In this talk, Professor Yue will deliver a comprehensive presentation on optical-wireless communication integrated circuits design. The presentation will cover two main topics as below.

Millimeter-wave transmitter (TX) design for phase-array beamforming systems. A Ka-band 4-element phased-array transmitter featuring an intermediate-frequency local-oscillator phase shifting (IFLO PS) architecture will be presented. The TX adopts sliding-IF architecture and integrates an on-chip phase-locked loop (PLL). The phase shift and variable gain control functions are executed at IFLO and IF signals, respectively, with precise and area-efficient implementations. A multiplex-/interpolation-based IFLO phase shifter and a transadmittance-transimpedance IF VGA are implemented to obtain outstanding performances of RMS phase error, RMS PS-induced gain error, and RMS gain control-induced phase error. With the above techniques, the TX achieves completely orthogonal PS and gain control, demonstrating superior power and area efficiency, highly linear gain-invariant PS, and phase-invariant gain control.

Optical transceiver design for short-reach optical communications. A 56-Gb/s quarter-rate 4-level pulse amplitude modulation (PAM-4) optical TX and a 48-Gb/s half-rate PAM-4 optical receiver (RX) will be presented. The TX features a piecewise compensation scheme for the three non-idealities of vertical-cavity surface-emitting lasers (VCSELs) including bandwidth nonlinearity, electrical-to-optical (E/O) gain nonlinearity, and asymmetric response to rising/falling edges. The TX adopts a thermometer code-based architecture with variable-transconductance cells, a 2-tap feed-forward equalizer (FFE), and continues-time linear equalizer (CTLE) to independently control the gain and equalization strength of the top/middle/bottom (T/M/B) data slices for full compensation of the bandwidth and E/O gain nonlinearities. Moreover, a pre-emphasis circuit is embedded within the CTLE to mitigate the data eye skew caused by VCSEL's asymmetric response issue. The proposed optical TX achieves full compensation for the VCSEL non-idealities with small overheads of power consumption and circuit complexity compared to conventional DSP-based methods. The optical RX integrates a TIA and a PAM-4 sampler. The TIA employs transadmittance transimpedance (TAS-TIS) structure to replace conventional CML-based VGA and post-amplifier, eliminating CTLE and inductive peaking while preserving the linearity and the gain-bandwidth product for PAM4 operation. The PAM-4 sampler exploits a 2-tap FFE and a 2-tap DFE to compensate for inter-symbol interference (ISI) of the TIA, ensuring correct data recovery. Timing criteria of DFE loop is achieved up to 30 GBaud by optimizing the clock-to-Q delay of slicers. The proposed inductor-less optical RX achieves high bandwidth density and superior energy efficiency and hence is promising for the application in high-density multi-channel optical interface.

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C. Patrick Yue (S'93–M'98–SM'05–F'15) received the B.S. degree in Electronic and Computer Engineering (Highest Hons.) from the University of Texas at Austin in 1992, and the M.S. and Ph.D. degrees in Electrical Engineering from Stanford University in 1994 and 1998, respectively.

Currently, he is the Director of the HKUST Integrated Circuit Design Center (ICDC), the Optical Wireless Lab (OWL), and the HKUST-Qualcomm Joint Innovation and Research Lab. His research interest includes optical wireless physical layer circuits and systems, high-speed wireline communication SoC, millimeter-wave communication and sensing circuits, indoor positioning and image processing technologies for robotic applications, and edge computing accelerator design for IoT applications.