

Circuits and Systems in Turkey

The father of Modern Circuit Theory in Turkey is Tarik Özker of the Istanbul Technical University (ITU). He was the first teacher who introduced discrete time systems with Dirac delta function $\delta(t)$ in the context of distribution theory in 1956. His successors were Yilmaz Tokad, Ahmet Dervisoglu, Cem Gökna, Fuat Anday, Ergul Akcakaya, Cevdet Acar, and Vedat Tavsanoğlu.

Yilmaz Tokad, a former professor of Michigan State University (MSU), East Lansing, Michigan, returned to Turkey in 1968 and joined the faculty of the Middle East Technical University at Ankara, Turkey and started teaching circuit and systems courses incorporating also mechanical signal variables. In 1974, he joined ITU as a Chair Professor of Circuits & Systems and head of the Electronics Research Division of National Research Center of Turkey. It should be noted that circuit theory's grandfather for Turkey was Professor Myril B. Reed as he was the Ph.D. adviser of Tariq Özker (University of Illinois, 1951) and Yilmaz Tokad, the two pillars of electrical circuits in Turkey.

Until mid 1970s, CAS lectures have been delivered only in Istanbul at ITU, Bogazici University, Yildiz Technical University, and Middle East Technical University (METU) in Ankara. After mid 1970s, university education has been spread out to Anatolia; firstly, with Black Sea Technical University where circuits and systems education was initiated by professors from ITU. Early in the 1980s, electrical engineering departments were established at several other cities in Turkey including Ege University at Izmir, Ataturk University at Erzurum, Erciyes University at Kayseri, Anadolu University at Eskisehir, Uludag University at Bursa, Gaziantep University under METU and Istanbul University at Istanbul.

Then, formal courses on circuits and systems along with laboratory instructions were offered by the graduates of ITU and METU, who also published textbooks on network analysis, active filters and switched-capacitor filters in Turkish language.

Nowadays in Turkey, well designed, advanced circuit and systems education programs both in undergraduate and graduate level exist country-wide. These programs include topics on computer aided linear/nonlinear circuit analysis, synthesis of passive, active, switched-

capacitor and digital filters, Analog to Digital and Digital to Analog Converter designs, digital dynamical systems, logic-digital circuit designs, fault detection and fault tolerant design, RF and microwave circuit design, IC, VLSI and MMIC designs etc. As far as system theory education is concerned, linear-nonlinear, analog, discrete-time, adaptive, fuzzy, chaotic, stochastic systems are covered at advanced undergraduate and graduate levels. In all CAS and circuit design courses, computer aided analysis and design tools such MATLAB, Simulink, SPICE, ADS, AWR, Cadence, Mentor etc. are employed by both undergraduate and graduate students as well as researchers. Advanced level research activities in CAS were initiated by T. Özker, A. Dervisoglu, C. Gökna, B.S. Yarman and V. Tavsanoğlu.

The first pioneering electric-circuit implementation work of Turkey was to locally design and manufacture analog filters using image parameters method by the Post Telephone and Telegraph Company in 1965. The urgent need, then, was to separate 12-analog voice channels of 3.4 MHz over the frequency band of 60 kHz to 108 kHz. This engineering project was led by the Lab director Fikret Yucel and his team composed of legendary engineers of the country namely Celal Altas, Ender Olcayto, Sucul Aribas and Ersan Kinayyigit. Upon the development of Digital Communication Systems in 1984, PCM based communication system components of the Turkish Telephone network were designed and produced at the Electronic Research Unit of the National Research Center of Turkey led by Prof. Yilmaz Tokad. Then, two major Telecom companies, namely Teletas and Netas were established to manufacture digital switches and microwave radio-links. Teletas used to rely on Alcatel's digital communication technology in France, whereas Netas was relying on Northern Telecom Technology of Canada. In 1975, Turkish Military Industries Corporation, namely ASELSAN became an active design and manufacturing house to produce RF and Microwave components and systems such as walkie-talkies, electronic warfare units etc. to cover the needs of military. In this regard, ASELSAN designs and manufactures microwave passive circuit components such as filters (using waveguides, lumped circuit elements, microstrip lines, co-planar lines etc.), matching networks, resonators, hybrids, antennas, and microwave active components such as microwave amplifiers (small single and multi-stage amplifiers and power amplifiers) etc. In Istanbul ITU, YTU and Istanbul University-Cerrahpasa,

in Ankara METU and Bilkent University in Ankara offer excellent microwave circuits and system design education as well as research infrastructure including METU's MEMS production facility. Bilkent University is also well known for having the first nano-technology center of Turkey where they have a GaN transistor foundry. Lately, ASELSAN with National Research Center of Turkey has expanded its silicon-based foundry to produce Si-Ge based VLSI circuits.

Turkey is an emerging high-tech country with promising CAS expertise especially, in VLSI and MMIC design and production capabilities.

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student in Electrical and Computer Engineering at the University of Porto. He is collaborating as an invited assistant professor, teaching laboratory classes of computer systems. His personal research interests are mainly in the fields of software development, computer applications for education, distributed applications, industrial automation systems, smart homes, and systems integration.



Mário Alves has been with the Electrical Engineering Department of ISEP (Politécnico do Porto) for over two decades. He has been teaching mostly around DC/AC circuit fundamentals, test & measurement and automotive

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Francisco Pereira has a PhD (2000) in Physics at the University of Porto. He is with the Electrical Engineering Department of ISEP/IPP since 1995, where his teaching activities have been mostly devoted to courses on electrical circuits,

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