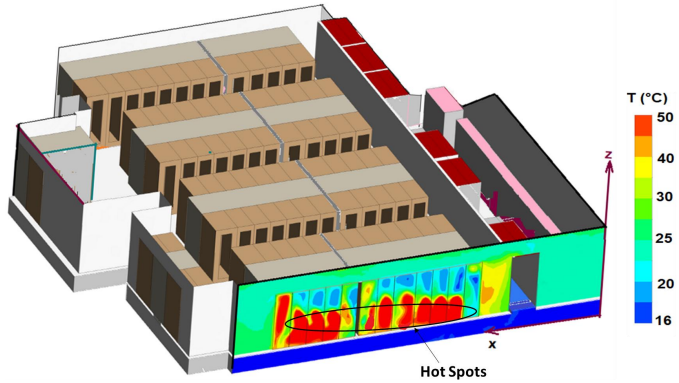
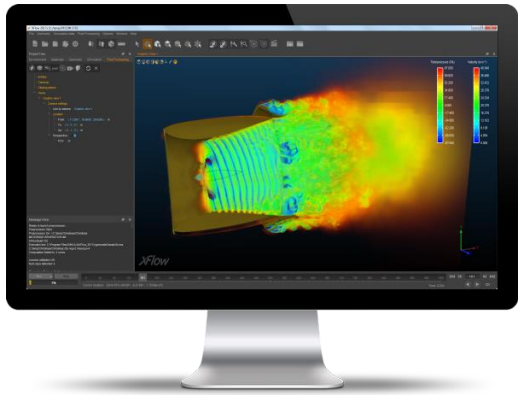
Applications of CFD

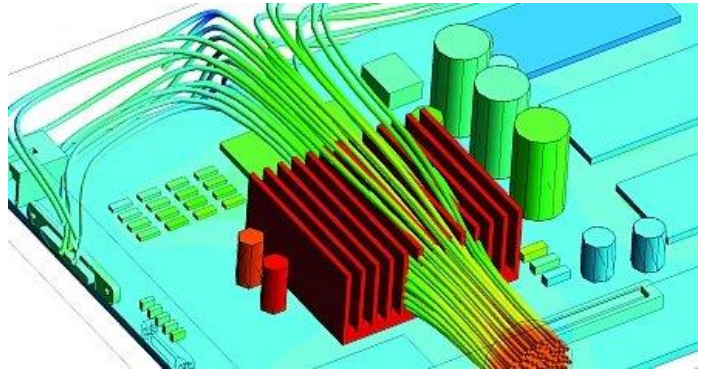
CFD Modeling Course- HVAC and Data Centre Modeling

- ✓ Syllabus
- ✓ Industrial Applications
- ✓ HAVC, Data Centre Modeling





Virtual Experiment



by

Dr. Sharad Pachpute

Design a New Product with Best Performance and Confidence

Part 1-CFD Online Courses: :Lectures

1. Basic fluid mechanics
2. Turbulent flow and its Modelling
3. Basic of CFD Modelling
4. Basic Heat Transfer and its modelling
5. Mass Transfer and Its Modelling
6. **Heating and ventilation, introduction to ASHRAE Handbook**
7. **Pressure drop calculation and duct design for AC ducting**
8. **PCB and Electronic Parts and Its CFD Modelling**
9. **Basic of Data Centre, Components: Cooling Methods**
10. **CFD Modelling of Data Centre**

Note:

- All Video lectures will be shared for all registered participants
- After lectures, additional e-books, case studies will be shared

Part 2: CFD Online Courses: List of Tutorials

❑ List of CFD Tutorials and Assignments

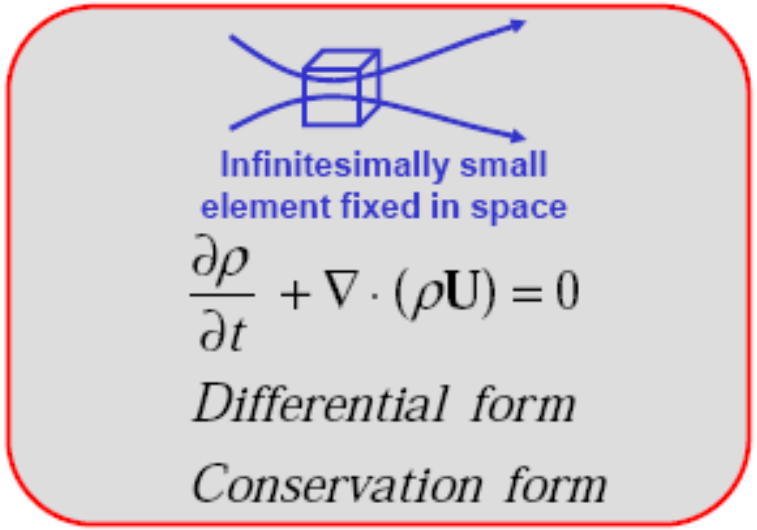
- Flow Through a pipe and duct optimization
- Flow over an obstacle, valve, car or aeroplane
- 7 Tutorials on Heat Transfer : Heating and ventilation, heat exchanger, Chips cooling
- Species Transport:
- Data Centre Modelling: Single Rack
- Data Centre Modelling: Multiple Racks
- Electronics Cooling PCB Modelling : two tutorials

Note:

- Practice all **Tutorials** and **assignment** after watching video lectures and studying relevant topics
- All **Video Tutorials** for geometry, meshing and Case set up in ANSYS FLUENT will be shared for all registered participants
- Additional **10 Tutorials and Notes of FLUENT** will be given

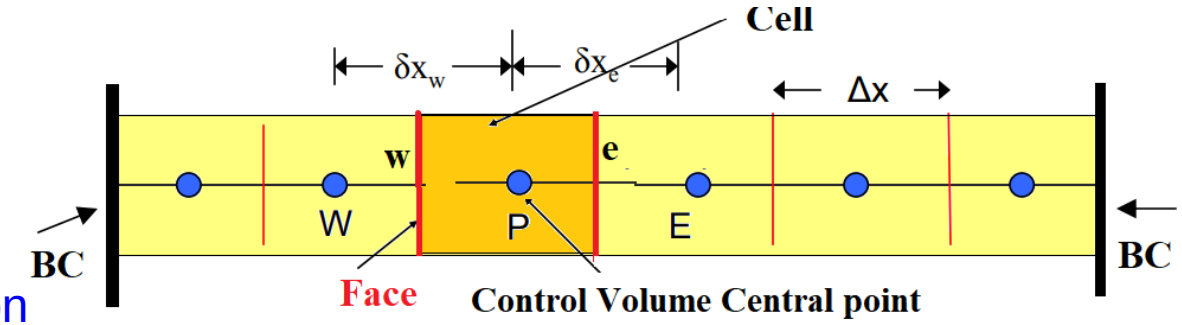
Lecture 1: Essential of Fluid Mechanics

1. Introduction and Application of Fluid Flows
2. Field theory: Tensor algebra, Scalar, Vector, 2nd order tensor
3. Hydrostatics
4. Classification of Fluid Flows
5. Navier Stokes equation for Newtonian fluids
6. Forces Acting on Fluid Flows
7. MHD Flow
8. Compressible Flow
9. Boundary layer theory
10. Laminar vs Turbulent Flow



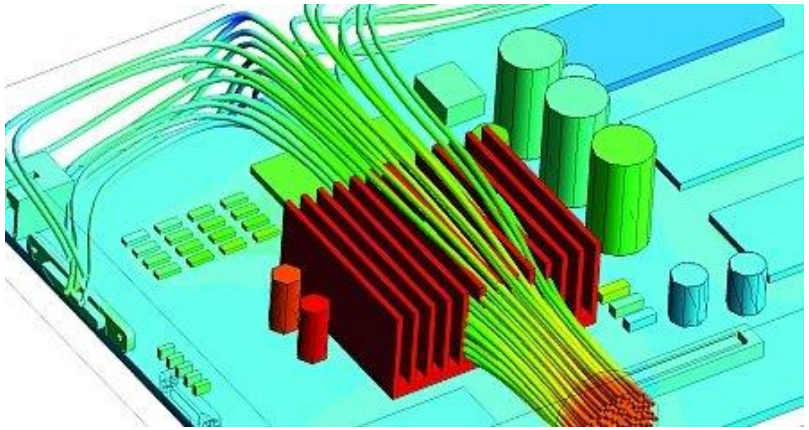
Lecture 2: Basics of CFD

1. Modeling and Simulation
2. Classification of Flow
3. Governing Equations
4. Numerical Simulation: Geometry, Meshing and Simulation
5. Introduction Discretization Method- FVM/FDM/FEM, Pressure –Velocity Coupling
6. Case studies of CFD analysis
7. CFD soft wares and resources
8. Structure of OpenFOAM



Lecture 3: Turbulence and its Modelling

1. **Physics of Turbulent Flow**
2. **Scales of Turbulent Flow**
3. **Methods of Turbulent Flow Investigations**
4. **Experimental methods** : (i) Dual Beam LDV , (ii) PIV, (iii) hot wire anemometer (HWA)
5. **CFD of Turbulent flow:** RANS, DES/LES, DNS
6. **Comparison of RANS, LES, DNS**
7. **RANS Modeling**
8. **Types RANS Models**
9. **Turbulent Boundary Layer**

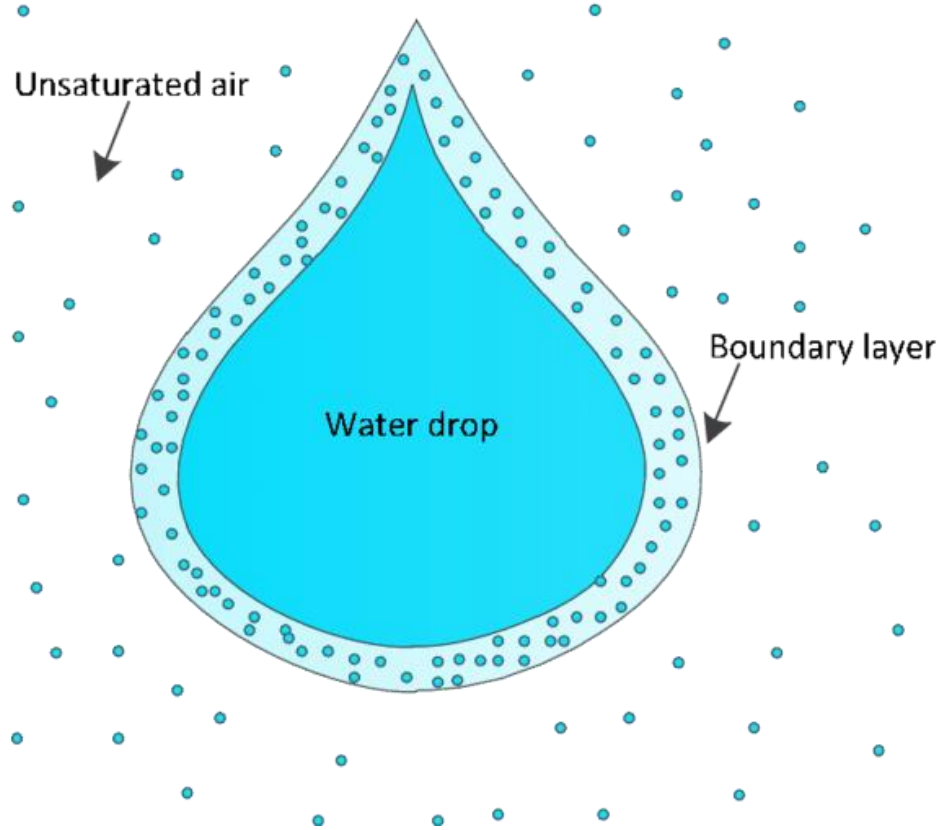


Lecture 4: Heat Transfer and its Modelling

1. **Introduction**: Application of heat transfer
2. **Conduction Heat Transfer**
3. **Forced Convective Heat Transfer:** RANS equations for mass, momentum and energy, Computation of heat transfer coefficients and convective heat transfer rate, Case studies
4. **Modeling of Natural Convection:** RANS equations for natural convection, Computation of heat transfer coefficients and convective heat transfer rate, Case studies
5. **CFD Modeling of Thermal Boundary Layer**
6. **Mixed Convection**
7. **Radiative Heat Transfer and Its Modeling**

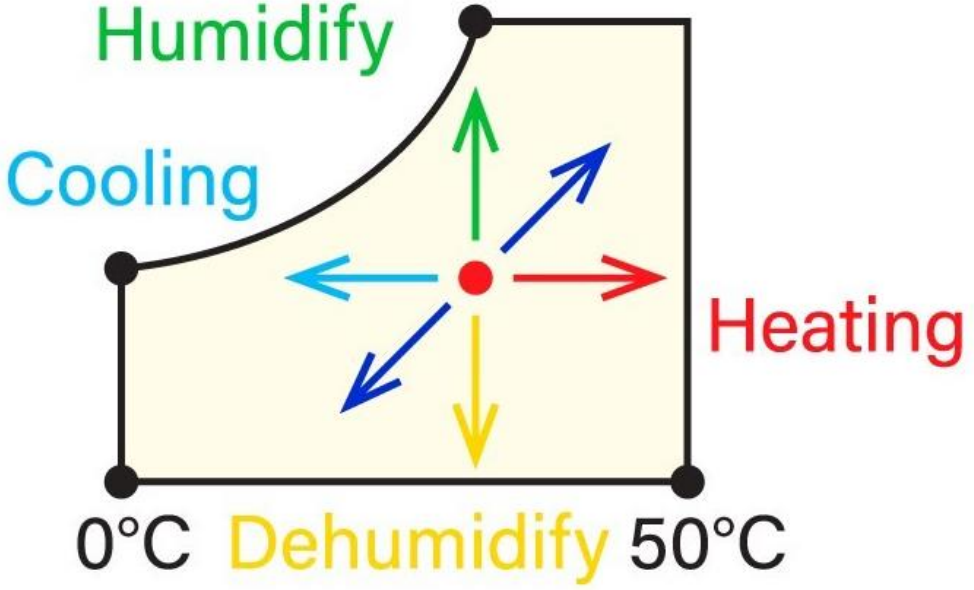
Lecture 5: Mass Transfer/Species Transport

1. Introduction of Mass Transfer
2. Laws of Mass Diffusion
3. Mass Diffusion for Gases
4. Convective Mass Transfer
5. Examples of Mass Transfers
6. Boundary Conditions
7. Industrial Case studies using CFD



Lecture :6 Basics of Air Conditioning

1. Thermodynamics View Air Conditioning
2. Basics of Air Conditioning
3. Air Conditioning Psychometrics
4. Basics of Operations
5. Components of Air Conditioning
6. AC Processes and Equations



First Law:

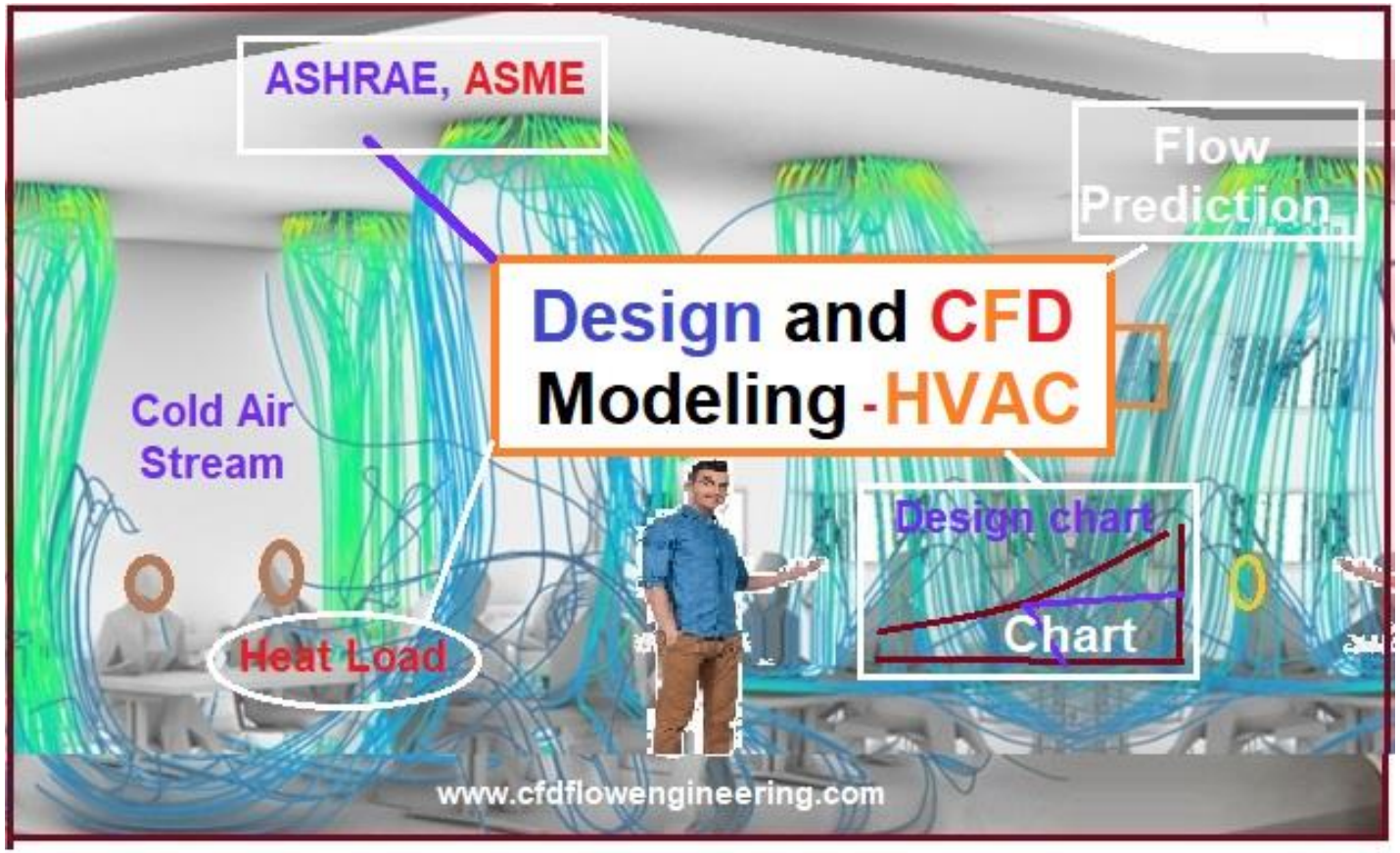
$$\dot{Q}_{IN} + \dot{W}_{IN} + \sum \dot{m}_i h_i = \dot{Q}_{OUT} + \dot{W}_{OUT} + \sum \dot{m}_e h_e$$

Enthalpy from Psychrometric Chart or:

$$h_i = h_{a_i} + w_i h_{v_i}$$

Lecture 6: HVAC Basics and Scope of CFD Modelling

1. Heating Ventilation and Air Conditioning
2. Key Subjects for HVAC
    - 2.1. Thermodynamics:
    - 2.2. Fluid Mechanics
    - 2.3. Heat and Mass Transfer
    - 2.4. ASME Standard
3. ASHRAE standard for HVAC
    - 3.1. ASHRAE for HVAC System
    - 3.2. ASHRAE Psychrometric Chart
    - 3.3. HVAC Design
    - 3.4. CFD Modeling
4. Advantages of CFD Modelings for HVAC
    - 4.1. Duct Design and Position of Vents and Diffusers
    - 4.2. Assessment of Airflow ad Efficiency HVAC
    - 4.3. Optimize Energy Consumption
    - 4.4. Flow Pattern, Velocity, and Temperature distribution
    - 4.5. Cost Saving
5. Applications of CFD Modelings in HVAC
    - 5.1. Ventilation and Air Distribution
    - 5.2. Thermal Comfort
    - 5.3. Energy Efficiency
    - 5.4. Indoor Air Quality
    - 5.5. Improved Performance
    - 5.6. Reduced Environmental Impact
    - 5.7. Enhanced Comfort and Health

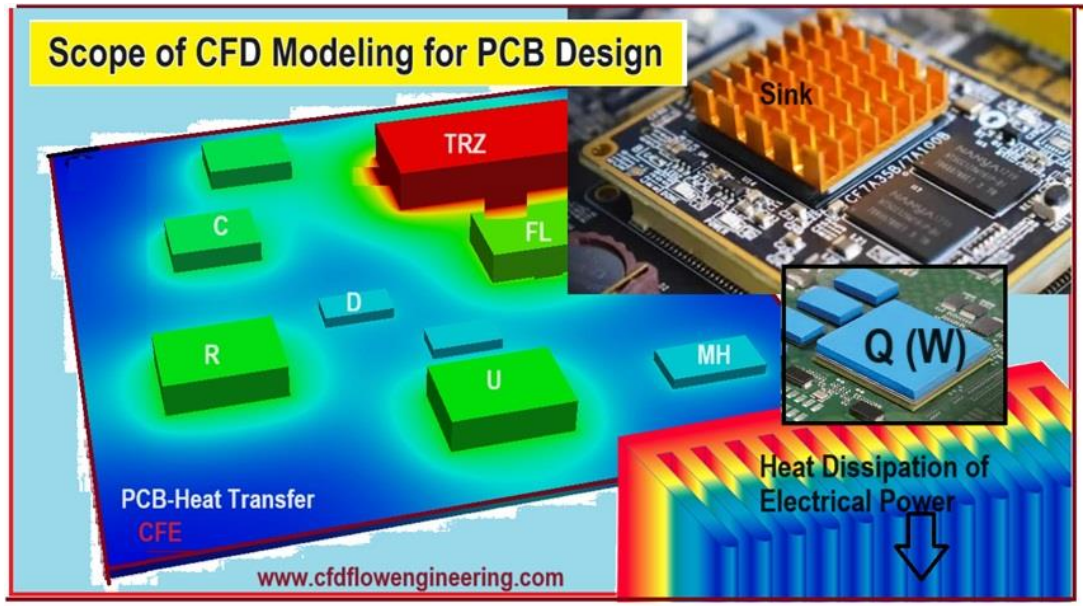


Lecture 7: HVAC Design and Selection

- Basics of HVAC
- Components of HAVAC
- Applications of HAVC
- Types of Ventilation Systems
- Controls of HAVC
- Selection of FANs
- How to Select AHU
- Pressure Drop calculation as per ASHRAE

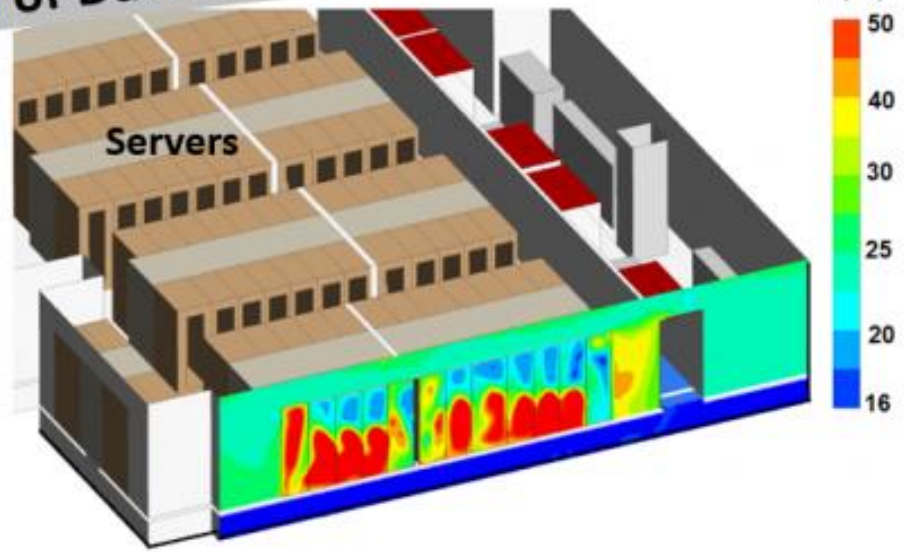
Lecture 8: PCB Cooling Tutorials

- **What is PCB?**
  - Key Parts of PCB
- **Heat Sinks of PCBs**
  - Purpose of PCB Sinks:
  - Types of Sinks
  - Attachment Methods:
  - Design Considerations:
  - Application Areas:
- **Role of CFD Analysis for PCB Design**
  - Heat Transfer Analysis:
  - Component Placement and Design Optimization:
  - Cooling System Design and Validation:
  - Thermal Management Strategies:
  - Prediction of Thermal Performance:
  - Failure Analysis and Reliability Assessment:
  - Environmental Impact Assessment:
- ***Heat Transfer Analysis of PCB***
  - Modeling the PCB Geometry:
  - Material Properties:
  - Heat Generation:
  - Analysis and Interpretation:
  - Validation:
- **Steps in CFD modeling of PCB**
  - Heat Transfer Simulation
  - Solver and Numerical Methods:
  - Post-Processing and Visualization:
  - Optimization:



CRAC

CFD Model of Data Centre

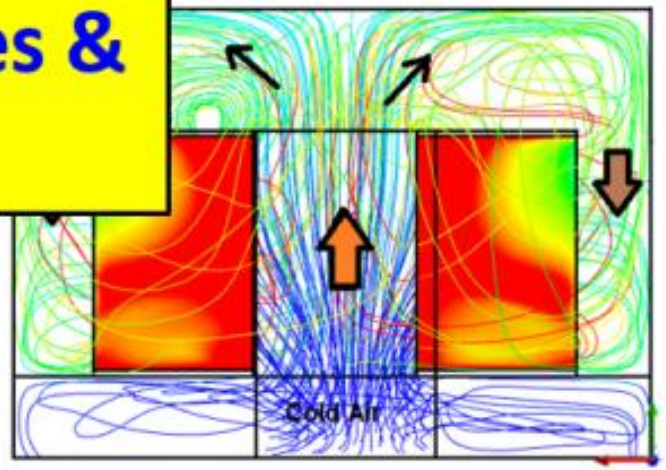


Data Centre Cooling Techniques & Scope of CFD Modelling

CFD Input Data

- ✓ Volume flow rate
- ✓ Supply Temperature
- ✓ Ambient Temperature:
- ✓ Number of PAC/CRAC Units
- ✓ Grill Size and opening area
- ✓ Heat Load for Racks
- ✓ Lighting Heat Load

CFD Model



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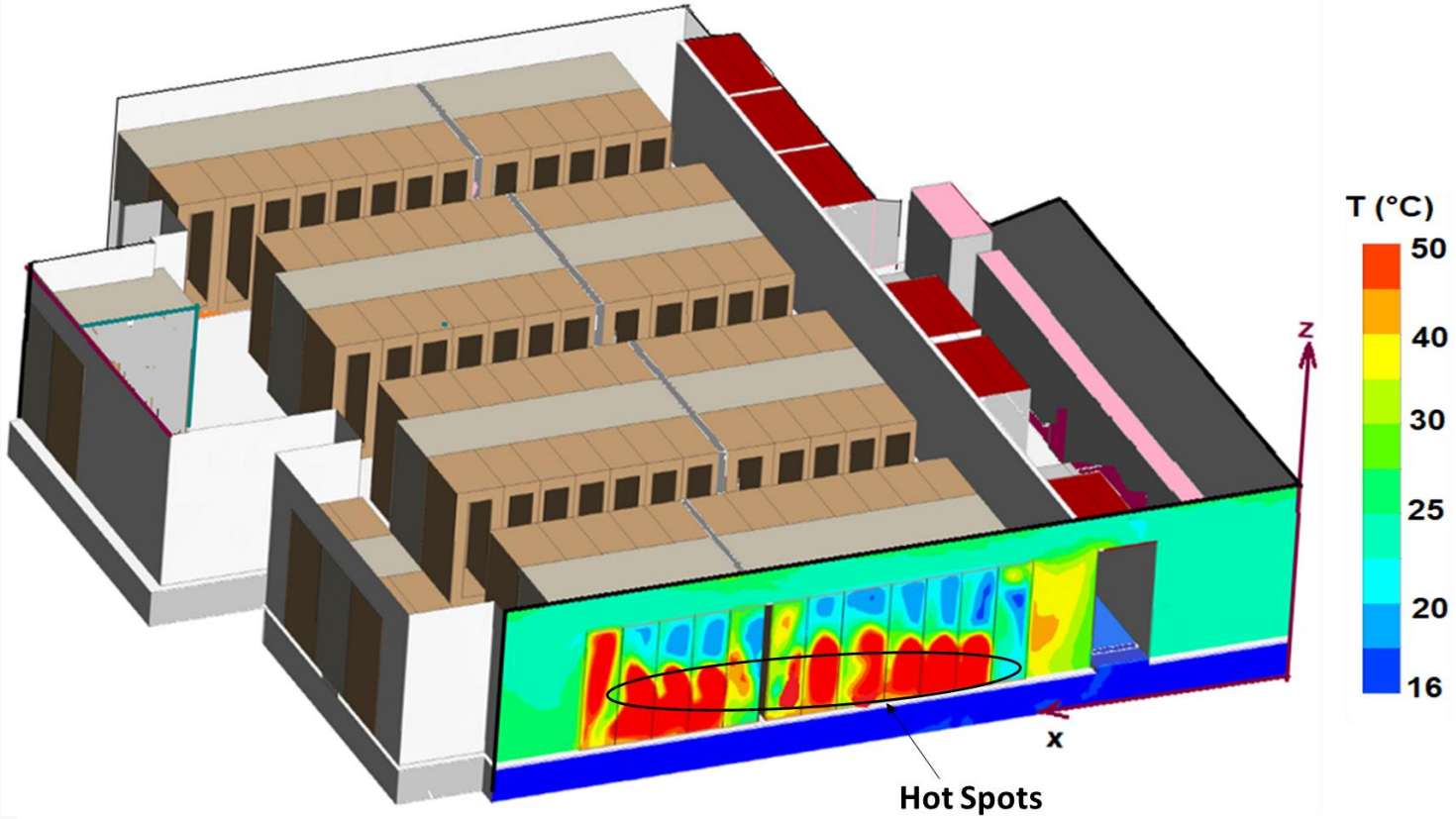
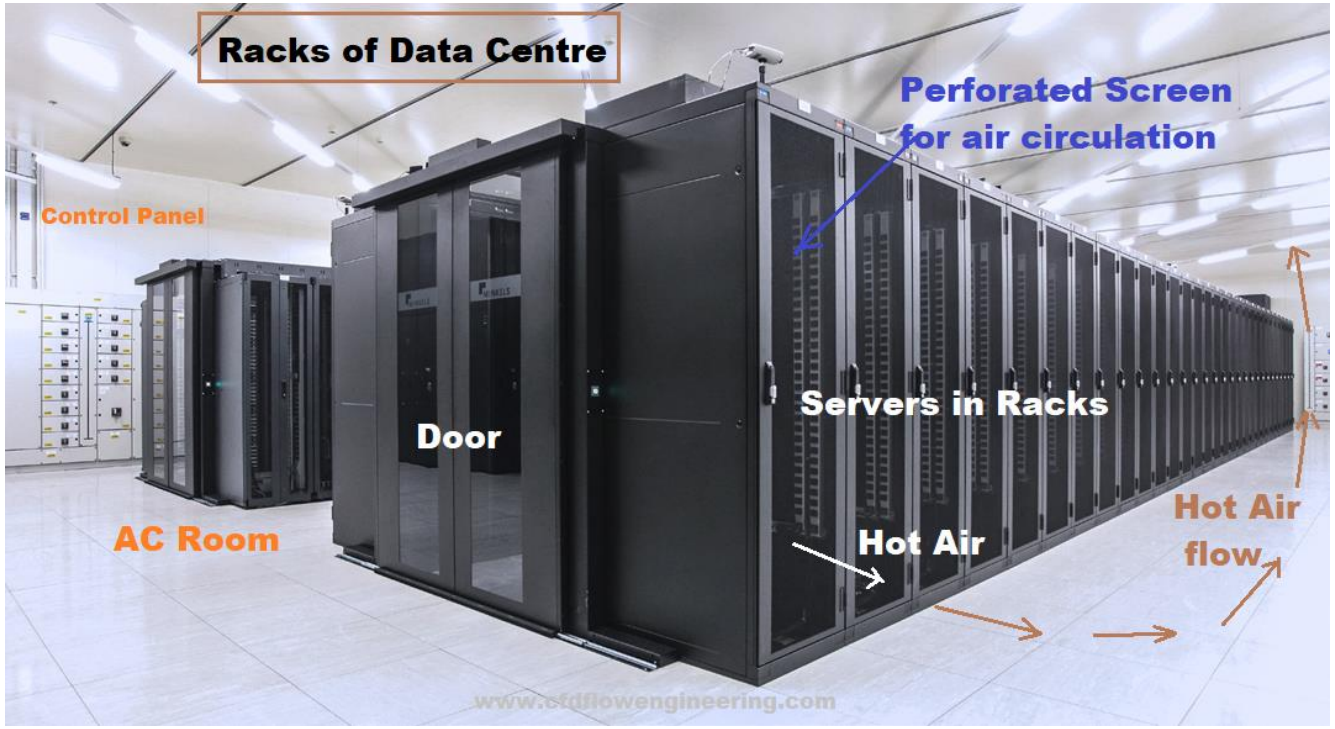
Lecture 9. Data Centre Modelling



10.Optimization of Data Centre

- Process calculation of Data centre
  - Pressure drop of PAS fans
  - Heat load of data centre
  - Sizing Rack
  - Filters and fans sizing
- Boundary conditions for CFD
- Selection PAC Units
- Design optimization of Centre based on CFD
- Case studies of Existing data centre



THANK YOU!

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