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The *G* Numbers and Their Application to the Theory of Waveguides

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G numbers are called the attained under definite conditions real positive limits of certain infinite sequences of real positive numbers, whose terms are designed through the zeros in the imaginary part of the complex first parameter of the complex Kummer, resp. of a transcendental function, involving complex Kummer and Tricomi confluent hypergeometric ones of expressly picked up parameters and variable(s) [1,2]. They appear in the theory of azimuthally magnetized circular, resp. coaxial ferrite waveguides, propagating normal TE_{0n} modes, described in terms of the functions mentioned. The configurations in question may operate as digital phase shifters at microwave frequencies and are appropriate for the development of electronically scanned antenna arrays for the TE_{01} mode [1-3].

A numerical investigation of the impact of the parameters of functions (of the transmission lines studied) on the numbers is accomplished. The new quantities are harnessed to derive the equations of and to compute specific envelope curves in the phase diagram of the structures examined for each mode which mark off the boundary of the characteristics (the area in which the wave might propagate) for negative (clockwise) magnetization of the anisotropic load from the side of higher frequencies. Based on these graphs the criterion for phase shifter operation of the waveguides is obtained in terms of the *G* numbers.

In addition, approximate methods for calculation of the differential phase shift, afforded by the aforesaid structures are worked out, using the envelope curves referred to and the numbers considered. They take advantage of the slight dependence of a specially determined characteristic parameter of the waveguides on the magnitude of off-diagonal tensor element and the normalized vs. frequency and ferrite relative permittivity guide radius [3]. The schemes are very simple and effective. The error they introduce is of the order of a few percent only. The normalized in the same way critical guide radii of the circular and coaxial ferrite configurations, corresponding to its cut-off frequencies by means of the quantities regarded, is also disclosed.

1. G. N. Georgiev, and M. N. Georgieva-Grosse, "Theorem for the $G_1(c, n)$ Numbers", (*Invited Paper* in the Special Session "Advanced Mathematical and Computational Methods in Electromagnetic Theory and their Applications – 1," organized by M. N. Georgieva-Grosse and G. N. Georgiev), *Progress In Electromagnetics Research Symposium Abstracts*, pp. 98-99, *PIERS Proceedings*, pp. 349-355, Prague, Czech Republic, July 6–9, 2015.

2. G. N. Georgiev, and M. N. Georgieva-Grosse, "Theorem for the $G_2(c, \rho, n)$ Numbers and its Application in the Theory of Waveguides," in *Proc. 2017 XXXII URSI GASS General Assembly and Scientific Symposium*, **2**, pp. 826-829, Montreal, Quebec, Canada, August 16–23, 2017.

3. M. N. Georgieva-Grosse and G. N. Georgiev, "Assumptions on the Characteristic Parameter of the Coaxial Ferrite Waveguide Phase Shifter and its Application," in *Proc. Fourteenth Int. Conf. Electromagn. Adv. Applicat. ICEAA'12*, Cape Town, South Africa, September 2–7, 2012, pp. 1129-1132, (*Invited Paper* in the Special Session "Advanced Applications of the Mathematical and Computational Electromagnetics," organized by G. N. Georgiev and M. N. Georgieva-Grosse).