cm^2/V \cdot s$ and $\mu_p = 500cm^2/V \cdot s$.

Exercise 6. (15pt)

Holes are being steadily injected into a region of n-type silicon (connected to other devices, the details of which are not important for this question). In the steady state, the excess-hole concentration profile shown in Fig.P1 is established in the n-type silicon region at room temperature. Here "excess" means over and above the thermal-equilibrium concentration (in the absence of hole injection), denoted p_{n0}. If $N_D = 10^{16}/cm^3$, $n_i = 1.5 \times 10^{10}/cm^3$, $D_p = 12cm^2/s$, and $W = 50\,nm$, find the density of the current that will flow in the x direction.

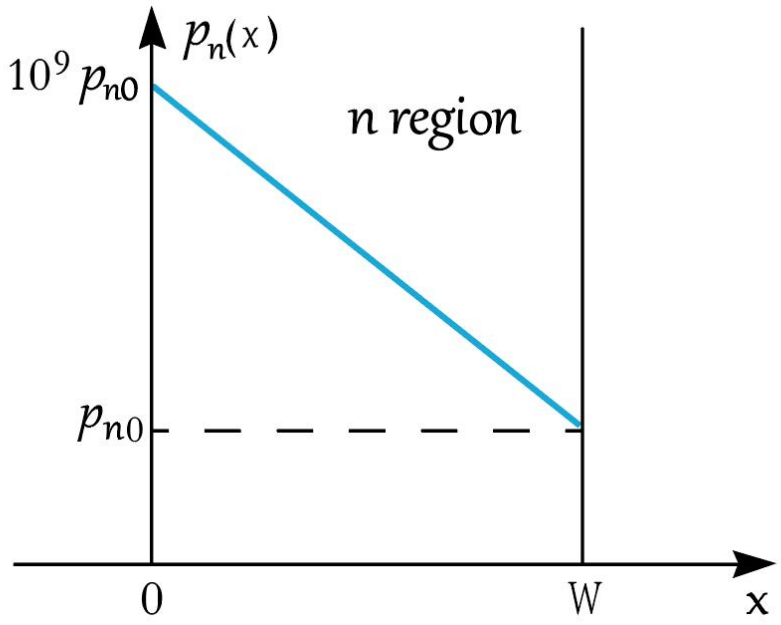

Fig. P1