



## IEEE EDS DISTINGUISHED LECTURER TECHNICAL TALK

### Carbon: The Soul of Nanoelectronics

by

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**Date: 23<sup>rd</sup> December 2014 (Tuesday)**

**Time: 10.30 – 11.30 am**

**Venue : Bilik Mesyuarat Gunasama, Level 5, Research  
Complex (Bangunan Penyelidikan), 43600 UKM Bangi  
Universiti Kebangsaan Malaysia (UKM)**

(map is attached at the end)

**FREE  
ADMISSION**  
(Refreshments  
will be served)

### Abstract

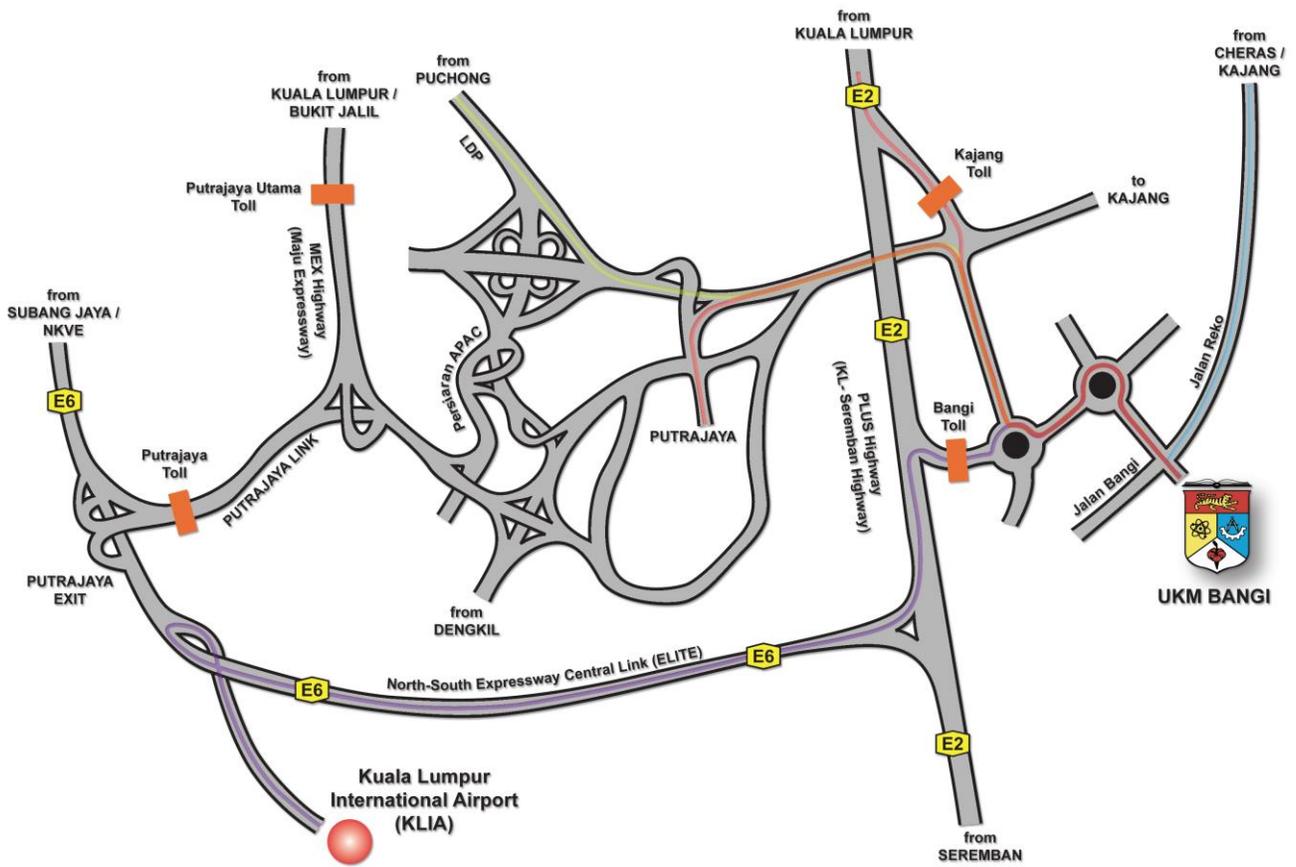
Quantum (digital-type) concepts in nanomaterials are gaining eminence over and above the classical ones (analog-type) in miniaturized devices where nanometer size can be less than or equal to the de Broglie wavelength of an electron in any of the three Cartesian directions. The silicon era is facing serious hurdles in meeting the expectations of Moore's law that in the past doubled the number of transistors on a chip every 18 months. As scaling progresses into nanoscale regime and new carbon-based nanomaterials on the horizon, the scientific community is looking for new breakthroughs in search of More than Moore. One clear aspect of this miniaturization is that an electric field driving carriers can be extremely high. This converts random carrier motion into a streamlined one, thereby limiting the velocity to thermal velocity or Fermi velocity depending on the degeneracy of the sample. This re-organization of the carrier velocities flouts familiar Ohm's law, thereby enhancing the role of high-field velocity saturation in performance evaluation and characterization of nanostructures. Non-equilibrium Arora distribution function (NEADF) is the key to understanding conversion of stochastic velocity vectors to streamlined ones in all nanomaterials. A free flight of a carrier may be interrupted by an emission of a quantum of energy in the form of a phonon or photon. This emission further limits the saturation velocity and also degrades the diffusion coefficient. This lecture will demonstrate that a higher mobility does not necessarily lead to a higher saturation velocity. Ballistic transport where the channel length is below the scattering-limited mean free path has interesting connotations for degrading mobility in contra distinction to the normally held view that elimination of scattering should result in mobility enhancement. NEADF sheds new light on collision-free ballistic transport, which contrary to normal expectations of resistance vanishing, not only shows enhanced resistance but also its quantization in a one-dimensional nanomaterial. This brings a new current-voltage relationship with resistance (both direct and incremental) rising with the applied dc voltage and reaching a resistance quantum in a nanowire or carbon nanotube, containing a very few electrons. Applications to nanolayers, nanowires, graphene, and carbon nanotubes will be discussed.



### **Biography**

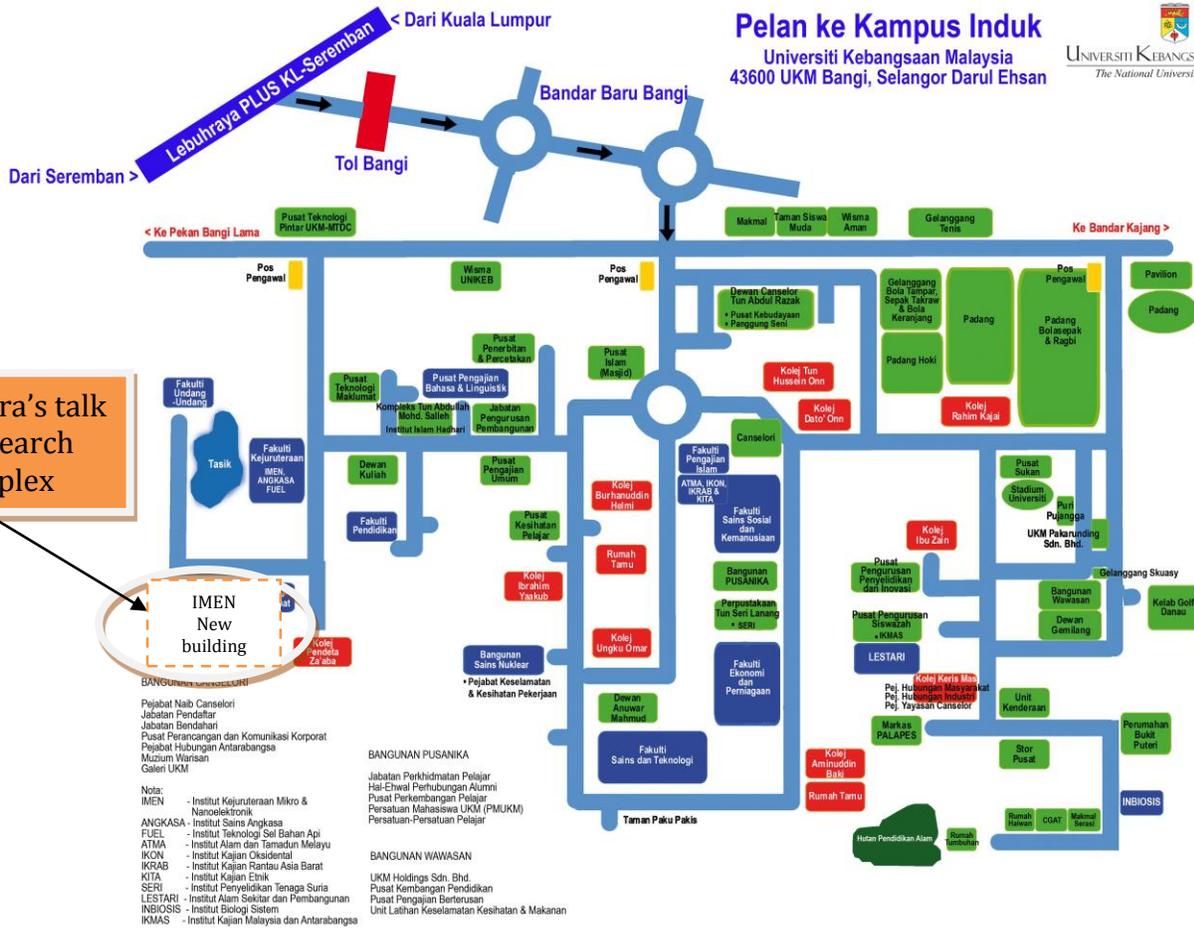
Professor Arora obtained his Ph.D. from the University of Colorado, U. S. A. In addition to his tenured appointment at Wilkes University, he is privileged to have held the distinguished visiting appointments at the University of Tokyo, National University of Singapore, Nanyang Technological University, University of Western Australia, and Universiti Teknologi Malaysia (UTM). Presently, he is a UTM distinguished visiting professor and an IEEE-EDS distinguished lecturer. Professor Arora has been invited to give keynote papers/lectures/courses at international forums, spanning from nanotechnology to nanoeducation to nanomanagement, both on and off a chip. He has published more than 100 papers in reputed journals and many uncounted publications in conference proceedings. Professor Arora serves on the editorial board of a number of journals. He was chair of NanoSingapore2006, NanotechMalaysia2010, and EscienceNano2012 conferences. He is listed in a number of Who's Who biographies. Professor Arora's most recent recorded forum (30 minutes) on Educating Global Engineers can be downloaded from his webpage <http://web.wilkes.edu/vijay.arora/> by clicking on the Faculty Forum 2013.

## Directions to UKM Bangi Main Campus



## Directions to Talk Venue

**Pelan ke Kampus Induk**  
 Universiti Kebangsaan Malaysia  
 43600 UKM Bangi, Selangor Darul Ehsan



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