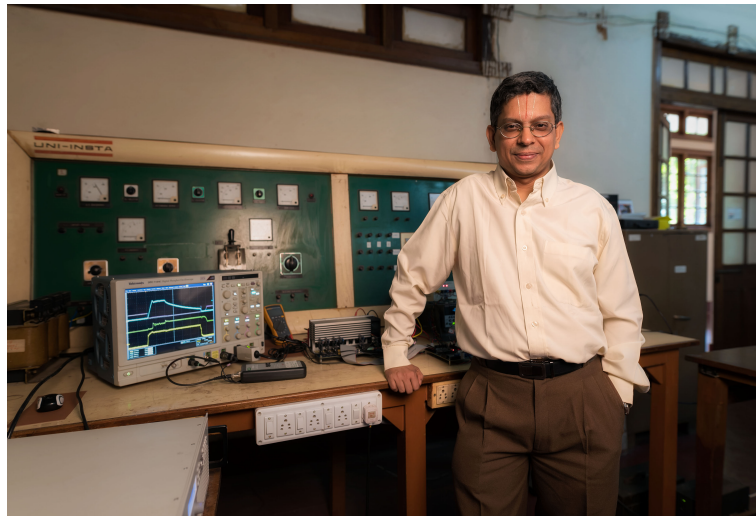


**G NARAYANAN (Professor, Department of Electrical Engineering)**

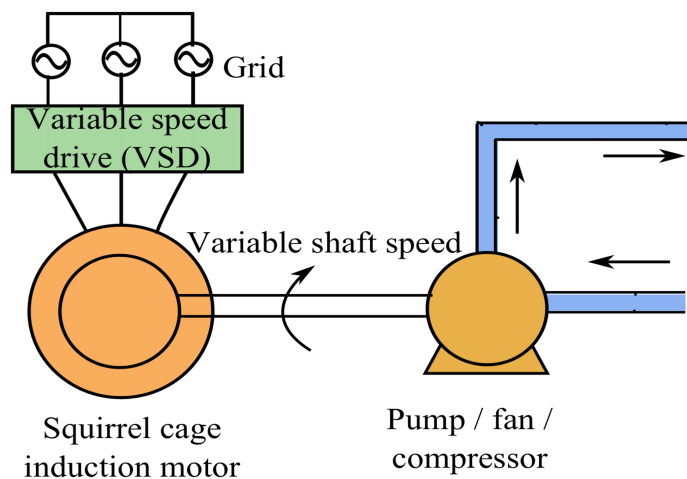
**MODULATING POWER**



“If you use black boxes for your research, you will have power electronics students who cannot handle power electronics devices themselves,” says G Narayanan, as we walk around the lab, filled with instruments built by students over the years—including Narayanan himself, who was once a PhD student in the lab.

One such black box, for most people, is the inverter. An inverter supplies alternating current (AC) from its stored power using a technique called pulse-width modulation, or PWM. But the PWM voltage waveforms are never ideal and the process not always efficient. The inverter’s output, for example, may not be purely in the form of sine waves. Over the years, Narayanan has built up a body of work, developing various PWM methods to minimize these effects.

More recently, Narayanan and his student, Anirudh Guha, found something unexpected when, using a standard PWM method, they ran an induction motor powered by AC from an inverter: oscillations of the motor current at certain low and medium speeds, where a steady current was expected.\* The inverter has transistors, working in pairs, which alternately turn on and off. But there is a small sliver of “dead time” in the conduction cycle during which, for reasons of safety of



**A fan/pump load driven by a variable speed induction motor, in atypical application**

the device, both transistors are off. Narayanan and Guha traced the erratic behaviour of the motor to the inverter dead-time, and developed a model for it that better predicts the region of instability. They also worked with industry to corroborate their findings.

Narayanan's work—which, he scrupulously points out, is not his alone—stems from his long-standing interest in power electronics. And his approach has been deeply influenced by his teachers in the Department—most of all by his PhD advisor, the late VT Ranganathan, who encouraged him to learn how to build an inverter and implement PWM methods from scratch. “While doing that work,” Narayanan recalls, “I found that things could be done very differently.”



\* Anirudh Guha and G Narayanan. 2016. Small-signal stability analysis of an open-loop induction motor drive including the effect of inverted deadtime. *IEEE Transactions on Industry Applications*. 52(1):242-253