

**Bharati Vidyapeeth**  
**(Deemed to be University)**  
**College of Engineering, Pune-43**  
**Department of E&TC Engineering**

Report on Technical Training Program

Date: 05/04/2021

Department of Electronics & Telecommunication organized a technical training program cum workshop for students on "Simulation on Nano-Photonic Devices and Phenomenon using Ansys Lumerical". Two days workshop was conducted by Mr. Ankush Sharma, with Masters in photonic, and designation Application Engineer, at CADFEM & ANSYS. Workshop was held on 2nd & 3rd of April, 2021. 48 students attended workshop.

**Day 01:**

- **Introduction to Photonic:**

Photonics come from photon which is the smallest unit of light as electron for electricity.

It is generation, process and manipulation of photons to achieve certain functions.

In this field you will come up with terms like Optics, Electro-optics, Opto-electronics etc., all these fields are a part of photonics.

- **The FDTD Method:**

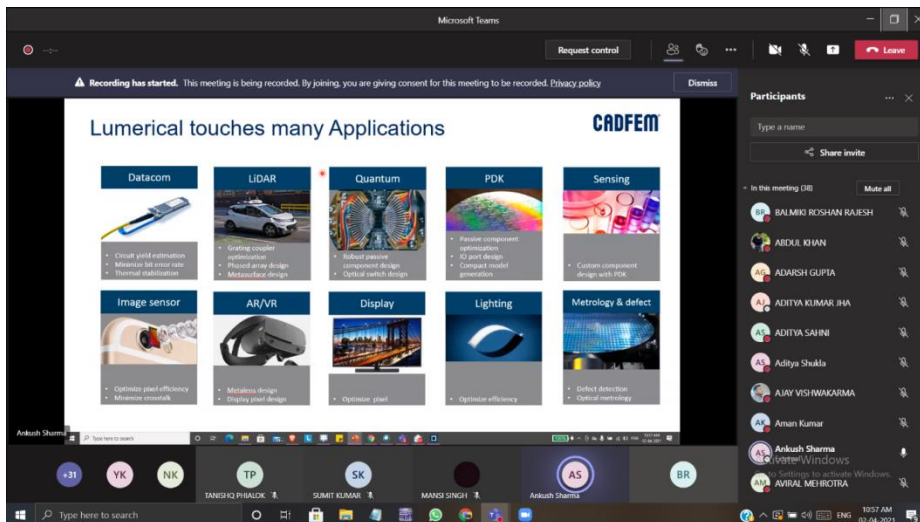
Finite-difference time-domain or Yee's method is a numerical analysis technique used for modelling computational electrodynamics. Since it is a time-domain method, FDTD solutions can cover a wide frequency range with a single simulation run, and treat nonlinear material properties in a natural way.

FDTD is a versatile modelling technique used to solve **Maxwell's equations**. It is intuitive, so users can easily understand how to use it and know what to expect from a given model.

- **Advantages of FDTD Method:**

1. General and versatile, no assumption about geometry or direction of light propagation.
2. Accurate, only approximation is the finite-sized mesh and finite-sized time step.
3. Broadband, as a time domain method, one stimulation gives broadband result.
4. Fast, the FDTD algorithm scales well with parallelization, so it is well suited to modern, multi-core and multi-processor computers
5. High performance computing clusters.

- **Application of FDTD:**



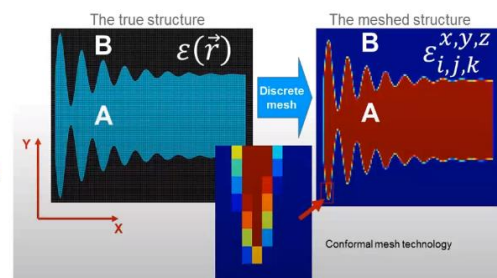
- THE Spatial Mesh:**  
 The stimulation geometry is divided up into yee cells, the fundamental unit cell of FDTD method.
- The YEE Cell:**  
 The E and H component are staggered in space over Yee cell. The particular location of E and H are ideal for calculating the spatial derivative at the correct location. This allows us to prevent second order accuracy in space on a uniform mesh.
- Interface between media:**

### Interfaces between media:



How can we handle complicated interface on a discrete FDTD mesh?

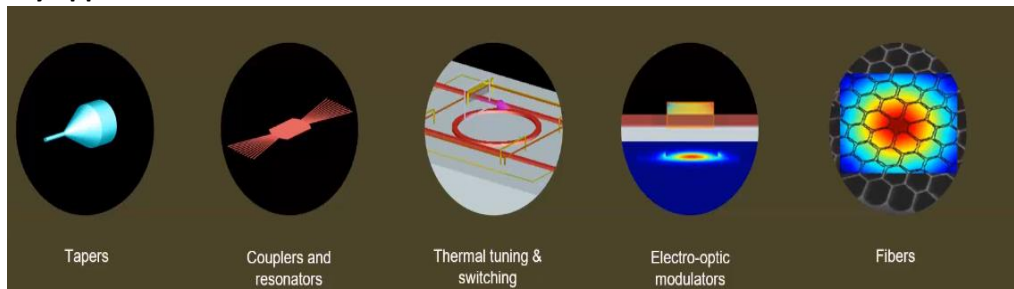
- $\epsilon$  is discrete
  - We need one  $\epsilon$  for each component of E field.
- There are many challenges
  - Position of interface is not well defined.
  - Normal E field components are discontinuous at boundaries.
  - Staircasing effects
    - Plasmonic hotspots
- Conformal mesh technology allows us to handle interfaces in a special ways to reduce the effects.



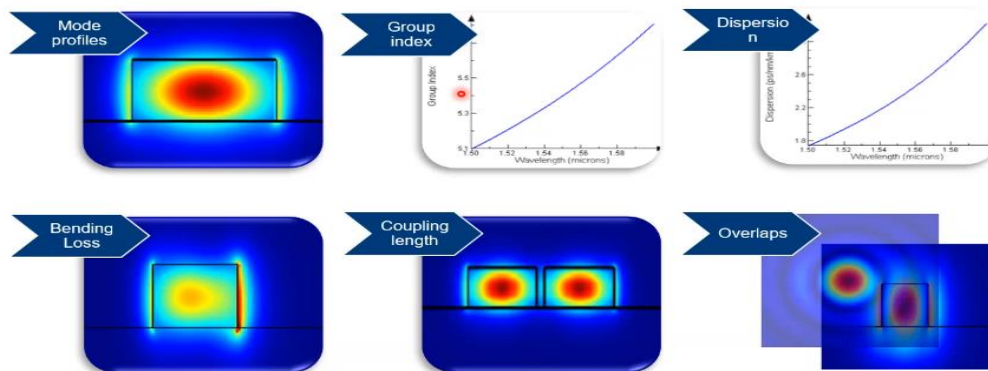
### Day 02:

- Ansylumerical mode:**  
 Whether you are working on fibre optics or integrated photonics, MODE solution has everything you need to get the most out of your waveguide and coupler designs. The bidirectional eigenmode expansion and varFDTD easily handle both large planar structure and long propagation length, providing accurate spatial field model frequency and overlap analysis.

- **Key applications:**



- **Finite difference Eigenmode solver: waveguides**



- **Non-linear stimulation methodology:**

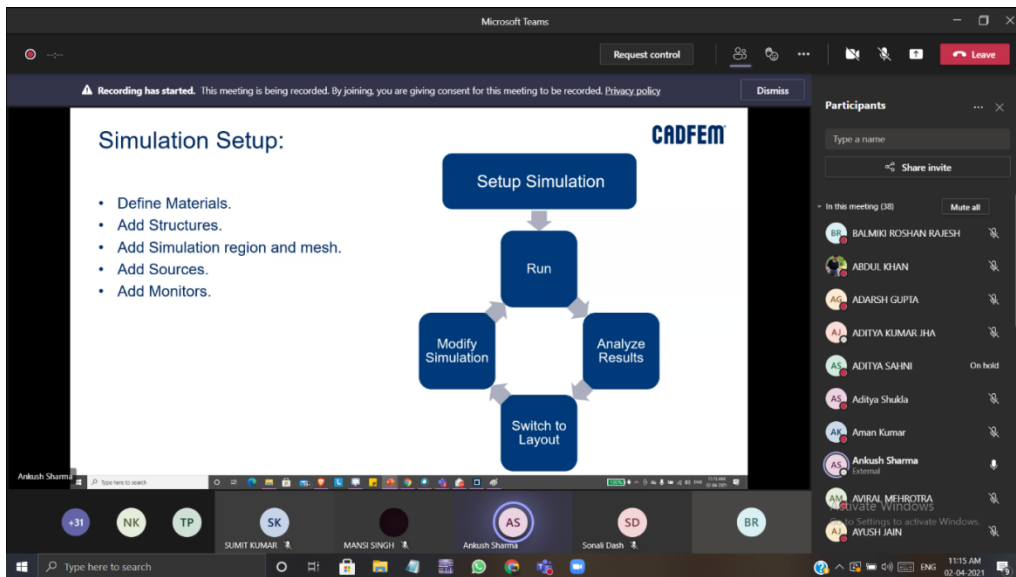
Source	Monitors	Simulations
<ul style="list-style-type: none"> <li>• Precise pulse shape is very important.</li> <li>• Often necessary to adjust source amplitude to required values to create non linear effects.</li> </ul>	<ul style="list-style-type: none"> <li>• Recording data outside the spectrum.</li> <li>• Necessary to adjust the sampling rate of time or frequency monitor.</li> </ul>	<ul style="list-style-type: none"> <li>• Simulation bandwidth override.</li> <li>• Careful while using Bloch boundary conditions.</li> <li>• Convergence and stability.</li> </ul>

**DETAIL ABOUT THE STIMULATOR USED:**

- **Why stimulate?**

Motivation for stimulation is it is faster and cheaper than prototyping a large number of design verify experimental results.

- **Steps for stimulation:**



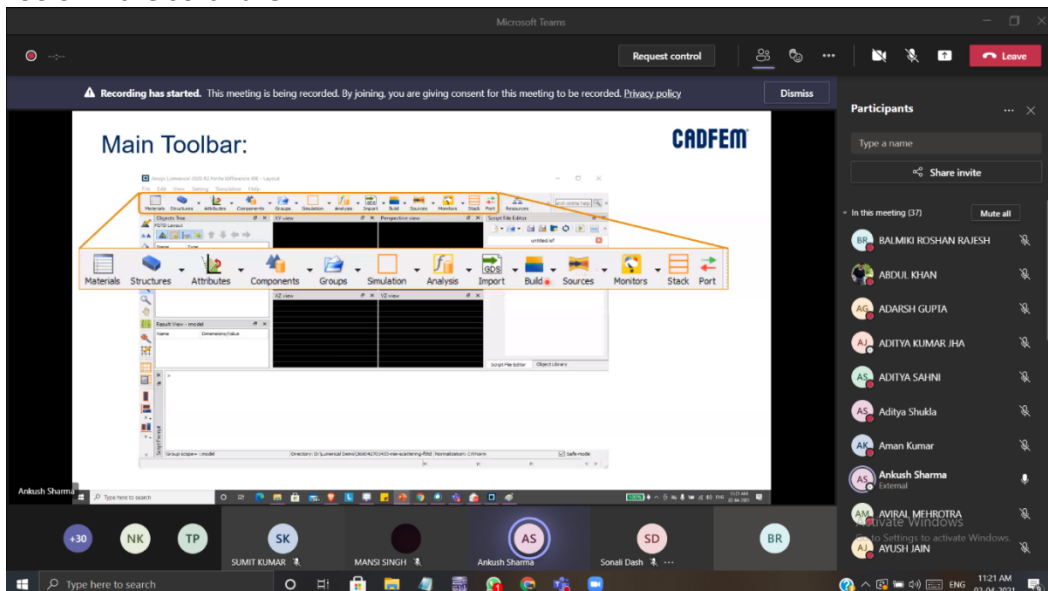
- **About the software:**

### Ansylumerical

Lumerical's tools enable the design of photonic components, circuits, and systems

Lumerical's DEVICE Suite of component-level simulation products use multiphysics-style simulation workflows to model optical, electrical and thermal effects at the physical level. Lumerical's SYSTEM Suite of system-level simulation products offer a rich set of analysis capabilities to design and optimize the performance of photonic integrated circuits

- **Tools in the software:**



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### Structures:

The screenshot shows the ANSYS LUMERICAL 2020 R2 Finite Difference IDE - Layout interface. On the left is a tool palette with options like Triangle, Rectangle, Polygon, Circle, Ring, Custom, Surface, Waveguide, Sphere, System, Planar Solid, 2D Rectangle, and 2D Polygon. The main workspace displays four 3D models: a circular lattice structure, a blue cylindrical waveguide, a blue rectangular block with a textured surface, and a white rectangular component with a blue internal feature.

Participants

- BALMIKI ROSHAN RAJESH
- ABDUL KHAN
- ADARSH GUPTA
- ADITYA KUMAR JHA
- ADITYA SAHNI
- Aditya Shukla
- Aman Kumar
- Ankush Sharma
- AVIRAL MEHROTRA
- AVUSH JAIN

11:22 AM 02-04-2021

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### Simulation and Mesh Override regions:

The screenshot shows the ANSYS LUMERICAL 2020 R2 Finite Difference IDE - Layout interface. The main workspace displays a 3D model of a circular structure with a mesh overlay. A specific region of the mesh is highlighted in orange, indicating a mesh override. The interface includes a menu bar with options like Materials, Structures, Attributes, Components, Groups, Simulation, Analysis, Import, Build, Sources, and Monitors.

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### Analysis Groups and Object Library:

The screenshot shows the ANSYS LUMERICAL 2020 R2 Finite Difference IDE - Layout interface. The main workspace displays a 3D model of a circular structure with a mesh overlay. An 'Object Library' window is open on the right, showing a list of objects with columns for Name, Type, and Date Modified. The objects listed are:

Name	Type	Date Modified
Optical journal	Optical journal	02-05-2020 04:08 PM
Cross section	Cross section	02-05-2020 04:08 PM
Power absorption	Power absorption	02-05-2020 04:08 PM
Power absorbed (balanced)	Power absorbed (balanced)	02-05-2020 04:08 PM
Power flow direction	Power flow direction	02-05-2020 04:08 PM
Transmission loss	Transmission loss	02-05-2020 04:08 PM

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11:27 AM 02-04-2021

### **OBJECTIVE OF THE WORKSHOP:**

- The main objective of this workshop was to learn a research-based topic called as photonic and gaining more knowledge about such an unexplored subject.
- To practice practical based on stimulator.
- Exploring wonderful opportunities for learning and internships.

### **CONCLUSION:**

- The workshop gave us a brief information about various aspects of photonics, as well as about the operation of the stimulator.
- In a book we only acquire theoretical knowledge but in actual the parametric implementation of the same can be grasped by using the stimulator.