Ten Important Technology Domains and Milestones

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Opportunities for IITs to Lead and Deliver

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I. Energy Harvesting and Energy Security

- **Solar/Renewable resources**: Harvesting, Key materials, Design, H-Storage, Wind, Fuel cells (specific power/energy/cost/life), SOFC
- **Hybrid power systems**: Design, Grid connectivity, Micro-grid, Distribution/stability, Gas hydrates, Smart materials switches
- **Thermal/Super-thermal power stations**: Capacity expansion and utilization, Efficiency in generation/distribution, Coal gasification (CTL/GTL), Pollution control, Coal/water/fly ash/environment issues
- **Nuclear power**: Reliability, Safety, Structures, Modeling, Fusion reactor (ITER), Loss of coolant simulation, Thermal engineering
- **Oil and Natural Gas**: Exploration, Refining, Gasification, Viscofier
- **Flexible electronics**: Solar energy harvesting, Devices and sensors, Flat panel displays, Large area solar cells/tiles
II. Sustainable Healthcare

• **Public health**: Policy on nutrition, sanitation, water, hospital
• **Bio-sciences**: Bio-informatics, Genomics/Gene-therapy, Drug design/delivery, Proteomics, Bio-scaffold, Synthetic blood
• **Bio-engineering**: Regenerative medicine, Trials, Tissue engineering, Therapeutics, Prosthesis/implants, Biomedical tools
• **Modern healthcare**: Tele-medicine, Health monitoring/diagnostic devices/tools/kit, Sensors, Actuators, Artificial organ and transplantation, Bio-compatibility
• **Traditional medicines**: Ayurveda, yoga and aura sciences
III. River Science and Water Resources

- **River health**: River health protocol, Space regulation, Flood management, River based transportation, agriculture and jobs
- **Aviral and nirmal dhara**: Hydro-meteorological and geomorphic mapping, River linking, Inter-basin water sharing, Water regulation, Waste/effluent/sewage treatment
- **Water policy**: Industrial/domestic water management, Water recycling/recharging, Rain water harvesting, Membrane or osmotic purification, Sludge treatment, Desalination
- **Ocean engineering**: Energy, oil, gas, mineral resource mining, Wind and tidal energy, Off-shore engineering
IV. Sustainable, Green and Smart Cities

- **Infrastructure**: Low cost and durable design, New/alternate building materials, Smart structures (pre-cast/fabricated)
- **Durability**: Structural health monitoring, Retrofitting, Life assessment, Smart security/surveillance, Energy economy
- **Environment**: Green norms/specifications, Waste utilization and recycling (waste to wealth), Pollution monitoring/control
- **Transportation**: Rapid and mass transport system, Intelligent traffic management, River transport, Water front design
- **Power**: Solar PV microgrid, Smart grid, Biomass utilization
- **Healthcare**: IT enabled monitoring, Disease prevention
V. Manufacturing Engineering

- **Small/large scale manufacturing**: Product design, Data analysis, Life cycle analysis, Intelligent decision system, AI
- **Rapid manufacturing**: 3-D printing, Robotics, Computer aided manufacturing systems, Additive manufacturing, Joining
- **Micro and nano-fabrication**: Precision components, Miniature machining, MEMS/NEMS, Micro/nano-lithography, ICs
- **Unmanned aerial systems**: UAVs, Drones, Guided balloons
- **Conventional manufacturing**: Innovations in areas like textile, automobile, metals, rubber, plastics, pottery, glassware, electrical, electronics, communication, defense
- **VLFM**: IITK + IITM + IIMC + JICA
VI. Nanoscience and Nanotechnology

- **Nanomaterials**: Design, synthesis, characterization of NSMs (semiconductor, composites, metals, ceramics), Nanomaterial for catalysis, memory chips, energy harvesting/storage
- **Nanoscience**: Tailoring of shape/size/morphology selection, Size dependent properties, Metamaterials, Nano-porosity, Nanofluid, Nano-battery, Nano-dots, Nano-robots
- **Nanotechnology**: Nanometric device fabrication and system engineering, Sensors, Actuators, Nano-photonics, Health monitoring devices, Thermal devices, Magnetic switches, Optical devices, Smart phone based applications
VII. Computer and Information Science

- **New area**: Data analytics, Big data, Cloud computing, VLSI
- **National need**: Network and cyber security, Image processing, Verification, Surveillance, Fake product detection
- **Challenges**: Real time monitoring and decision making tools, Integrate through easy information gateway, Unique identity system/card, VLSI hardware, Data link cards
- **Societal need**: Semantic web, Language/speech processing technology, Digital rights management, Firewall framework
- **Problems**: Ethical/societal issues in digital world, Accessibility and dissemination of data/information, Net addiction
Sustainable agriculture: Solar PV driven water pumping based on crop need, Water harvesting and recycling, Smart-phone based sensors for moisture, nutrients and crop management 

IT Solutions: Cloud-based information base for each farm, Digital Mandi, Advisory broadcast on planting, pest control, Crop protection, Food value preservation/processing 

Bio-technology: Micronutrient (Fe/Zn) fortification, Biodiverse agriculture, Genetically modified and high yielding food crops (productivity), IP solutions and protection 

Nano-Biotechnology: Novel veterinary vaccines, Intelligent fertilizers, Bio-sensors, Membrane filtration reactors
IX. Outreach and Mass Education Program

• **New approach**: IT enabled platforms, tools and models, Online test/examination and certification
• **Training**: Large classes, On-line/on-job empowerment of professionals, Intelligent/interactive tutoring and training
• **Supplementary tools**: e-learning models, MOOCs, Flipped classroom, Lecture repository (NPTEL), Virtual laboratory and easy pace experiments, Web based tool kits
• **Challenge**: Source/course material creation, Model for sharing, Authenticity, Accreditation, Reaching out at low cost
• **Novelty/Benefit**: Skill + Scale + Speed
X. Advanced Materials

- **New materials**: Design, synthesis, fabrication and processing of new structural/functional materials, New techniques
- **Tailored materials**: Bio-inspired/bio-medical materials and systems, Compositionally/functionally graded materials
- **Engineering materials**: High specific strength materials for automobiles/aviation industry, High temperature resistant materials for strategic sectors (space, atomic energy, defense), Advanced textile products, Sustainable process technology to convert minerals to metals
- **Electronic materials**: Wide band gap materials, Quantum structures, Opto-electronic devices and optical fibers
In last 50 odd years, IITs have established themselves:

- International brand name for quality education
- Backbone of knowledge eco-system in engineering
- Seat for technology development and entrepreneurship

What IITs should do now:

- Partner, develop and deliver complete technology
- Lead globally in selected domains of Science & Tech
- Help the country improve its manufacturing skill/base
- Create technological solution to large societal problems
- Help the country bridge the gap in manpower training, improve national infrastructure, fortify economy, create more jobs, prove useful partner to PSU/industry, and strengthen strategic sectors (DAE/DoD/DoS)

Thank you and namaskar!