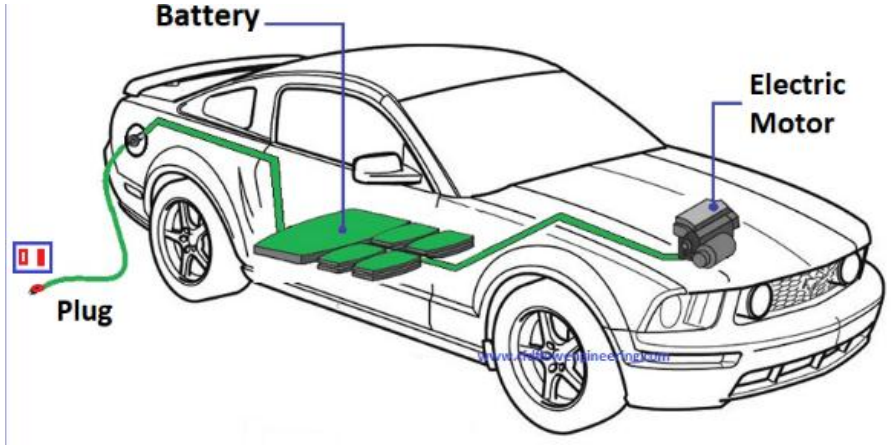
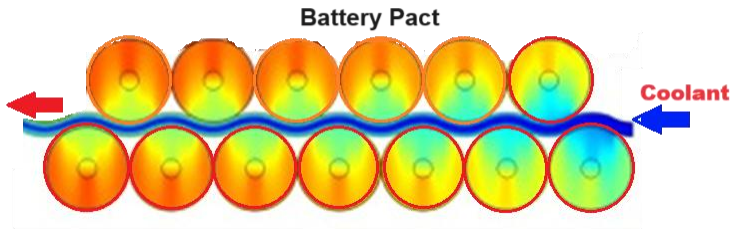
Course Introduction

# Basic of Battery, BTMS and CFD Modeling for EV







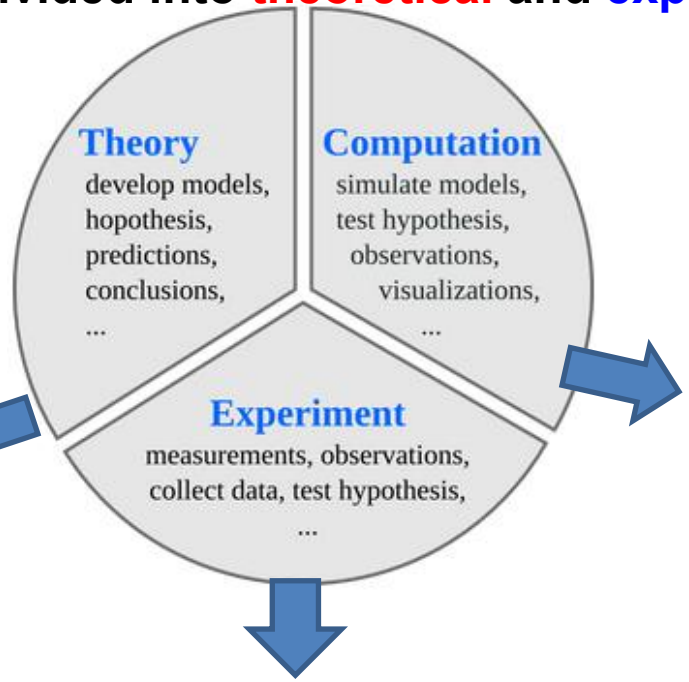

by

**Dr. Sharad Pachpute**
**CFD Flow Engineering**

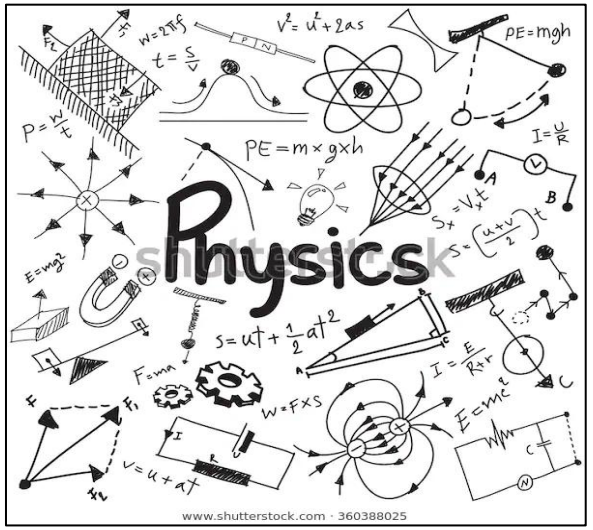
*Understating BTMS and its Modeling for Battery Safety*

# Scope of Modeling & Simulation

- Science has traditionally been divided into theoretical and experimental disciplines



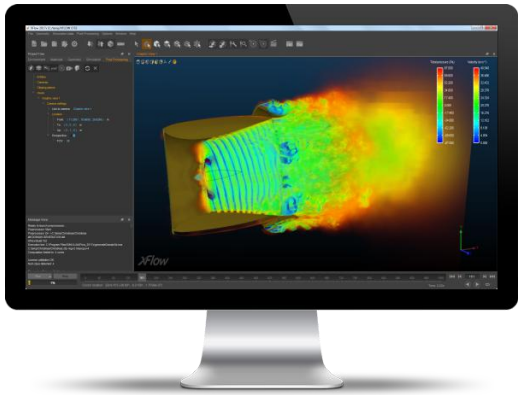

✓ **Theory : Science & Math**
✓ **Period : 1600-1900**




- **Theory is for Simple Problems**
- **Experiments are costly and risky for complex system**

✓ **Practical /Laboratory**
✓ **Period : 1800-2000**

✓ **Modeling & Simulation**
✓ **Based on Science, Math and computer science**
✓ **Period : 1950-2100+**



**Virtual Experiment**

***Futuristic Technology***

# Part 1-CFD Online Courses: :Lectures

## ❑ List of Lectures

1. Essentials of Fluid Flow for CFD Modeling
2. Basics of CFD Modelling
3. Turbulent Flow Modelling
4. Heat Transfer and its CFD modelling
5. Mass Transfer or Species Transport
6. Customization of CFD Solvers: ANSYS FLUENT UDFs
7. Basic of Battery and Electro-Chemistry
8. BTMS, Cooling Techniques and Battery Modeling
9. Design and Selection of Battery for Electric Vehicles
10. Causes of Fire and its Prevention Battery

**Note**:

- First 5 Lectures are important as strong engineering basic for BTMS Modelling and design
- All Video lectures will be shared for all registered participants
- After lectures, additional e-books, case studies will be shared

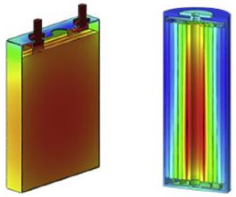
# BTMS and Battery Modelling

**Learn Online from Basic to Advanced Level**

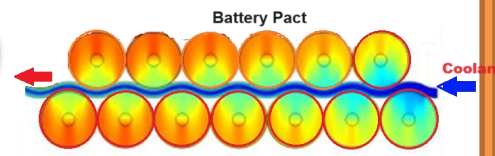
| Features | Cost for 7 months |
|---|---|
| • 10 Lectures<br>• 10 CFD Tutorials<br>• 10 Assignments<br>• Training materials<br>• CFD and Technical Support for 6 month<br>• Job assistance for interview | • **Rs 4500** for students<br>• **Rs. 6500** for Professionals<br>• Overseas (~USD 160) |

- **Refer the detailed syllabus on the website for all topics related CFD analysis**
- **6 Month Subscription**: You will get all the 10 recorded Video lecture & tutorials, Notes, 10 Problems in Assignment, ANSYS , Meshing using ANSYS tools, Additional 10 ANSYS FLUENT Tutorial etc.
- Online self-test to asses your subject knowledge
- **Online CFD support and jobs**: What's app, Google /Zoom meeting

Limited Seats

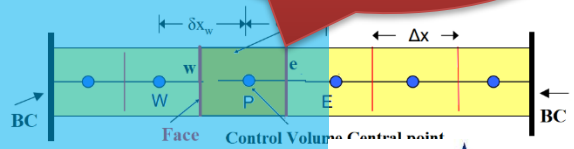


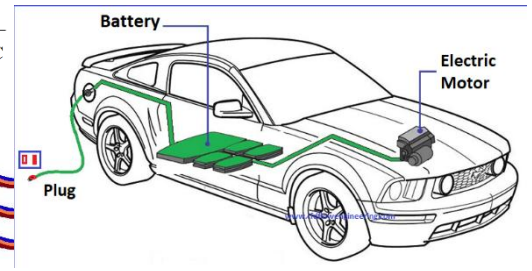
**Expand Your Opportunities**




**How Can Join:**

- ✓ You can attend a First demo lecture for Doubt clarifications
- ✓ Complete Online Course. You can join any time.
- ✓ Share your queries by email: cfdflowengineering@gmail.com
- ✓ Email to get the ***registration form***

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**CFD Flow Engineering**

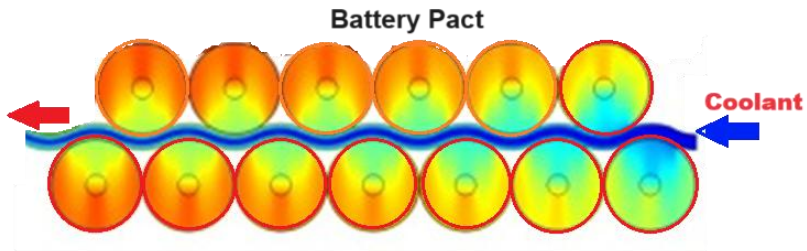
All about Flow Analysis | Technology

# Part 2: CFD Online Courses: List of Tutorials

1. Flow Through a pipe and duct Flow optimization
2. Flow over an obstacle, valve, car or aeroplane
3. Heat Transfer Tutorials : Heating and ventilation, Heat exchanger, Electronic cooling
4. Species Transport
5. CFD Modelling of Battery using PCM Techniques
6. Modelling of Battery Pacts with Liquid coolant
7. CFD Modelling of Battery with ECM Models – Cylindrical or Palm cells
8. Modelling of Battery with MSME Models – for Charging and discharging
9. Battery Pacts Cooling for EV
10. Modelling of Battery Fires and Thermal Runways
11. Additional ANSYS FLUENT tutorials for Battery Modelling

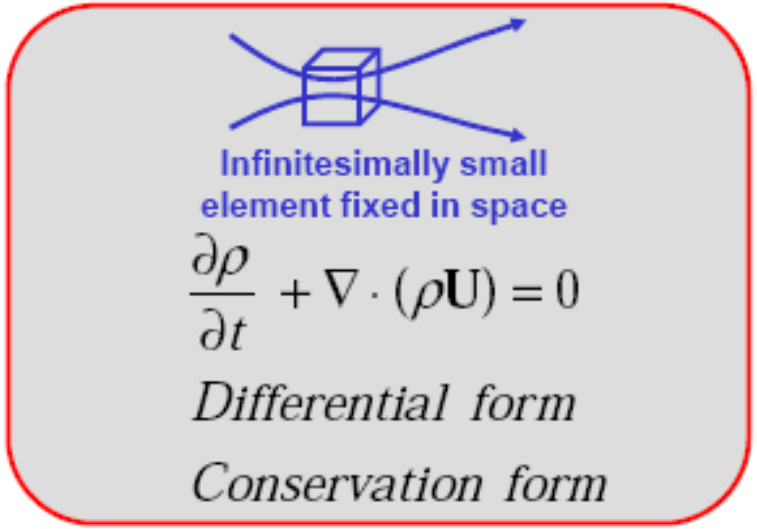
**Note**:

- 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
- Assignment similar to video tutorials will be given for practice
- Additional **10 Tutorials and Notes of FLUENT** will be given



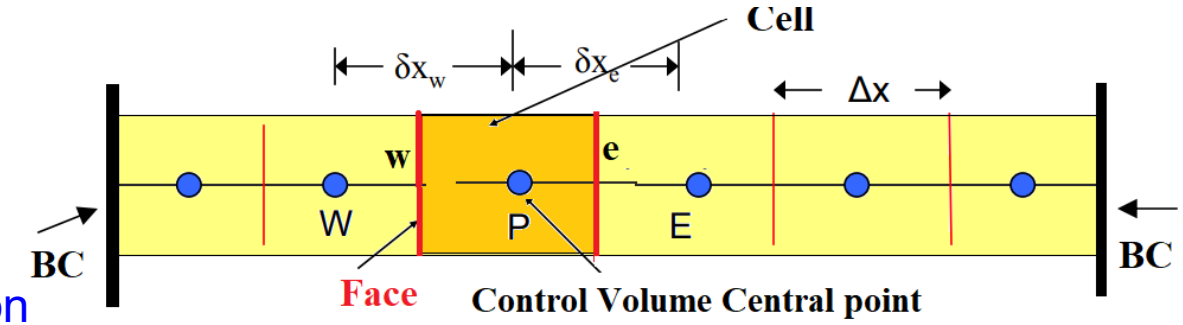
## Lecture 1: Essential of Fluid Mechanics

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

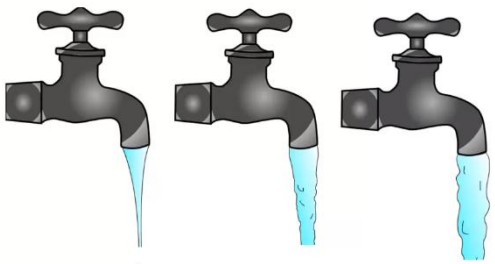



## Lecture 2: Basics of CFD

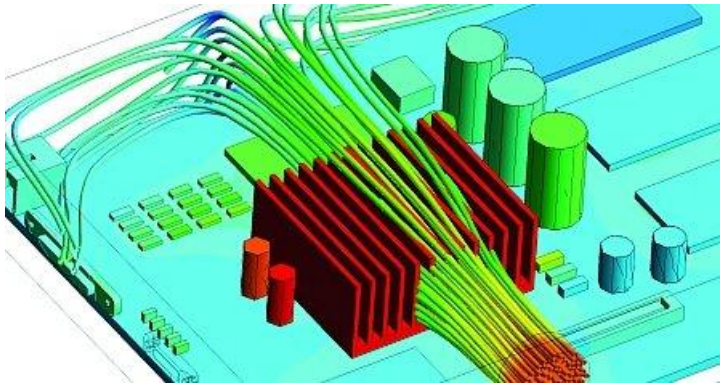
1. Modeling and Simulation
2. Classification of Flow
3. Governing Equations
4. Numerical Simulation: Geometry, Meshing and Simulation
5. Introduction Discretization Method- FVM/FDM/FEM, Pressure –Velocity Coupling
6. Case studies of CFD analysis
7. CFD soft wares and resources
8. Structure of OpenFOAM



# 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**

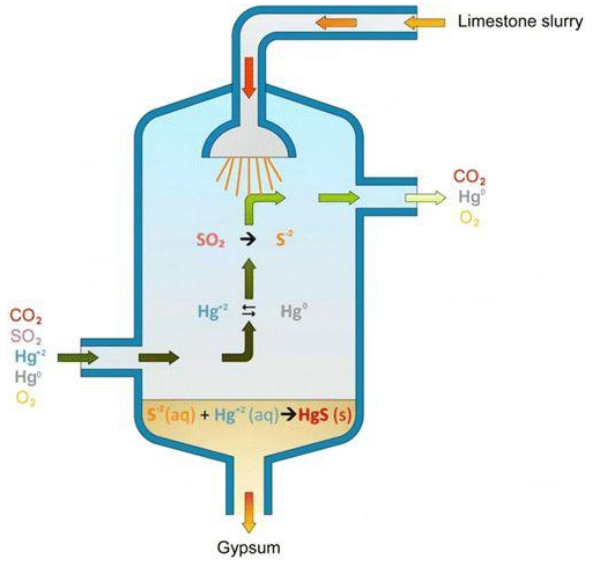


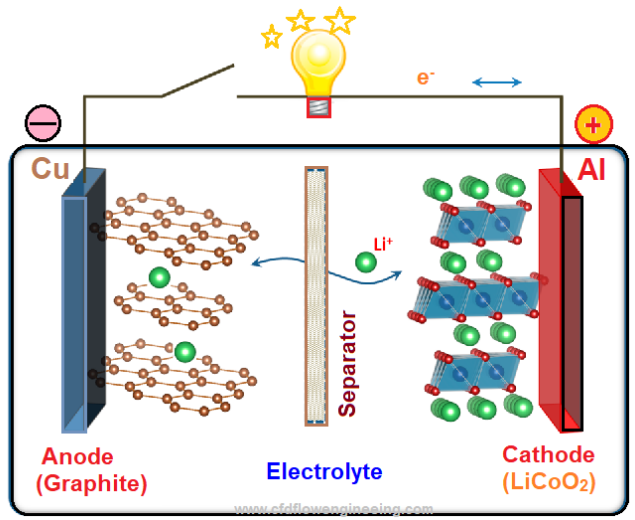
# Lecture 4: Heat Transfer and its Modelling

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



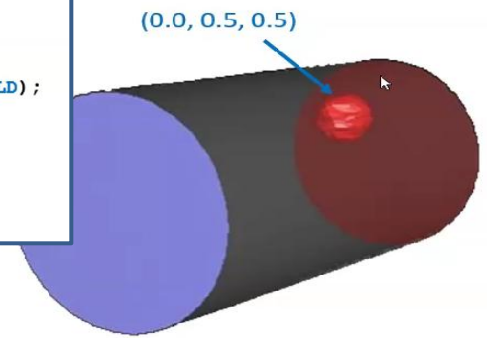




## Lecture 6: Customization of CFD Solver : FLUENT

1. Scope of Solver Customization
2. User Defined Functions in FLUENT: Data type, variable declaration
3. Types of UDFs in FLUENT
4. UDF for Velocity, temperature, Material Properties, Heat Flux and Heat Source etc.
5. Source code and application in FLUENT solver
6. Mathematical Expressions for Input

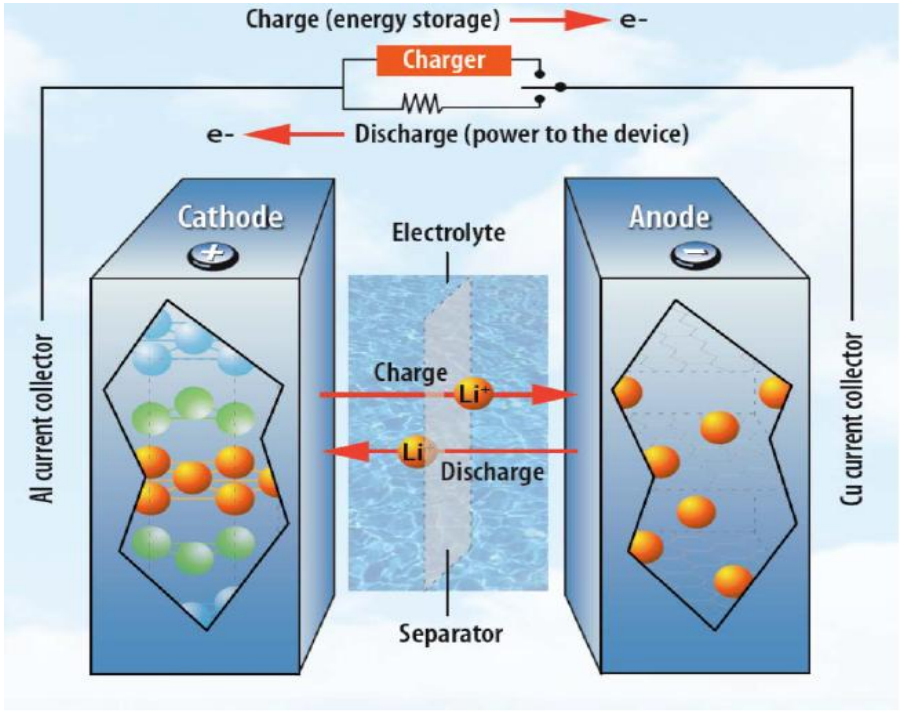
**UDF**

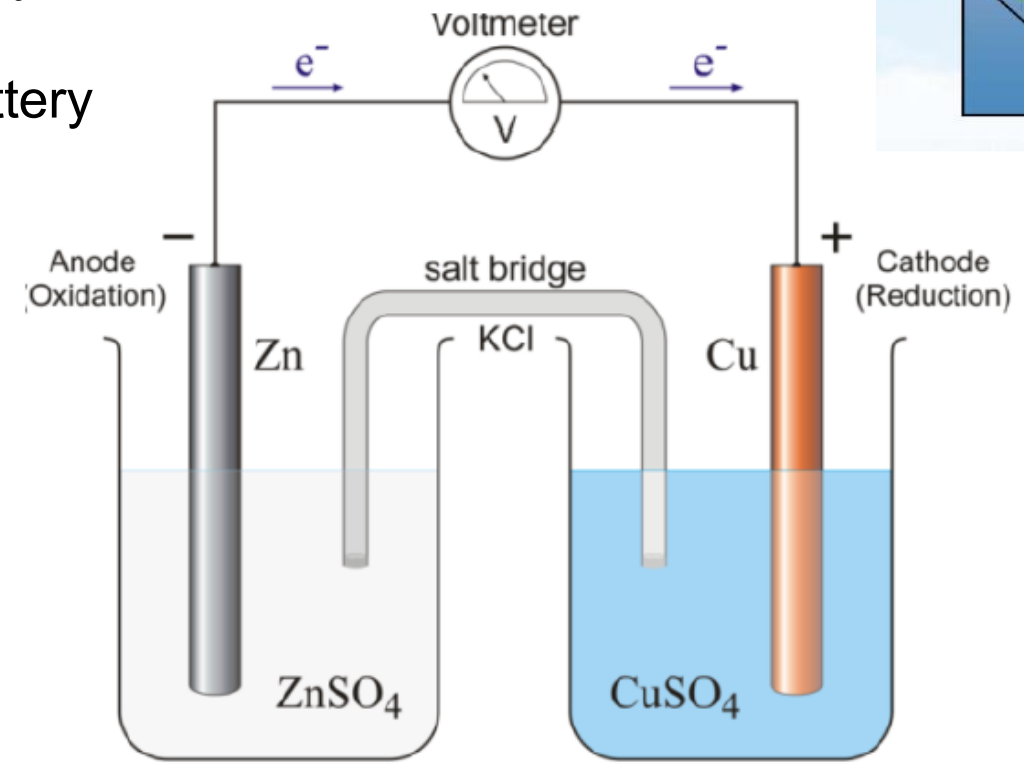
```
#include "udf.h"
#define T_HOT 288.0
#define T_COLD 286.0
#define MU_HOT 5.5e-5 /* Low viscosity when hot */
#define MU_COLD 1.0 /* High viscosity when cold */

DEFINE_PROPERTY(freezing_viscosity, c, ct)
{
  real temp, mu_laminar;

  temp = C_T(c,ct);

  if (temp > T_HOT)
     mu_laminar = MU_HOT;

  else if (temp > T_COLD)
     mu_laminar = MU_COLD + (temp - T_COLD)*
            (MU_HOT - MU_COLD)/(T_HOT - T_COLD);

  else /* temp <= T_COLD */
     mu_laminar = MU_COLD;

  return mu_laminar;
}
```



# Lecture 7: Basics of battery and Electro-Chemistry

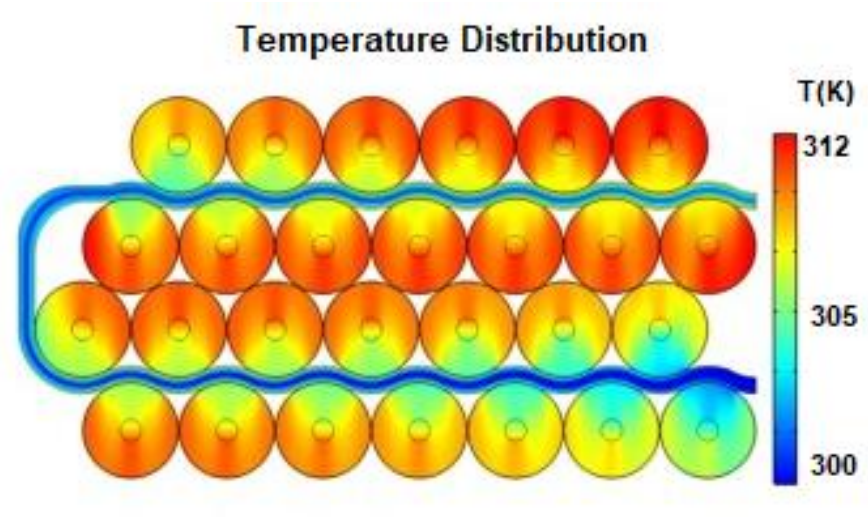
1. What is electrochemistry
2. What is voltage/charge/current in Cells
3. Electrolytic Cells
4. Basics of Lithium Ion Battery
5. Overall Battery Reactions
6. Components of Battery
7. Types of Battery
8. Requirements of a battery

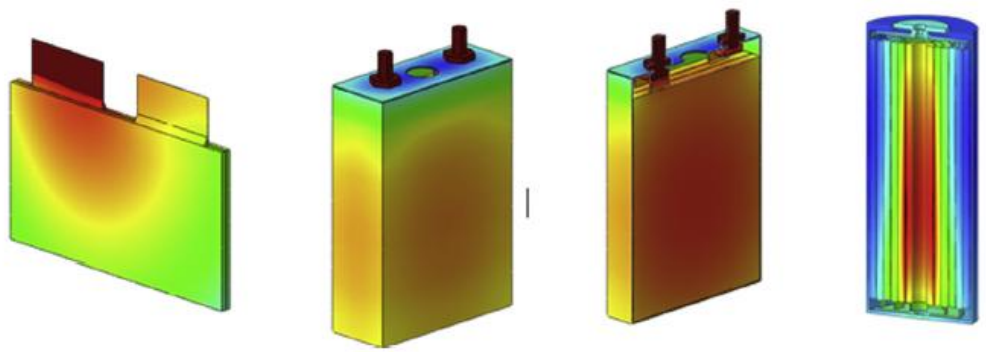


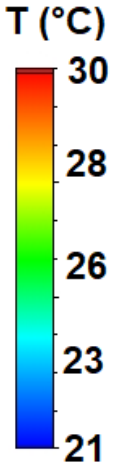



# Lecture 8: Battery Cooling and Thermal Management

- Components of Battery and EV
- Governing Equations
- Heat transfer from battery
- Chemical kinetics of reactions in Battery
- Modeling of heat transfer and chemical reaction for Battery
- Techniques for cooling in todays Electric vehicle
- Battery Thermal Management Mapping
- Selection of PCM Materials
- FLUENT UDF for PCM Properties
- CFD Modeling of Battery : MSMD, NTGK, Electro - chemistry

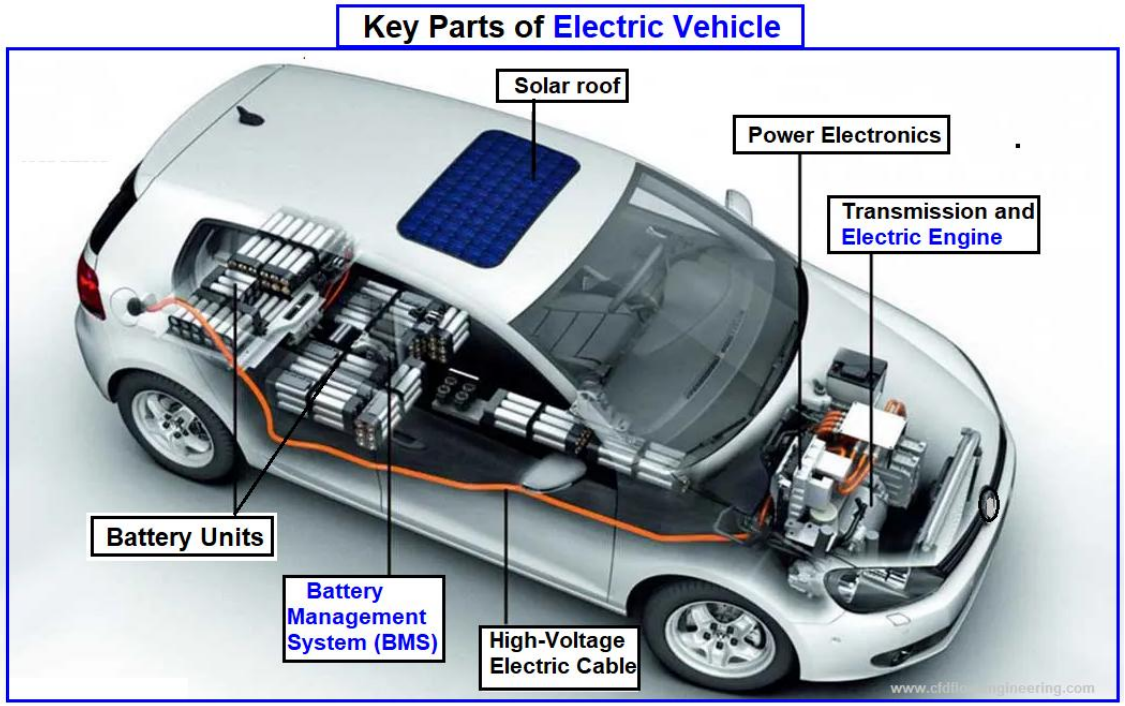


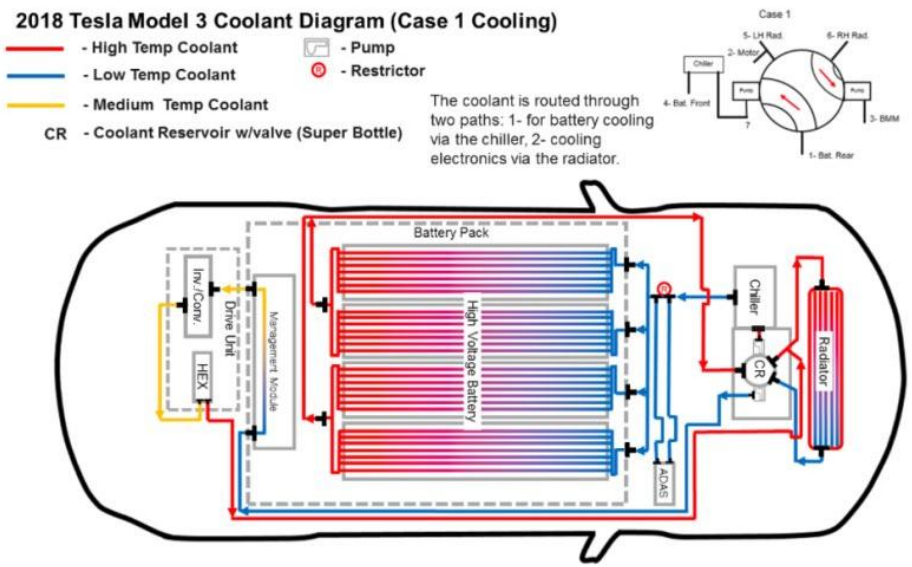





# Lecture 9: Design and Selection of Battery for EV

- Key Components of Electrical Vehicles
- Selection of Battery for EV
- Design Consideration of Battery Pact for EV
- Selection of BTMS for EV
- Challenges of Battery of Electric Vehicles



# Lecture 10: Cause of Fires and Its Prevention in Battery

- Major Causes of Fires in Battery
- Thermal runways: cause and prevention
- Methods for Safe Charging and Discharging of Battery
- Sources of Fire and Propagations in Electrical Vehicles
- Scope of BTMS for Prevention of Fires: Advantages and disadvantages of BTMS
- Modelling of Thermal runway or Fires in Battery

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# CFD Flow Engineering


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