ON EFFECTIVE IMPEDANCE OF NETWORKS

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It is known that electrical networks with resistors can be considered as weighted graphs. Similarly, the infinite electrical networks with resistors can be introduced. In this case the effective resistance of a network can be defined, and it is related to Laplace operator and random walk on graphs.

A natural generalization of a network with resistors is given by an electrical network with resistors, capacitors, and inductors (so called network with impedances). It is more convenient for us to work with the admittance (i.e. the inverse of impedance). We define the mathematical notion of effective admittance $\mathcal{P}$ of a finite network and consider it as a rational function of λ. Although initially $\lambda = i\omega$, where ω is the frequency of an alternating current, we consider more generally λ as taking arbitrary values in $\mathbb{C}$. We present some estimates of the function $\mathcal{P}(\lambda)$ in terms of λ. Moreover, we discuss the possibility to define an effective admittance of a given infinite electrical network. The idea is to exhaust an infinite network by a sequence of finite networks. The main result is the following

Theorem 1 *Let $\{\mathcal{P}_n(\lambda)\}_{n=1}^{\infty}$ be a sequence of the effective admittances of the finite networks exhausting a given infinite network. Then the sequence $\{\mathcal{P}_n(\lambda)\}$ converges as $n \to \infty$ locally uniformly in the domain $\{\lambda \mid \operatorname{Re}\lambda > 0\}$.*

Therefore, the effective admittance of an infinite network can be defined in the right-half plane. Some other domains are also discussed.

References

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[2] Anna Muranova. *On the effective impedance of finite and infinite networks.* arXiv e-prints, arXiv:1908.10025, August 2019.