Transistor teaching back to Transfer-Resistor

A summary table of definitions and students’ perceptions

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Abstract—The Bipolar Junction Transistor (BJT) study is a regular subject on analog electronic subjects taught in the initial phase of electronic engineering courses. This electronic component, often considered elementary, is far from being simple to explain because it covers several concepts, such as three Regions of Operation, two Working Regimes, and two Region of Operation Boundaries. It is not surprising then that students often find it difficult to understand the functioning of this component. The present article describes partially the work developed by a team with a number of students in order to understand the difficulties of teaching/learning the BJT. We present the students’ perceptions from the analysis of several traditional and modern means to support the learning of the BJT. Interestingly, the learning BJT model considered simpler for beginner students corresponds to the model that originally gave it the name i.e. Trans-Resistor (Transistor).

Keywords—Bipolar Junction Transistor, leaning support means, students perceptions

I. INTRODUCTION

Higher-level education is seen as a key factor and as an essential role for people who wants to have future success in modern societies. Its importance is well recognized regardless of the significant costs carried for every country. In fact, the number of people who pursue this level of education has impressively risen in the last half century. This increase in students brings new challenges for both, each country’s economy and teaching systems [1]. Traditional methodologies mainly centered on the professor have been revealed to be ineffective when delivered to the masses [2]. This unsustainable situation has led not only to an adjustment of teaching strategies but also to divert more attention into students and teaching/learning methods [3,4]. The Bologna reform brought a reorganization inside universities in order to optimize education resources [5,6], which in turn led to a tendency for shortening their degrees’ time and to center them in a given knowledge specific area [7,8]. These kinds of degrees became very narrow, with a high level of specialization and a thin scope. This is a new strategy that brought advantages and disadvantages, particularly in the case of engineering education [9]. On one hand, this strategy allows the development of technological and educational processes closer to each other [10]. As the scope becomes narrower, the easier it is to achieve a higher skill level, and in particular if it is supported by technological means.

On the other hand, the mentioned strategy brings the disadvantage of decreasing competences in terms of abstraction for dealing with more realistic and complex models. This is an issue that assumes special importance in Electric and Electronic Engineer courses. Traditionally, in the first years students work mostly with simpler and ideal models of electrical elements and then, in last years, they use more realistic and detailed models.

This is important in Electronic Engineer Degrees where electronic subjects are typically divided in two different arenas commonly called Digital Electronic and Analog Electronic. At a degree level, we can observe a fragmentation, i.e. students taking options that will later define their own jobs. Inside the Electronic Engineering degree we can see students clearly oriented to hardware design, while others prefer software design. Even inside hardware design, a new fragmentation takes place: a very important part of students prefers digital design, whereas just a few others select the analog and mixed-signal design. As a consequence, we have an unbalanced situation resulting on lots of specialists in the digital arena, contrasting with few in the analog arena. In fact, there exist a few analog programmable / configurable components, called PSoC and FPAA [11], but the market acceptance has been slow and they are not usually part of the Analog Electronic curricula. The students’ inclination for digital circuits instead of analog and mixed-circuits is clear. The reason that explains this behavior, however, is more complex than the simple division of the type of signals involved. The fact is that the design flow of each arena presents significant differences as a consequence of each arena’s maturation state. In the digital area, the design is mostly based on software, whereas in the analog arena the design is based on hardware and also on components behavior knowledge. One of those components is precisely the Bipolar Junction Transistor (BJT). For teachers this is no more than one elemental component. For students, it is nowhere as simple, for this component poses important constraints on its understanding.

The BJT study is a regular subject on analog electronic subjects taught in the initial phase of electronic engineering courses. This basic current amplifier electronic component, often considered elementary, is far from being simple to explain because it covers several concepts, such as three Regions of Operation, two Working Regimes, and two Regions of Operation Boundaries, besides other features. Students often find this non-linear component difficult to understand. A