Scanning the Issue

Point-of-View:
Today's Engineering Education Is a Liberal Arts Education of the Future
W. Kenneth Jenkins

In this month's Point-of-View article, the author argues that as technology gets more integrated into our daily lives, today's engineering education will become increasingly popular in the future as it provides an alternate form of a liberal arts education. A liberal arts education, as per the author, provides many educational skills that enable people to function well and have a comfortable life within our society. In the article, the author defines the basic three goals of a liberal arts education in today's world and then draws comparisons to how an engineering education will satisfy these goals in the highly technical society of the future.

A Tutorial on the Flexible Optical Networking Paradigm: State of the Art, Trends, and Research Challenges
Ioannis Tomkos, Siamak Azodolmolky, Josep Solé-Pareta, Davide Careglio, and Eleni Palkopoulou

In this regular papers issue we cover flexible optical networking, geometric algebra for electrical and electronic engineers, and neuromorphic circuits for building autonomous cognitive systems.

Since its introduction about 25 years ago, the Internet has seen a tremendous growth in the number of users. A recent report suggests a growth of about 38% in terms of global users annually. In addition to this the amount of data is doubling every two years. The generated data are being consumed via the Internet, which has led to a staggering growth in Internet traffic estimated at anywhere between 25% and 60%. This growth has put a tremendous amount of pressure on the current infrastructure that supports the Internet.

Traditional wavelength division multiplexing (WDM) networks operated within fixed modes cannot keep up with this increased demand. Thus, to fully utilize the capacity of the networks, the concept of flexible optical networking has been recently introduced. This survey paper provides a comprehensive view of the different pieces composing the "flexible networking puzzle" with special attention given to capturing the occurring interactions between different research fields. Only when these interrelations are clearly defined, an optimal network-wide solution can be offered. Physical layer technological aspects, network optimization for flexible networks, and control plane aspects are examined. Furthermore, future research directions and open issues are discussed.

Geometric Algebra for Electrical and Electronic Engineers
James M. Chappell, Samuel P. Drake, Cameron L. Seidel, Lachlan J. Gunn, Azhar Iqbal, Andrew Allison, and Derek Abbott

In 1637, Descartes developed the Cartesian coordinate system celebrated as one of the key mathematical developments in the progress of science. The Cartesian system allows geometrical curves to be described algebraically and forms the foundation for both Heaviside's and Clifford's vector notation. Heaviside's vector notation is currently widely adopted, however, there is an increasing interest in the use of Clifford's notation, i.e., Clifford or geometric algebra.

Geometric algebra can simplify the representation of formulas and provides for structural checks that go beyond the conventional checking of physical dimensions. These and other benefits contribute to potential improvements in problem solving. This tutorial paper defines geometric algebra, charts its history, and analyzes its various benefits at calculating and representing quantities in Cartesian space as well as applications to the general and special theories of relativity, with a focus on applications in the field of electromagnetism.

Neuromorphic Electronic Circuits for Building Autonomous Cognitive Systems
Elisabetta Chicca, Fabio Stefanini, Chiara Bartolozzi, and Giacomo Indiveri

Neuromorphic engineering, also known as neuromorphic computing, is a relatively new interdisciplinary field of research that spans biology, physics, mathematics, computer science, and electronic engineering, and

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focuses on building artificial neural systems. Many efforts have been made over the years to capture the mechanism of cognition into machines. A lot of progress has also been made; however, animals still seem to easily outperform our best technology in the areas of sensory processing, motor control, and pattern recognition. In the presence of noisy and uncontrolled sensory output, the differences are even more dramatic. An important reason for this is that unlike modern computers, biological nervous systems use hybrid analog/digital unreliable processing elements; they emphasize distributed, event-driven, collective, and massively parallel mechanisms and make extensive use of adaptation, self-organization, and learning.

This paper starts by reviewing neuromorphic circuits for emulating neural and synaptic dynamics in real time. The challenges of realizing spike-based synaptic plasticity in real physical systems, and present examples of analog electronic circuits that implement them, are investigated. The computational properties of recurrent neural networks are discussed, and how neuromorphic winner-take-all circuits can implement working-memory and decision-making mechanisms is presented. Experimental results in support of the proposed neuromorphic approach are provided, and an argument is made as to how the circuits and networks presented in this work can represent a useful set of components for efficiently and elegantly implementing neuromorphic cognition.

Scanning Our Past:
Nils Gustaf Dalén
Simón Reif-Acherman

This month we learn about the early life and achievements of Nils Gustaf Dalén, a Swedish engineer and inventor, who was presented the Nobel Prize in 1912. He received the Nobel Prize "for his invention of automatic regulators for use in conjunction with gas accumulators for illuminating lighthouses and buoys."

Dalén studied engineering at the Chalmers Technical High School in Gothenburg, Sweden, followed by a year and a half at the Federal Polytechnic in Zurich, Switzerland. In 1897, Dalén established a firm at Chalmers along with Henrik von Celsing (1873–1910) to develop inventions that would lead to useful products. One of their developments related to acetylene and its possible applications became a milestone in Dalén's career. The history of Dalén's inventive and scientific achievements is closely intertwined with that of Actiebolaget Gas Accumulator (AGA), the company that he helped found and that he was president of for nearly three decades. ■