The relentless development of semiconductor technologies has enabled the design of highly complex systems. Electronic engineers are now expected to build chips which have more than a billion transistors. Novel computing paradigms have recently emerged such as many-core systems and the Internet of Things. Graduates of electrical and electronic engineering degrees need to be appropriately educated on the design techniques of complex systems-on-chips, parallel computer architecture and hardware security.

This is our first IET Circuits, Devices and Systems Special Section on developments and advancements in electronic and electrical engineering education. This Special Section highlights the state-of-the-art educational practices and research in this field, and includes the following topics:

**Topic 1: embedded system design**

Paper 1 by Sarah Harris et al. introduces MIPSfpga, a teaching infrastructure that offers access to the non-obfuscated Register-Transfer Level (RTL) source code of the MIPS processor, this learning platform focuses on hands-on learning that emphasizes computer architecture, System on Chip (SoC) design and hardware-software co-design, which enables students to design their own embedded systems based on the MIPS architectures, the latter is widely adopted by the IC design industry.

Paper 2 by Benjamin Pfundt et al. proposes a curriculum of three courses on the design and implementation of reconfigurable heterogeneous systems, this course has also a strong practical component, where in students learn to develop an embedded system for a smart camera application.

Paper 3 by Lutfi Albasha et al. presents a course on the design of RFIDs, which can be viewed as one of the most resource-constrained embedded systems. The proposed course aims at bridging the gap between the academia and industry by providing the students with the necessary skills to be able to design, implement and test RFID chips.

**Topic 2: hardware security**

The multi-national and geographically distributed nature of the IC supply chain, which relies heavily on the re-use expertise from all over the world, introduces a host of hardware security threats, such as Trojans, sided channel attacks and counterfeiting.

Paper 4 by Basel Halak introduces a course on the design and implementation of secure embedded systems. One of the unique features of this module is its approach of treating hardware security as an integral part of the chip design process and as one of the design metrics which can be evaluated and optimised, this allows students to better understand the root causes of this issue and to think more constructively about effective mitigation techniques.

**Topic 3: internet of things**

The development of smart devices with web connectivity is a challenging task, it requires knowledge in a number of areas including computer architectures, electronics design and programming, and therefore many young learners may perceive this area as difficult, hence less appealing.

Paper 5 by Slim Chtourou et al. proposes an accessible learning platform for the development and testing of smart devices. The ease of use of this platform and its diverse applications makes it ideal for stimulating the interest of school children in the area of embedded system and internet of things. The authors demonstrated how such a platform can be used to develop a voice recognition device, a fire detector and a robot.

Paper 6 by Yoshio Mita et al. introduces another interesting approach for teaching this topic, it is based on the use of Flip-class room technique, where students are asked their own invention based on loosely defined initial specifications. Students are actively encouraged to seek knowledge, learn design skills on their own with the help, and support from the instructor, which help enhance their creative thinking and self-expression skills.

**Topic 4: electrical drive**

The modern control of electric drives utilises complex control strategies and algorithms embedded into DSP to provide desired operation. Paper 7 by Alecksey Anuchin et al. discusses the design principles of instructional laboratory equipment applied for practical investigations of electric drive control, their proposed curriculum cover principles of operation of DSP control systems, real-time software execution and the influence of the control structure tuning on motor performance.

**Topic 5: eddy current testing**

Eddy current testing (ECT) is one of the Non-destructive evaluation (NDE) techniques used in many industries, especially in oil and gas, nuclear and coating industries. They characterized noisy data to the less-than-perfect detection and as an indication of serious false alarm problem. However, not many researchers have described in detail the intelligent ECT crack detection system on their application in eddy current techniques for non-destructive testing. Paper 8 by Kharudin Bin Ali introduces a review of ECT technique and factors that affect the signal fundamental according to the hardware and software development.

**Conclusion**

The main challenge facing educators in the field of electrical and electronics engineering is the fast-paced development of new technologies, which is not always reflected by curricula thought at universities around the world. This problem may lead to an increase in the gap between the actual skills of graduate students and those expected by potential employers.

The papers presented in this special section present a number of approaches to deal with this challenge, which can be summarised in the following points:

(i) Increasing the reliance on open source material (Paper 5) and industry-developed courses (Paper 1) to reduce the time and effort of course development and to keep courses relevant to ongoing advances in the field.

(ii) Enhancing the quality and quantity of the practical laboratory through the use of industry-standard tools and approaches (Papers 3, 4, 7 and 8).

(iii) Introducing new topics to the curriculum which reflect the latest industrial and research trends in this area such as hardware security and heterogeneous systems (paper 2 and 4).

The authors demonstrated how such a platform can be used to develop a voice recognition device, a fire detector and a robot.
(iv) Encouraging student-centric learning approach by providing accessible learning platforms (paper 5) and adopting flip classroom teaching approaches (paper 6).

It is hoped that this special section can help start the conversation on the common challenges faced by educators of electronics engineering courses all over the world, and encourage sharing of knowledge and skills.

**Guest Editor Biography**

Dr Basel Halak is the director of the Embedded Systems master program at Southampton University, he has written over 50 conference and journal papers, and authored two books. He received his PhD degree in Microelectronics System Design from Newcastle University in 2009. He was then awarded a knowledge transfer fellowship to develop secure and energy efficient design for portable health care monitoring systems. His background is on the design and implementation of microelectronics systems, with special focus on reliability and security. In particular Dr Halak is interested in developing secure hardware implementation for cryptographic primitive such as physically unclonable functions. He has recently presented a tutorial session on the use of PUF for security applications in the IEEE 59th International Midwest Symposium on Circuits and Systems. Dr Halak is the recipient of the Vice Chancellor Teaching Award in 2016, and the bronze leaf award in IEEE PRIME conference for his paper on current-based physically Unclonable functions. Dr Basel Halak is a senior fellow of the Higher Education Academy (HEA), a guest editor of the IET CDT, and serves in several technical program committees such as IEEE ICCCA, ICCCS, MTV, IWSV and EWME. He is also member of hardware security working group of the World Wide Web Consortium (W3C).