Exercise 0602 for “Semiconductors”

Problem setting: 19/05/2021 出題 2021 年 5 月 19 日
Solution submission deadline: 02/06/2021 解答提出期限 2021 年 6 月 2 日

General notes / 一般的注意

The text part in the answer should be typed (not handwriting) in English or Japanese. The scoring does not depend on the language. It doesn't matter if you are good at grammar, vocabulary, or sentences, but if I cannot catch the meaning, the scoring will get deducted regardless of English or Japanese. The answer sheet should be in small-sized (hopefully less than 1 MB) PDF format, which can be appropriately displayed by Adobe Reader. The file of the answer should be submitted through ITC-LSM.

解答のテキスト部分は手書きでないようにお願いします．英語，日本語のどちらでも良く，採点は言語に依存しません．文法や語法，文章の上手下手は問題にしませんが，意味が取れない場合は，英語日本語にかかわらず，減点します．解答は，ファイルサイズのできるだけ小さな (1 MB 以下が目安)，Adobe Reader できちんと表示できる PDF ファイルにまとめ，ITC-LSM を通して提出してください．

0602-1 Dielectric function of a free electron gas

The relative dielectric function of a free electron gas is given by

$$\epsilon_{\rm r}(\omega) = \lim_{\gamma \to +0} \left(1 - \frac{\omega_{\rm p}^2}{\omega^2 + i\gamma\omega} \right),$$

where $\omega_{\rm p}$ is the plasma frequency, $\omega_{\rm p}^2 = ne^2/\epsilon_0 m$.

1. Show that $\epsilon_{\rm r}(\omega)$ satisfies the Kramers-Kronig relations.
2. Evaluate
$$\int_0^\infty \omega {\rm Im}\epsilon_{\rm r}(\omega) d\omega$$
.

0603-2 The Hall effect

A semiconductor Hall device at T = 300 K has the following geometry: d=10^{-3} cm, W=10^{-2} cm, and L = 10^{-1} cm. The following parameters are measured: I_x =0.50 mA, V_x =15 V, $V_{\rm H}$ (Hall voltage)= 5.2 mV, and B_z = 0.10 T(tesla). Determine the (a) conductivity type, (b) majority carrier concentration, and (c) majority carrier mobility