Lab 6: Taper Design with Eigenmode Expansion (EME)

Objective:

Design a tapered edge coupler using EME.

Background:

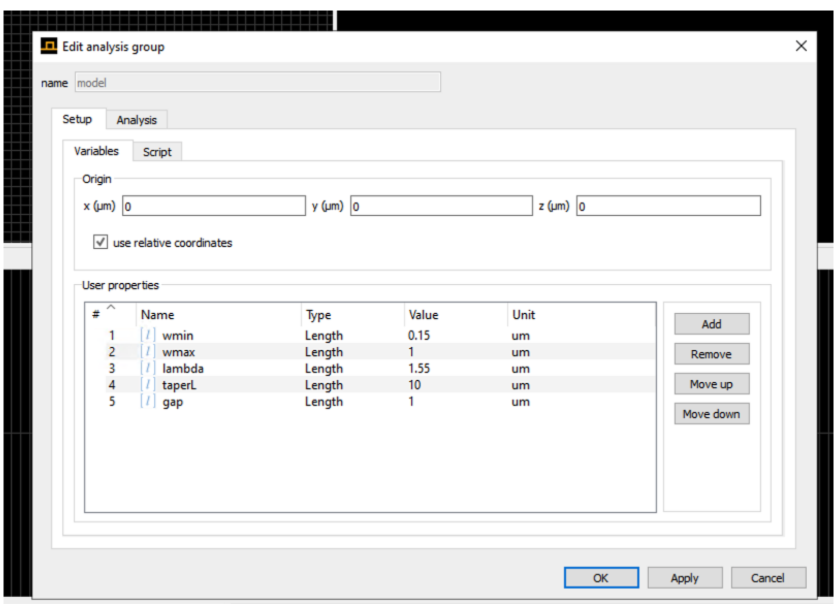
Lumerical Eigenmode Expansion (EME):
Lumerical EME is a software tool for computing the modes of waveguides and other structures. It expands the electric field distribution of a mode in terms of the eigenmodes of the waveguide or structure and computes the expansion coefficients using mode overlap integrals. EME can simulate the coupling between different eigenmodes and allows for the optimization of device designs.

Procedure:

Open MODE from the desktop shortcuts folder

1. Initialize simulation variables

Create four simulation variables: *wmin*, *wmax*, *taperL*, *lambda,* and *gap*. These will control the taper geometry, simulation wavelength, and the EME spacing.



2. Parameterize taper geometry

Create a Lumerical polygon based on the taper starting width, ending width, and length. Assume 220 nm SOI with symmetric top oxide.

```
selectall;
delete;

V = [-taperL/2, -wmin/2; -taperL/2 - 5e-6, -wmin/2; -taperL/2 - 5e-6, wmin/2;  -taperL/2, wmin/2; taperL/2, wmax/2; taperL/2 + 5e-6, wmax/2; taperL/2 + 5e-6, -wmax/2; taperL/2, -wmax/2];
addpoly;
set('name', 'taper');
set('vertices', V);
set('x', 0);
set('y', 0);
set('z', 0);
set('z span', 220e-9);
set('material', 'Si (Silicon) - Palik');
```

3. Define EME solver region

Create an EME solver with three groups. Make the groups span across the input waveguide, taper, and output waveguide respectively. Space the FDE cells by approx. one wavelength. Include two ports on the input and output of the component. Add a mesh.

```
emespan = 10e-6;
addeme;
set('background material', 'SiO2 (Glass) - Palik');
set('x min', -taperL/2 - 4e-6);
set('y min', -emespan/2);
set('y max', emespan/2);
set('z min', -2e-6);
set('z max', 2e-6);
set('z min bc', 'symmetric');
set('z max bc', 'metal');
set('wavelength', lambda);
set('number of modes for all cell groups', 4);
set('number of cell groups', 3);
set('cells', [floor((4e-6)/gap);floor((taperL)/gap);floor((4e-6)/gap)]);
set('group spans', [4e-6; taperL; 4e-6]);
set("subcell method",[1; 1; 1]);
set('display cells', true);

select("EME::Ports::port_1");
set('port location', 'left');
set('y min', -emespan/2);
set('y max', emespan/2);
set('z min', -2e-6);
set('z max', 2e-6);
set('x', -taperL/2-4e-6);
set('mode selection', 'fundamental TE mode');

select("EME::Ports::port_2");
set('port location', 'right');
set('y min', -emespan/2);
set('y max', emespan/2);
set('z min', -2e-6);
set('z max', 2e-6);
set('x', taperL/2+4e-6);
```

```
set('mode selection', 'fundamental TE mode');

dr = 50e-9;
addmesh;
set('x max', taperL/2 + 4e-6);
set('x min', -taperL/2 - 4e-6);
set('y', 0);
set('y span', emespan);
set('z', 0);
set('dx', dr);
set('dy', dr);
set('dz', dr);
```

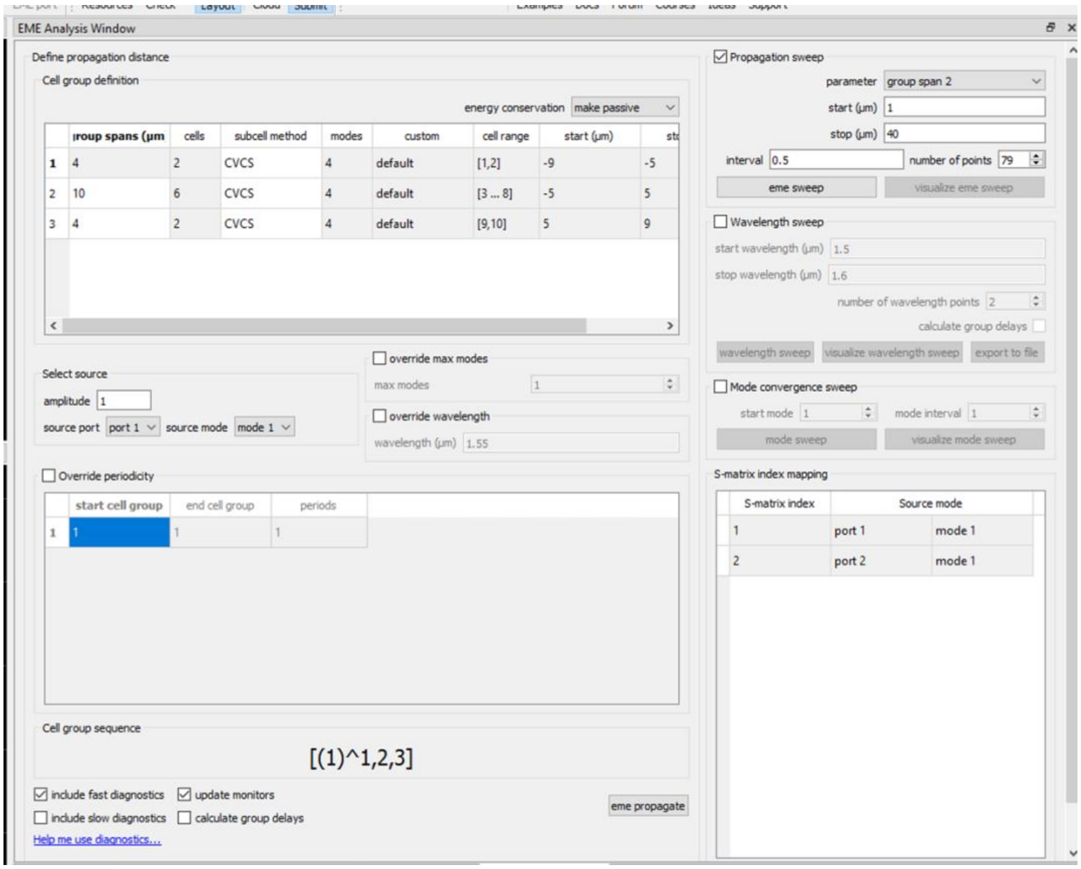
4. Add field monitor

Add a field monitor to span the length of the taper.

```
addemeprofile;
set('name', 'profile');
set('x max', taperL/2 + 4e-6);
set('x min', -taperL/2 - 4e-6);
set('y', 0);
set('y span', emespan);
set('z', 0);
```

5. Run solver and perform propagation sweep

Switch to the EME Analysis Window. Click *eme propagate*



6. Run convergence tests to verify simulation accuracy

Many variables contribute to the accuracy of the simulation. Vary the number of FDE cells, length of the initial taper, mesh size, etc.