

**ONLINE FACULTY DEVELOPMENT PROGRAMME**

*on*

**"MATHEMATICAL MODELLING AND CONTROLLER DESIGN FOR NON-LINEAR PROCESS"**

**(OCTOBER 11<sup>th</sup> -15<sup>th</sup>, 2021)**

*Sponsored by*

**AICTE TRAINING AND LEARNING (ATAL) ACADEMY**

AICTE Training and Learning (ATAL) Academy sponsored online Faculty Development Programme (FDP) on "**Mathematical Modelling and Controller Design For Non-Linear Process**" was organized by Department of Electrical and Electronics Engineering, Sree Vidyanikethan Engineering College (Autonomous), Tirupati, Andhra Pradesh, India during October 11<sup>th</sup> -15<sup>th</sup>, 2021. An amount of Rs. 93000.00 (Rupees Ninety Three Thousands only) was sanctioned to **Dr. A. Yasmine Begum** on September 21, 2021 (F. No.: AICTE-SCRO/ATAL/2020-21/243) for organizing the FDP.

The online FDP was conducted using the Google meet conference. A total of 187 participants were applied for this FDP, out of which 124 participants were successfully completed this training program. The participants are the faculty and research scholars of various Engineering colleges and Government institutions across the country. Further, the participants have been trained by the eminent resource persons from IIT's, NIT's, Research institutes, State universities and Industry experts from Brain Child Electronics and Pantech Solutions. The experts conducted hands-on based training virtually on diverse aspects of modeling of various non-linear process using MATLAB. The FDP has received an overwhelming response from the participants. A total of 14 sessions were conducted. Out of 14 sessions, 13 were "**Technical sessions**" and one was on "**Stress Management**" conducted by Art of Living Bangalore to promote the FIT INDIA movement across the country.

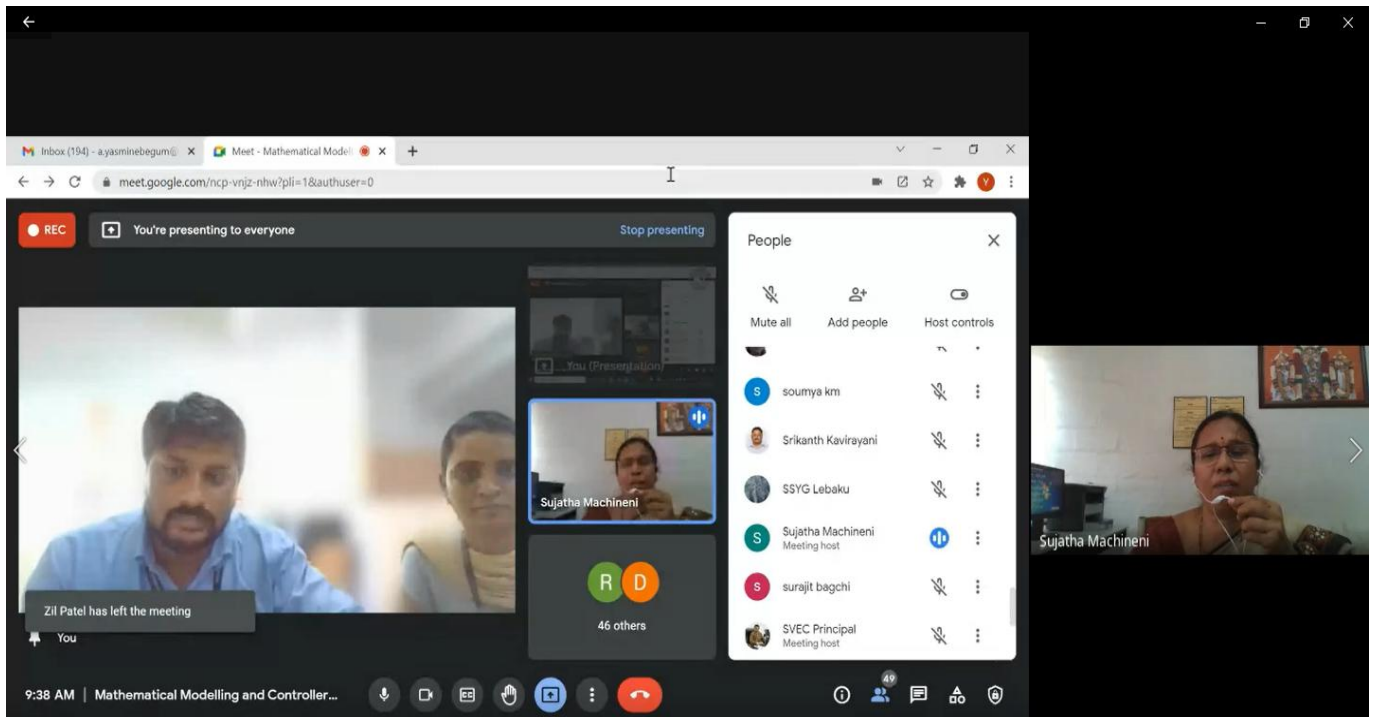
The main objective of the FDP is to provide insights and hands-on training for faculty on Mathematical Modelling and controller Design for various Non-Linear Process using MATLAB. Mathematical models are routinely used in the physical and engineering sciences to help understand complex systems and optimize industrial processes. The outcomes of FDP are as follows:

- ❖ Gain knowledge on Mathematical Modelling of various non-linear Processes.
- ❖ Design controllers for various non-linear Processes.
- ❖ Train students by conducting hands-on sessions on Mathematical Modelling and controller design using MATLAB and make the students industry ready.

The inaugural function of this online FDP was conducted on October 11<sup>th</sup>, 2021 at 9:30 AM.

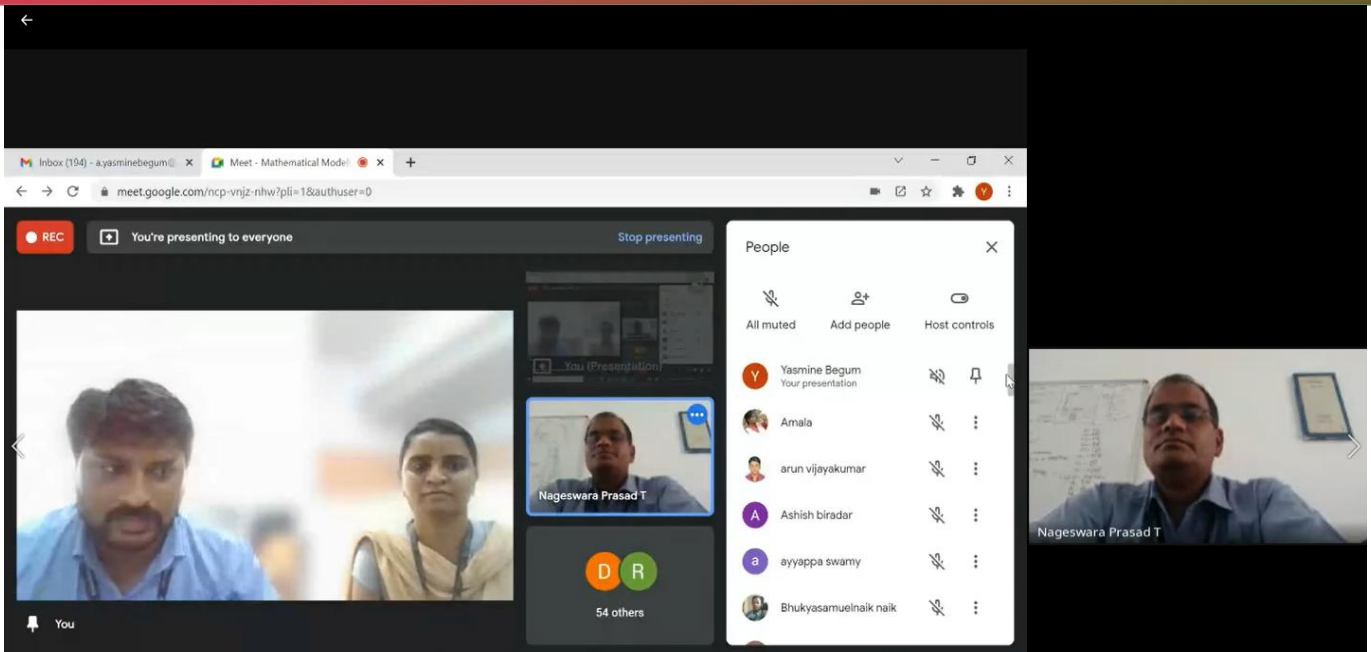
**Dr. A. Yasmine Begum**, Associate Professor of EEE & Coordinator of this program has given the welcome speech. The coordinator welcomed the chief guest **Mr. Kirk Daniel Svensen, OFS Manager-Sales, Marketing & Service Delivery, National Petroleum Services Company (K.S.C.P.) Kuwait**, **Dr. B. M. Satish, Principal, SVEC**, **Dr. T. Nageswara Prasad, Vice-Principal, SVEC**, **Dr. M. S. Sujatha, Convener & HoD, Department of EEE**, and all the **participants** to the online FDP and she expressed her gratitude towards the ATAL academy for sponsoring the FDP. The event was started with a prayer song.

**Dr. M. S Sujatha**, Professor & Head, Department of Electrical and Electronics Engineering welcomed the participants and highlighted the importance of Mathematical Modelling in various interdisciplinary fields.



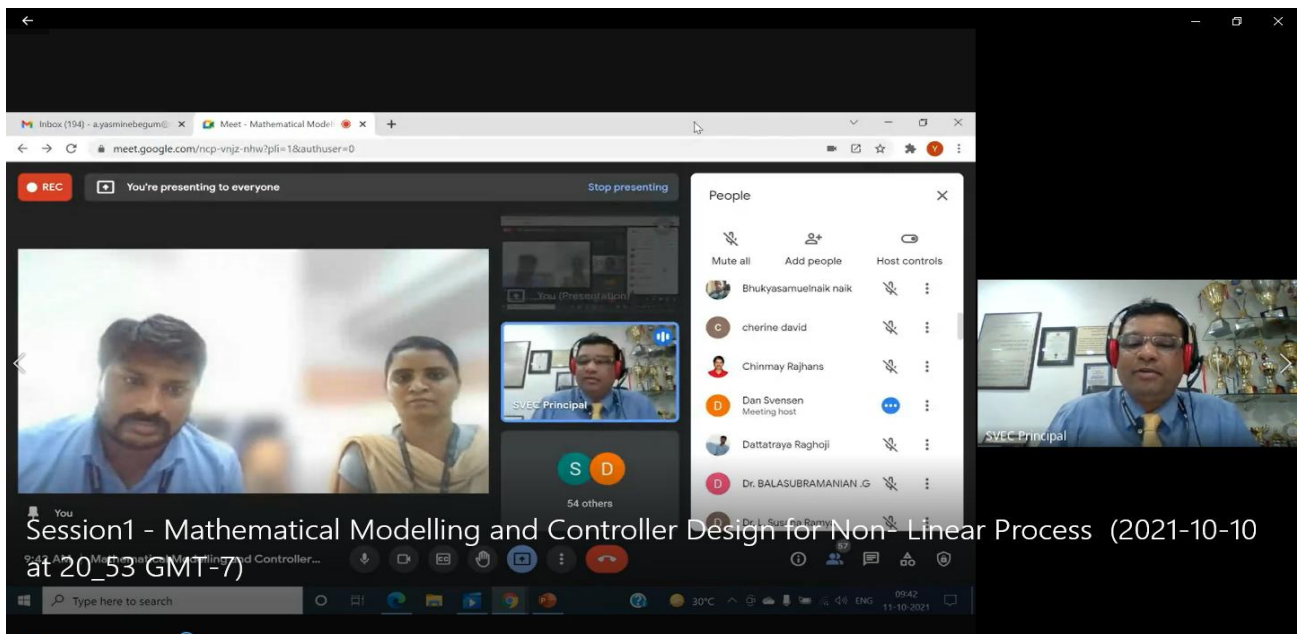
**Dr. M. S. Sujatha**, Convener & HoD of EEE welcoming the chief guest and the participants.

**Dr. T.Nageswara Prasad, Vice-Principal**, Sree Vidyanikethan Engineering College, addressed the participants about the Modelling of Linear and Non-Linear Systems and its applications.

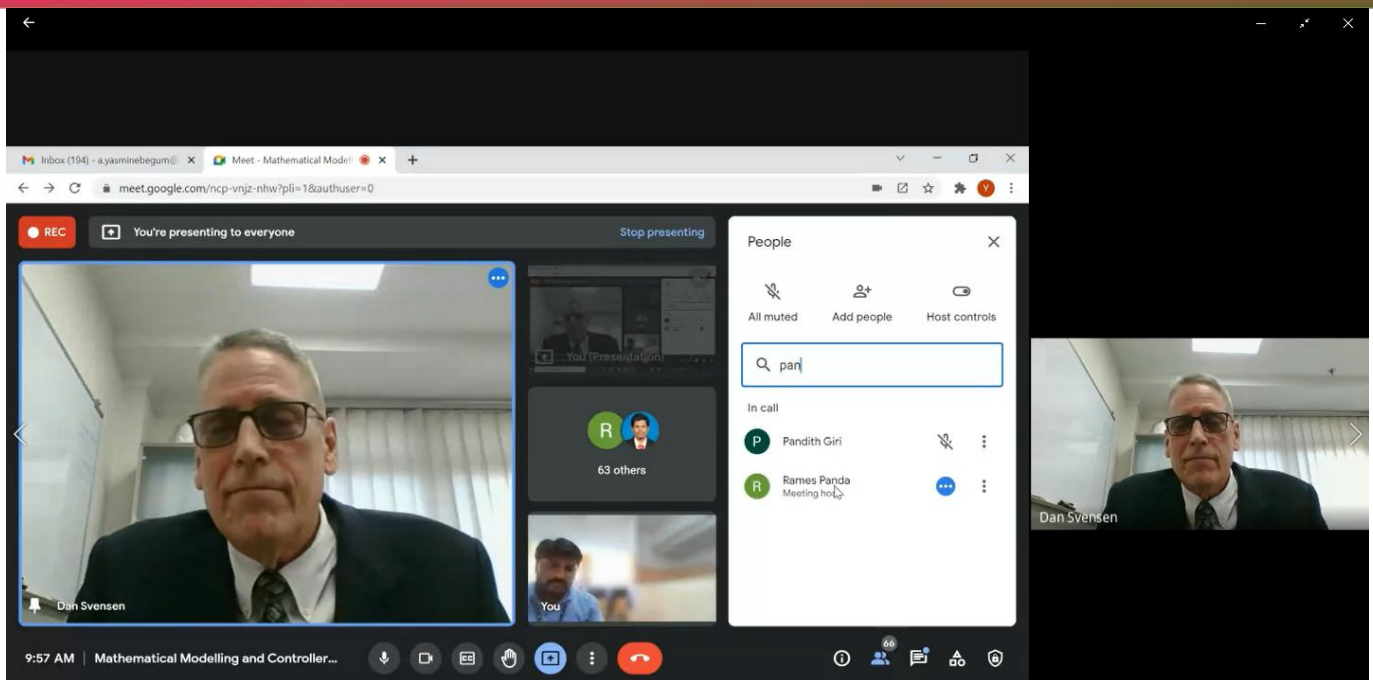


**Dr. T. Nageswara Prasad**, Vice-Principal, Sree Vidyanikethan Engineering College is addressing the participants

**Dr.B.M Sathish**, Principal, Sree Vidyanikethan Engineering College, addressed the participants about ATAL platform to learn the emerging trends in industry. Later, Dr.A.Yasmine begum, Associate Professor, Department of Electrical and Electronics Engineering introduced the chief guest **Mr. Kirk Daniel Svensen, OFS Manager-Sales, Marketing & Service Delivery, National Petroleum Services Company (K.S.C.P.) Kuwait**, to the participants.



**Dr. B.M. Satish**, Principal, Sree Vidyanikethan Engineering College is addressing the participants



**Mr. Kirk Daniel Svensen**, OFS Manager-Sales, Marketing & Service Delivery, National Petroleum Services Company(K.S.C.P.) Kuwait is addressing the participants

**The schedule of the workshop was as below:**

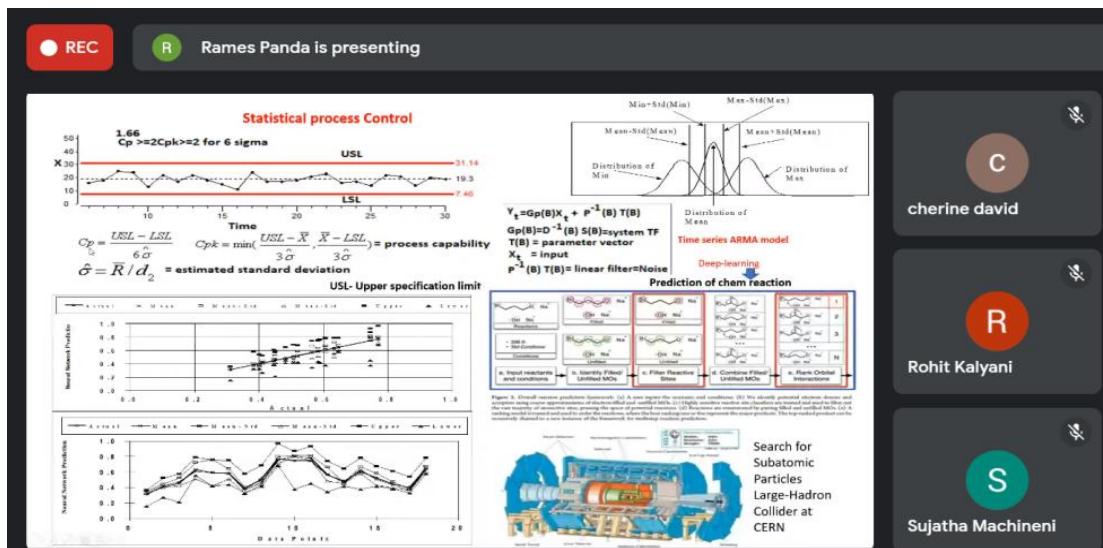
Day & Date	10:00 AM – 12:00 Noon	12:45 PM – 02:45 PM	02:45 PM – 4:45 PM
Day 1 11.10.2021	<p><b>Inaugural function followed by keynote speech</b> by <b>Dan Svensen</b> Sales,Marketing &amp; SD Manager, National Petroleum Services Company (K.S.C.P), Kuwait</p> <p><b>Session 1</b> "Mathematical Modelling and Controller design for steam-hydrolysis of Fat" <b>Dr. Rames Chandra Panda</b> Sr.Principal Scientist &amp; Professor-AcSIR Chemical Engineering, CSIR-Central Leather Research Institute, Adyar,Chennai</p>	<p><b>Session 2</b> "Applications of PID Controllers" <b>Mr. ThillaiNayagam</b> Senior Field Application Engineer, Brain Child Electronics Company, Taiwan.</p>	<p><b>Session 3</b> "Model based Control Techniques to power Electronic Systems" <b>Dr. Taraknath</b> INSPIRE Faculty Department of Electrical Engineering Indian Institute of Technology, Goa</p>
	<p><b>Session 4</b> "Model Predictive Control: Theory and Applications" <b>Dr. Chinmay Rajhans</b> Assistant professor "VeermataJijabai Technological Institute, Mumbai.</p>	<p><b>Session 5</b> "Digital Control System" <b>Dr. K. Srinivasan</b> Associate Professor, Department of Instrumentation and Control Engineering, National Institute of Technology, Tiruchirappalli -620015.</p>	<p><b>Session 6</b> "Advanced Control Schemes for Automatic Process Control" <b>Dr. P S Saikrishna</b> Assistant Professor, Department of Electrical Engineering Indian Institute of Technology Tirupati</p>
Day 2 12.10.2021	Lunch Break (12:00 Noon – 12:45 PM)		
Day 3 13.10.2021	<p><b>Session 7</b> " Mathematical Modelling Of Pulse Oximeter " <b>Ashoka Reddy Komalla, PhD</b> Principal Professor of ECE Kakatiya Institute of Technology &amp; Science Warangal, Telangana – 506015</p>	<p><b>Session 8</b> "Feedback Linearization - Mother of all Nonlinear Controllers" <b>Dr RamakalyanAyyagari</b> Professor, Dept of Instrumentation &amp; Control Engg., NIT Tiruchirappalli.</p>	<p><b>Session 9</b> "Mathematical Modeling of Physiological Systems" <b>Dr Sharvan Kumar Pahuja</b> Associate Professor Department of Instrumentation and Control, NIT Jalandhar.</p>
Day 4 14.10.2021	<p><b>Session 10</b> "Mathematical Modeling of photovoltaic Systems" <b>Dr.K.SRINIVAS REDDY FNAE</b></p>	<p><b>Session 11</b> "Modeling and Control of Cyber-Physical Systems" <b>Dr. P S Saikrishna</b></p>	<p><b>Session 12</b> "PLC and DCS based Control System" <b>Dr. K. Srinivasan</b></p>

	Professor, Department of Mechanical Engineering Indian Institute of Technology ,Madras Chennai – 600036.	Assistant Professor, Department of Electrical Engineering Indian Institute of Technology (Tirupati).	Associate Professor, Department of Instrumentation and Control Engineering,National Institute of Technology, Tiruchirappalli 620015.
<b>Day 5</b> <b>15.10.2021</b>	<b>Session 13</b> <b>"Stress Management"</b> <b>Ms Kranti Yerram Setty</b> Andhra Pradesh State Coordinator <b>The Art of Living</b> Bangalore	<b>Session 14</b> <b>"Motor Control for Electric Vehicles"</b> <b>Mr. M. Malaiyappan</b> Director Pantech Learning Private Limited Chennai	<b>Session 15</b> <b>Feedback Session &amp;Valedictory Function</b> Online Test for participants Feedback from the participants Closing ceremony: By <b>Dr. M.S.Sujatha,Convener</b> Vote of Thanks: By <b>Dr. A. Yasmine Begum, Coordinator</b>

The details of technical sessions are as follows.

**October 11, 2021 (Day – 1, Session – 1)**

**Dr. Rames C Panda, Sr principal Scientist & Professor, Department of Chemical Engineering, CSIR-CLRI, Adyar, Chennai** acted as a resource person for Day-1,Session-1 to deliver Modeling of Nonlinear Systems & Control-Application to Chemical Reactors. The first session of Day-1 is started at 10.00 a.m.



**Dr Rames C Panda** was explaining about Statistical Process Control.

The participants were trained on the following concepts of Modeling of Nonlinear Systems & Control.

- Nonlinear System Modeling
- Identification/Estimation
- Stability
- Control

**October 11, 2021 (Day – 1, Session – 2)**

The second session of Day-1 was started at 12:45 PM. In this session, **Mr. Thillai Nayagam** discussed PID Controllers and Industrial applications of PID Controllers. The participants were introduced with the various types of Temperature controllers used in industries. He also explained about:

- PID Controller Selection
- Tuning of Controller
- PID Controller standard size
- Applications of PID controller
- Manufacturers of PID Controllers.

**PID Controllers**

- ▶ **What is a PID Controller?**
  - ◆ PID is an acronym that stands for Proportional, Integral, Derivative.
  - ◆ A PID controller is an instrument used in industrial control applications to regulate temperature, flow, pressure, speed and other process variables. PID, which stands for proportional integral derivative, controllers use a control loop feedback mechanism to control process variables and are the most accurate and stable controller.
  - ◆ PID control uses closed-loop control feedback to keep the actual output from a process as close to the target or setpoint output as possible.

**Mr. Thillai Nayagam** was demonstrating about the industrial application of PID Controller.

**October 11, 2021 (Day – 1, Session – 3)**

The final session of Day-1 started at 2:45 PM. In this session, **Mr. Tarakanath Kobaku** explained about Non-minimum phase systems and its control challenge.

**The participants have gained the practical knowledge on the following concepts.**

- Model based Control
- Internal Model Control

- Limitations of unconstrained Internal Model Control
- Anti-reset windup compensator for Internal Model Control
- Application to power electronic converter.

**1DOF IMC**

➤ Design :

$$P(s) = P_m(s) = \frac{e^{-s}}{4s+1} \quad P_n(s) = P_{pm}(s) = \frac{e^{-s}}{4s+1}$$

$$C(s) = \frac{4s+1}{0.2s+1}$$

'0.2' is the filter time constant for a noise amplification factor of 20

For a step type disturbance :

(i) Control effort

$$d(s) = -P_{pm}(s)C(s)\frac{1}{s}$$

(ii) Output

$$V(s) = [1-P_m(s)C(s)]P_{pm}(s)\frac{1}{s}$$

$$V(t) = 0.274e^{-0.25(t-2)} - 0.0526e^{-5(t-2)}, t \geq 2$$

Tarakanath Reddy

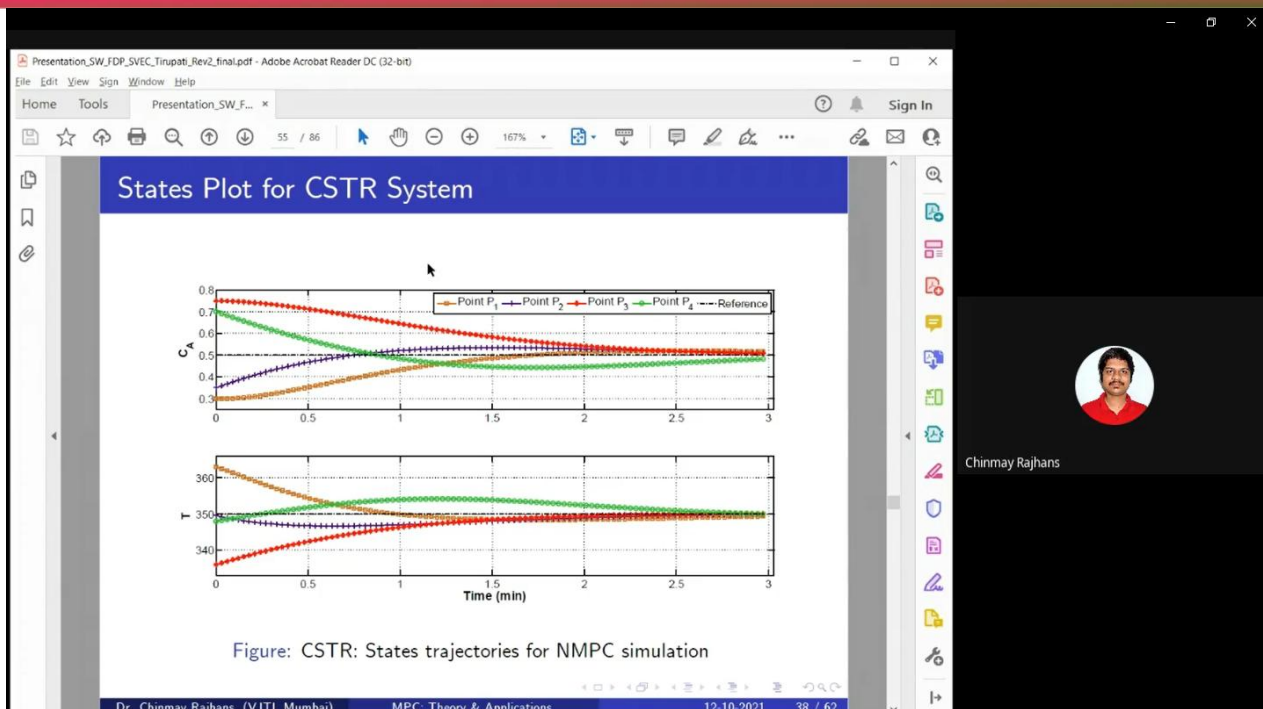
Mr. Tarakanath Kobaku was explaining the design of Internal Model Controller

### October 12, 2021 (Day – 2, Session – 1)

**Dr.Chinmay Rajhans, Assistant Professor, Veermata Jijabai Technological Institute, Mumbai.,** acted as a resource person for the first session of Day-2. Dr.Chinmay Rajhans has conducted the session on Model Predictive Control:Theory and Applications. The first session of Day-2 was started at 10:00 AM. In this session, **Dr.Chinmay Rajhans** explained the Design of Model Predictive Controller for Continuous Stirred Tank reactor System.

The participants have gained the knowledge on the following concepts.

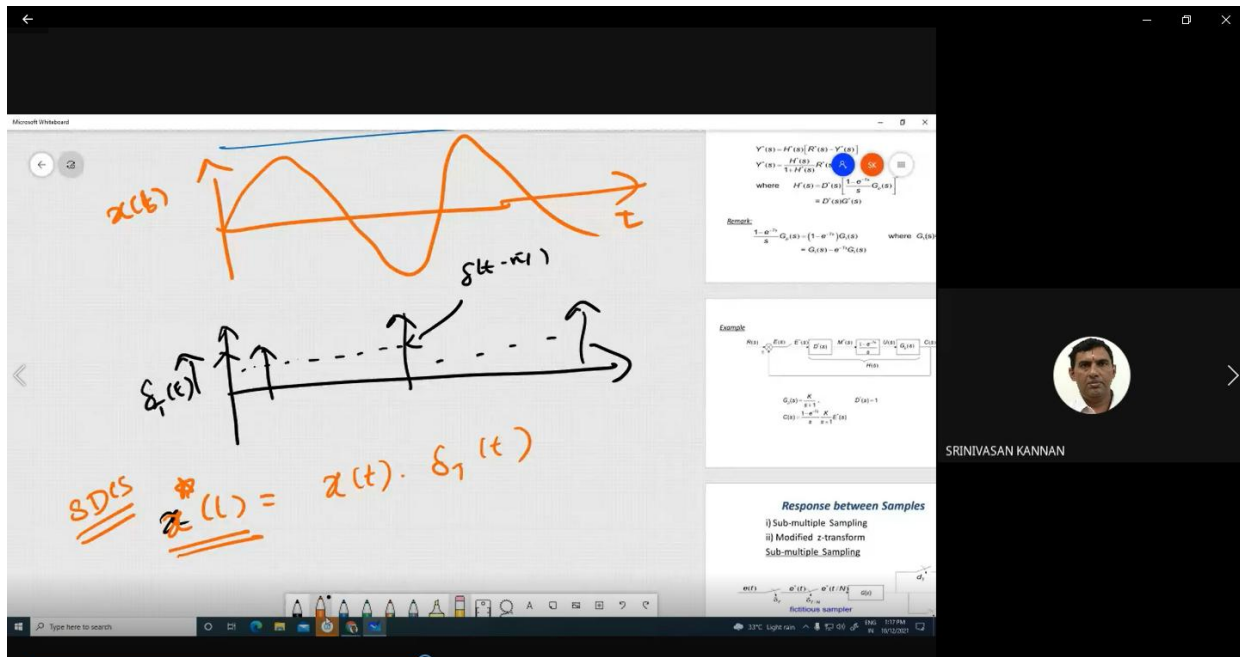
- Model Predictive Controller Scheme
- Model Predictive Controller Types
- Lyapunov stability
- Continuous Stirred Tank Reactor System



Dr. Chinmay Rajhans was showing the states plot for CSTR System.

**October 12, 2021 (Day – 2, Session – 2)**

**Dr. K.Srinivasan Associate Professor, Department of Instrumentation and Control Engineering, National Institute of Technology, Tiruchirapalli** acted as a resource person. The session was started at 12.45 PM. **Mr.M.Balaji**, Assistant Professor, Department of ECE introduced the resource person to the participants.



Dr. K.Srinivasan was explaining the sampling method of Discrete Control System.



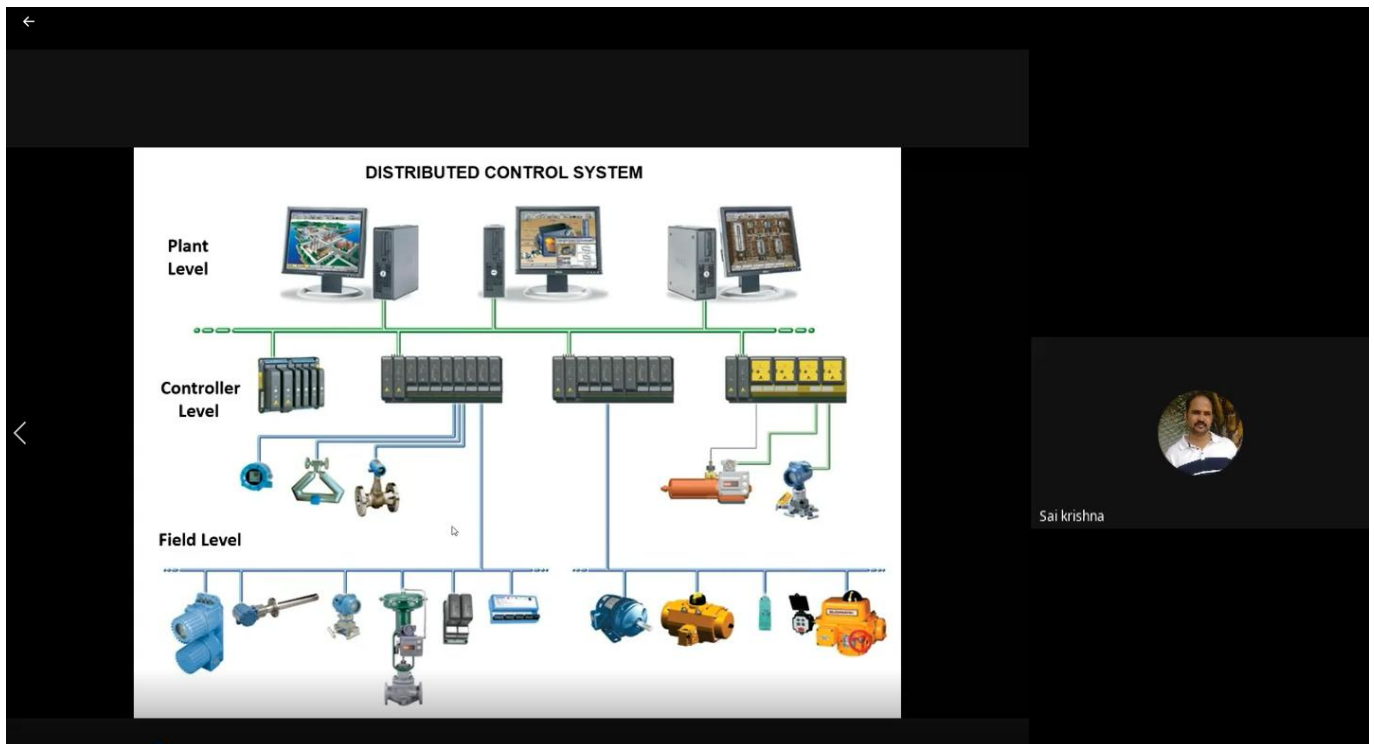
In this session, **Dr. K. Srinivasan** has delivered a lecture on Digital Control System. He explained the Discrete Control System, Desirable properties of Digital Control Algorithm and design of Dead beat controller, Dahlin's Controller, Servo-Regulatory Response of Dahlin's Controller, Digital PID Controller and Design of Internal Mode Controller.

**October 12, 2021 (Day – 2, Session – 3)**

**Dr. P. S Sai Krishna Assistant Professor, Department of Electrical Engineering, Indian Institute of Technology, Tirupati** acted as a resource person. The session was started at 2.45 PM. Dr. A. Yasmine Begum, Associate Professor, Department of EEE introduced the resource person to the participants.

In this session, **Dr. P. S Sai Krishna** has delivered a lecture on Advanced Control Schemes for Automatic process Control. The participants have gained the knowledge on the following concepts.

- Cascade Control
- Ratio Control
- Override Control
- Selective Control
- Feed Forward Control



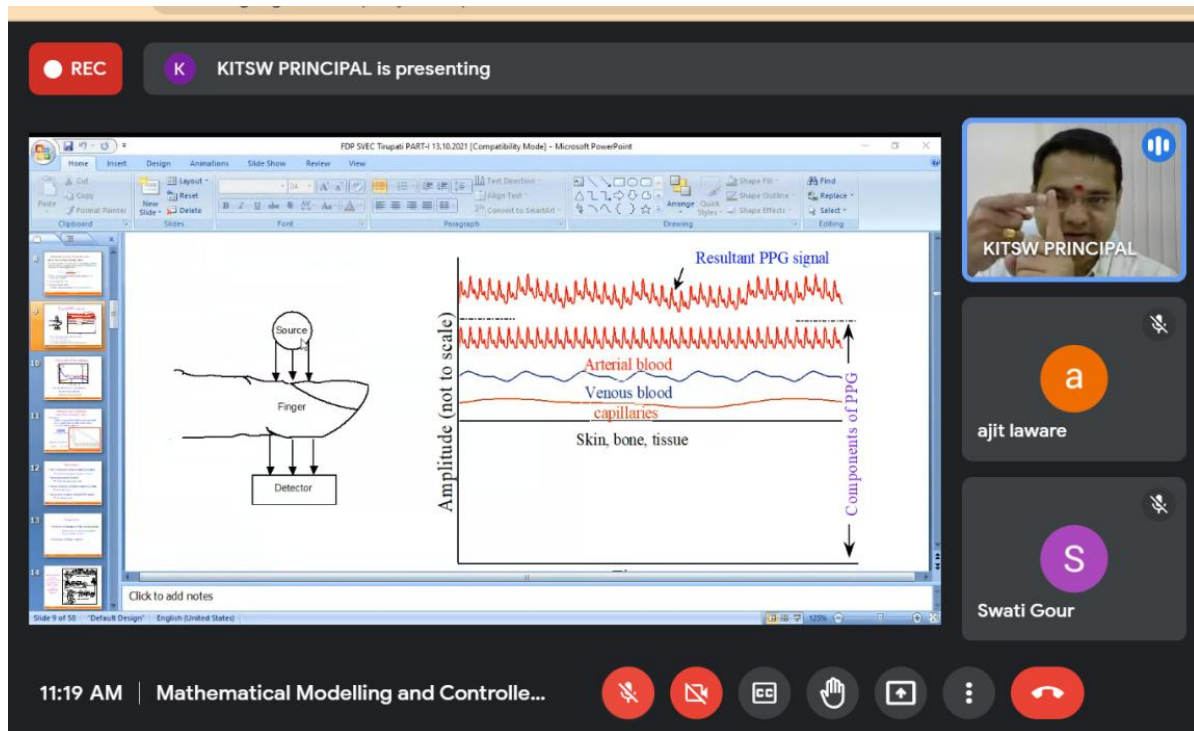
**Dr. P.S Sai Krishna was explaining about Distributed Control System.**

**October 13, 2021 (Day – 3, Session – 1)**

**Dr.K.Ashoka Reddy Professor, Department of Electronics and Communication Engineering, Kakatiya Institute of Technology and Science,Warangal** acted as a resource person. The session was started at 10.00 A.M. Dr.A.Yasmine begum, Associate Professor, Department of EEE introduced the resource person to the participants.

In this session, **Dr.K.Ashoka Reddy** has delivered a lecture on Mathematical Modelling of Pulse Oximeter PPG Signals. The participants have gained the knowledge on the following concepts.

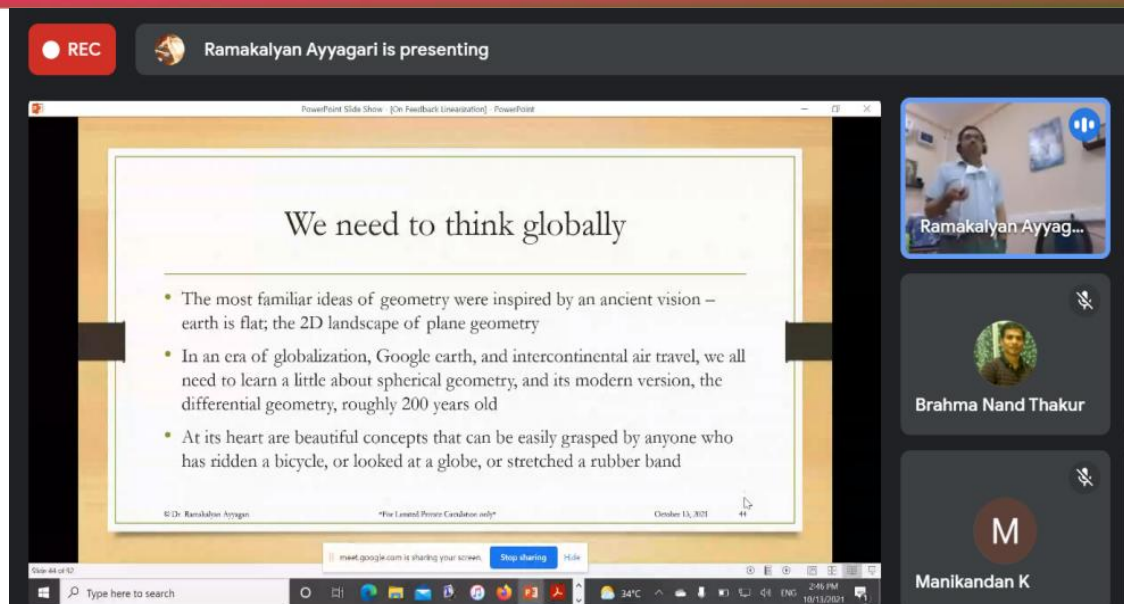
- Pulse Oximetry
- PPG signal and its absorption characteristics
- SaO<sub>2</sub> Estimation using Pulse Oximeter
- Analog front end for simultaneous recording of PPG,ECG and respiratory signals.



**Dr.K.Ashoka Reddy** was explaining working of Pulse Oximeter.

**October 13, 2021 (Day – 3, Session – 2)**

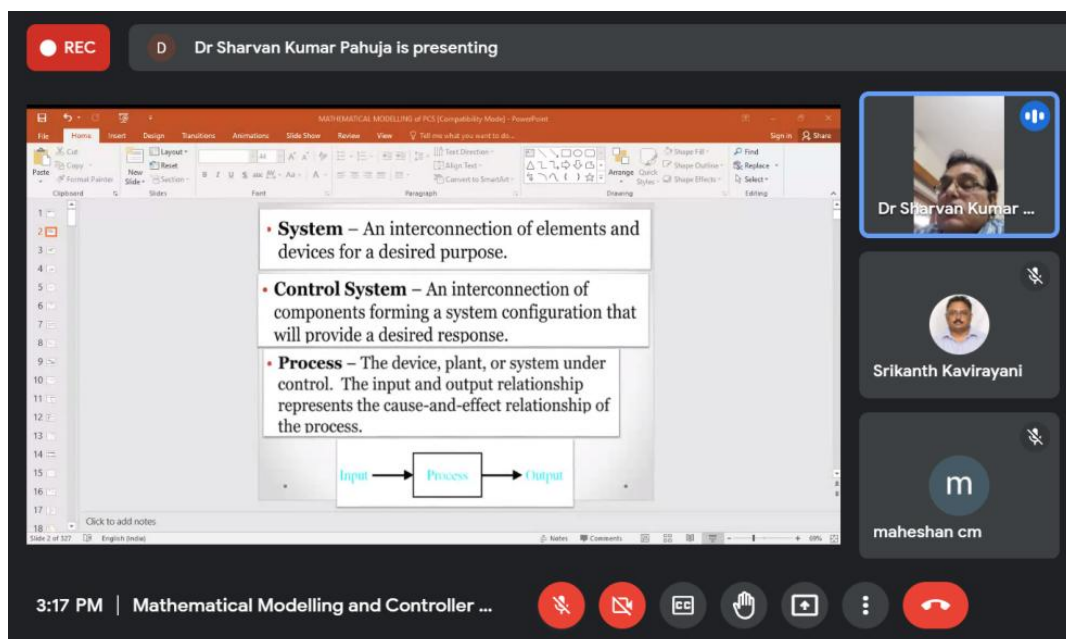
Dr Ramakalyan Ayyagari, Professor, Dept of Instrumentation & Control Engg, NIT Tiruchirapalli acted as a resource person for second session of day-3 to deliver about feedback Linearization. The second session of Day-3 is started at 1.00 PM. The participants are trained on the concepts of, Mathematical Modelling of Induction Motor, Linear state feedback and Extension to Nonlinear Systems. In addition, the participants have gained the practical knowledge on Mathematical Modelling of Induction motor.



**Dr Ramakalyan Ayyagari** is explaining the importance of differential geometry.

### October 13, 2021 (Day – 3, Session – 3)

The third session of Day-3 was started at 2.45 PM. **Dr. Sharvan Kumar Pahuja, Associate Professor Department of Instrumentation and Control, National Institute of Technology, Jalandhar**, acted as a resource person to deliver the concepts of Mathematical Modeling of Physiological Systems”. In this session, the participants have gained the knowledge on cardiovascular model, respiratory model, Nervous system model, Muscular model, Skin System model, Drug delivery model etc.

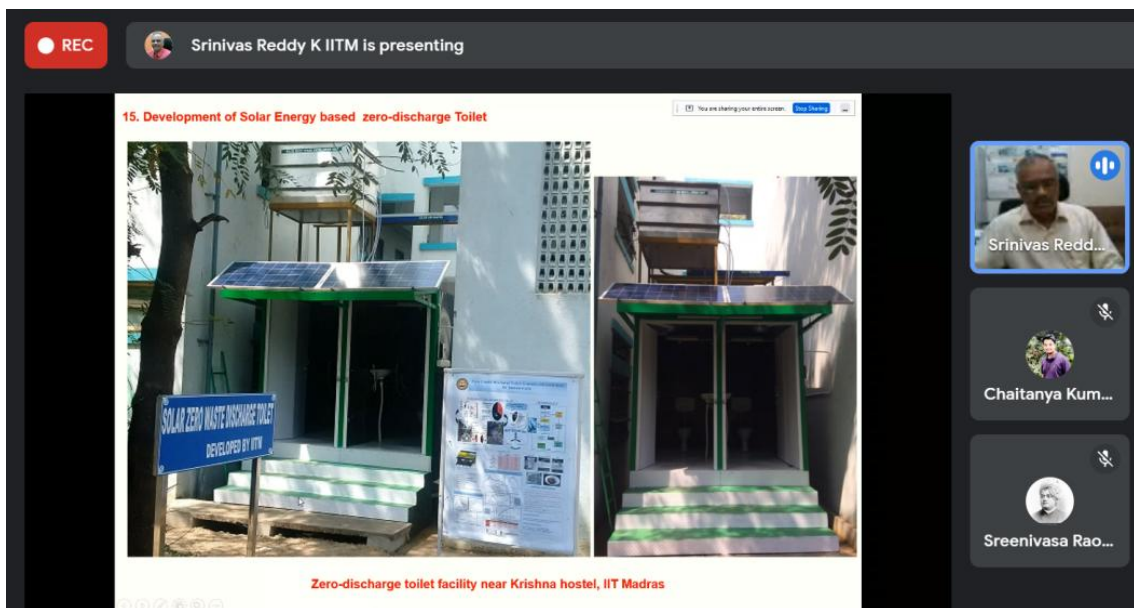


**Dr. Sharvan Kumar Pahuja** was explaining about Process Control System.

**October 14, 2021 (Day – 4, Session – 1)**

**Dr.K. Srinivas Reddy, Professor, Department of Mechanical Engineering, Indian institute of Technology, Chennai** acted as a resource person for session-1 of Day-4 to deliver the lecture on Mathematical Modelling of photovoltaic Systems. The first session of Day-4 was started at 10:00 AM. **Dr. A. Yasmine Begum**, Coordinator of ATAL FDP introduced the resource person to the participants. In this session, the participants have gained the practical knowledge on the following:

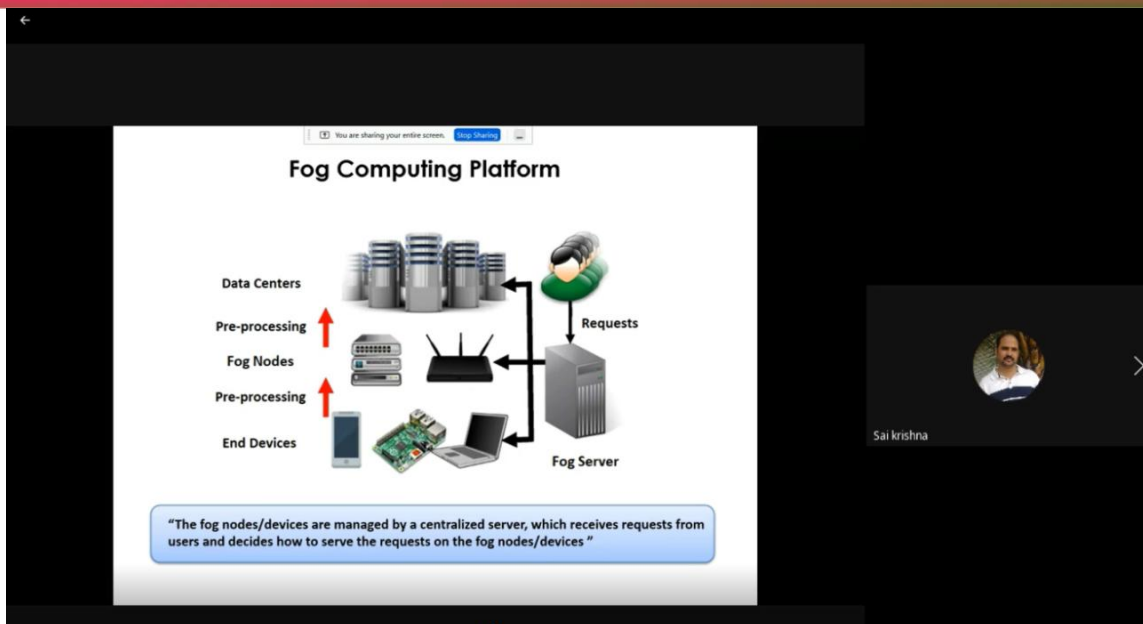
- Renewable energy based Technologies
- Solar PV Systems for power generation.
- Solar Photovoltaic cells.
- Solar cell performance.
- Development of Solar energy based zero-discharge toilet.
- Mathematical Modelling of the Low Concentrating Photovoltaic System for Co-generation and Tri-generation.



**Dr.K. Srinivas Reddy** was showing about design of Zero-discharge toilet facility in IIT Madras.

**October 14, 2021 (Day – 4, Session – 2)**

Dr.P.S.Sai Krishna was explaining about Fog computing. The second session of Day-4 was started at 12.45 PM. **Dr.P.S.Sai Krishna,Assistant ofessor, Department of E.E.E,IIT Tirupati**, acted as a resource person.

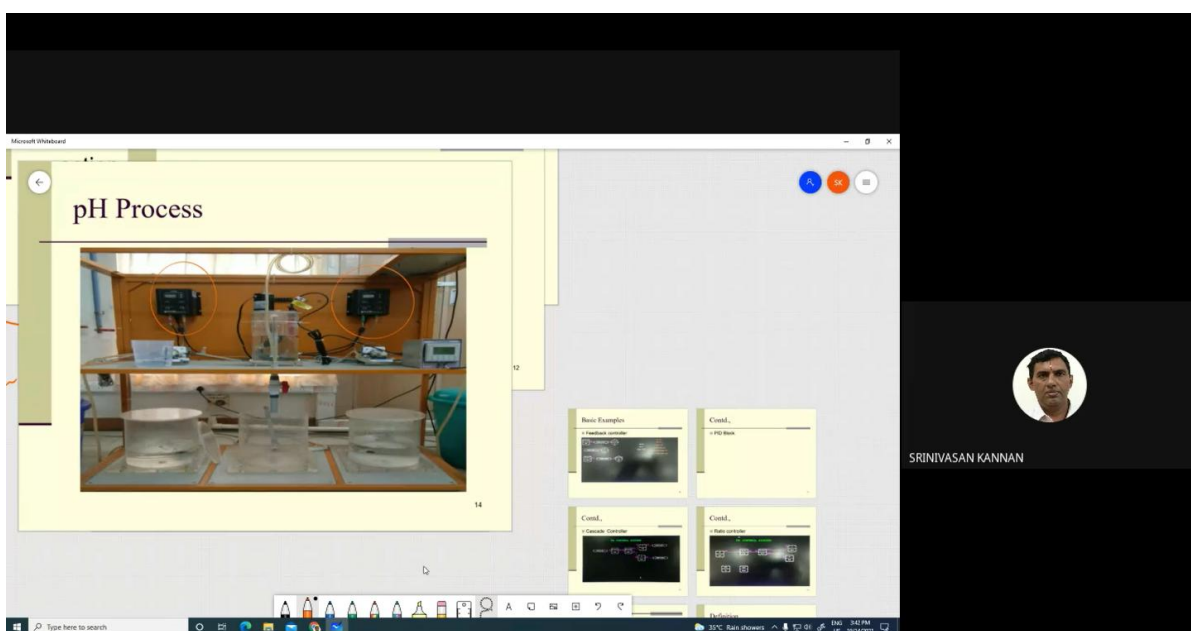


**Dr. P.S. Sai Krishna** was explaining about Fog computing platform in industries.

He delivered the lecture on the concepts of Cyber-Physical Systems. In this session, the participants have gained the practical knowledge on Internet of Things, Cloud Centric IoT, Fog Computing platform, Automation Pyramid, Cloudification of Automation Pyramid, Networked cloud Robotics, Microgrid.

**October 14, 2021 (Day – 4, Session – 3)**

The session 3 of the Day-4 was started at 2.45 P.M. In this session, Dr. K. Srinivasan Associate Professor, Department of Instrumentation and Control Engineering, National Institute of Technology, Tiruchirapalli acted as resource person to deliver the concepts of PLC and DCS based Control System.



**Dr.K. Srinivasan** was showing pH control process in NIT,Tiruchirapalli

The topics that are discussed in this session are:

- DCS architecture.
- PLC Programming.
- HART protocol and field bus & RTDA Controller.

### **October 15, 2021 (Day – 5, Session – 1)**

The first session of the Day-5 was started at 10:00 AM. As a part of FIT INDIA movement and to promote it across the country, the session on “**Stress Management**” was conducted.

This session was delivered by Mrs Kranti Yerramsetty, Andhra Pradesh State Coordinator, The Art of Living, Bangalore. Mrs. Kranti Yerram Setty explained the following:

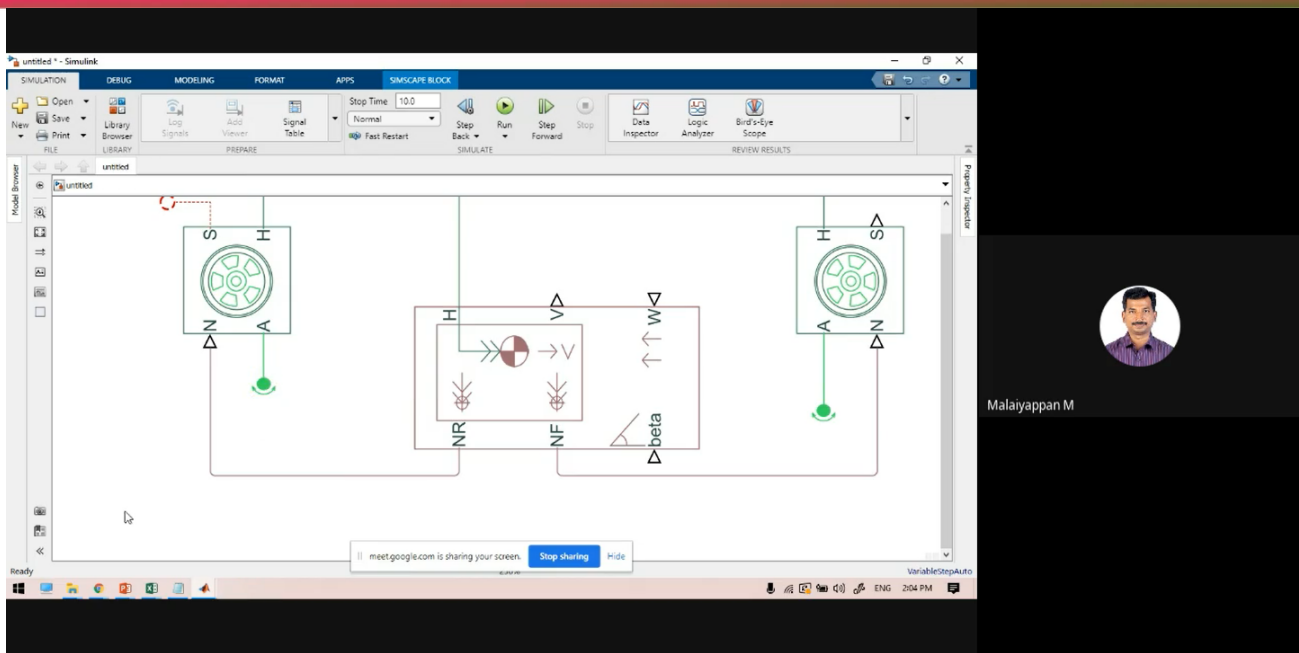
- Strategies of stress management which includes Yoga, Exercise, Supplements etc
- Stress management strategies include controlling thoughts, goal setting, time management, task priority and realistic deadline settings, regular exercises and relaxing techniques.



**Mrs Kranti Yerram Setty** was explaining about stress management through massaging around eyes.

### **October 15, 2021 (Day – 5, Session – 2)**

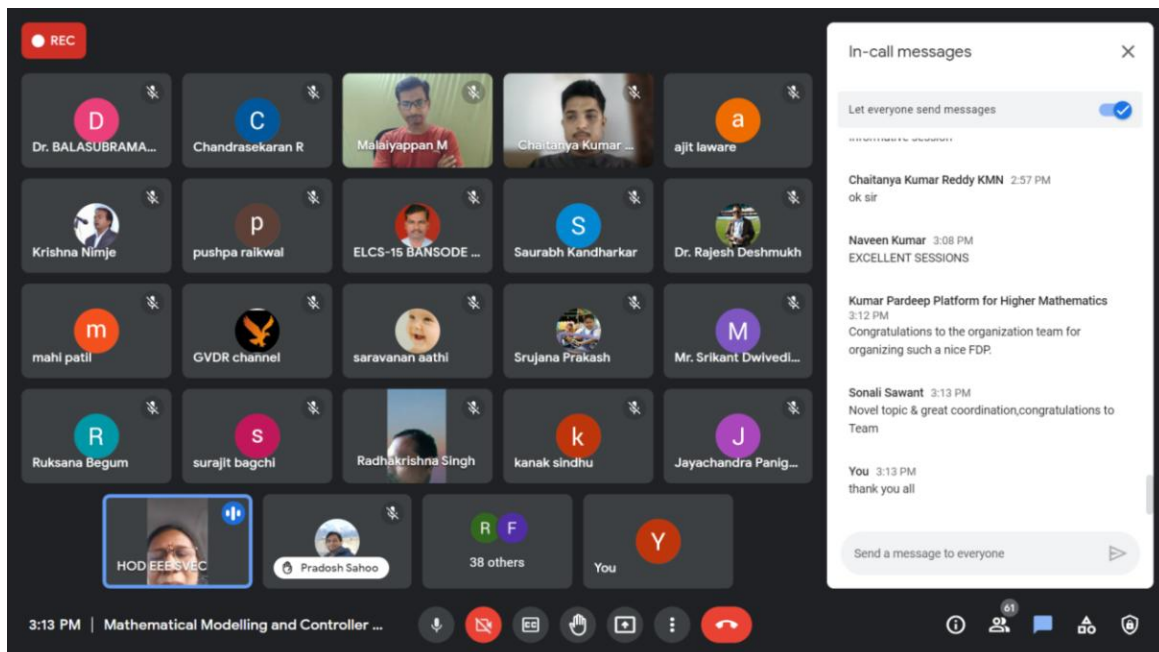
The last session of Day-5 was started at 12:45 PM. In this session, **Mr. M. Malaiyappan**, Director, Pantech learning Private limited, Chennai acted as resource person to deliver the concepts of the participants have shown the steps to design Motor Control of Electric vehicles in MATLAB.



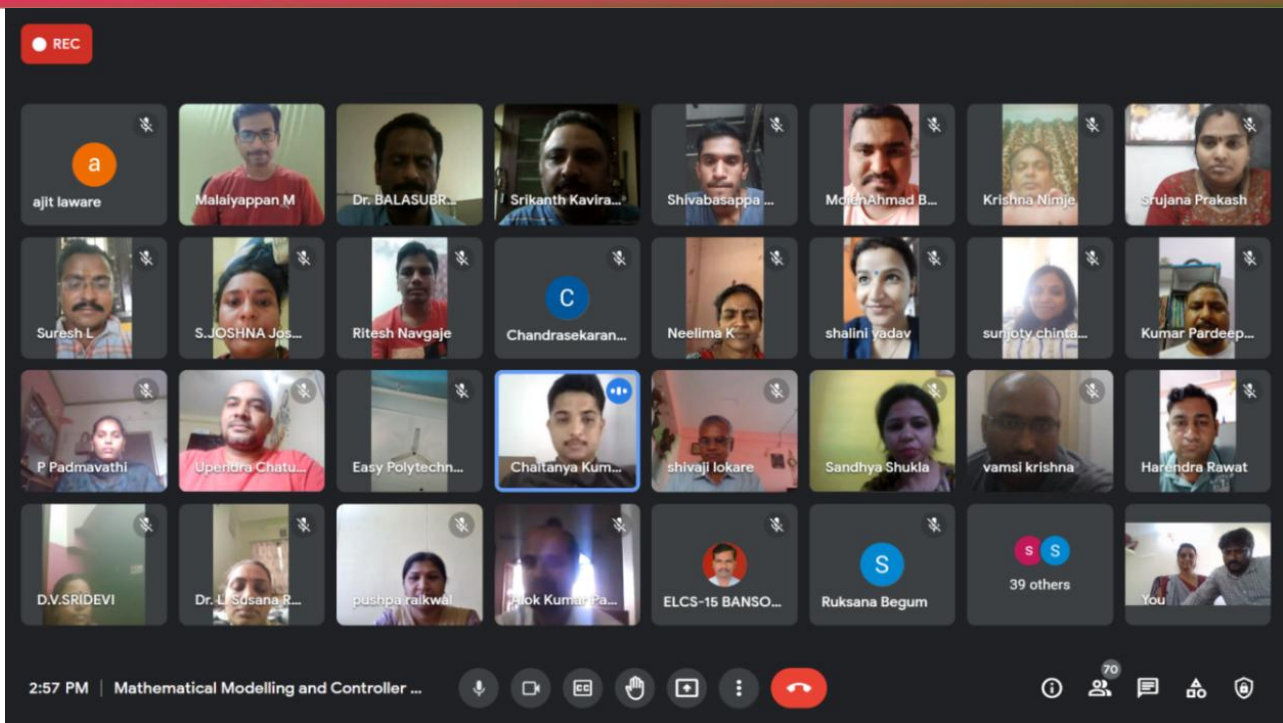
**Mr. M. Malaiyappan** was performing hands on design of motor control of Electric vehicles using MATLAB

**The valedictory function** of AICTE Training and Learning (ATAL) Academy sponsored online Faculty Development Programme (FDP) on “Mathematical Modelling and Controller Design for Non-Linear Systems” was started at 2.45 PM on October15, 2021. In the valedictory function, Mr.M.Balaji invited the chief guest Mr. M. Malaiyappan, Director, Pantech Learning Private Limited, Chennai to share his views about the FDP.

Mr. M. Malaiyappan suggested the participants to practice the concepts that are learnt in the FDP which help in improving the personal skills as well as to train students.



**Dr. M. S. Sujatha**, Professor and Head, Department of E.E.E appreciating the participants and coordinator for their active participation in the FDP.



**Group photo of participants**

**Dr. A.Yasmine Begum**, Coordinator, ATAL FDP proposed a Vote-of-Thanks. Initially, the coordinator thanked the Core team of ATAL for sponsoring the FDP to organize at national level and also for their suggestions, support and guidance to conduct the FDP. Later, she thanked the participants of various engineering colleges and government institutions across the country for their enthusiastic participation. At the end, she conveyed her heartfelt thanks to the management, Sree Vidyanikethan Engineering College (Autonomous), Tirupati, Andhra Pradesh, the Principal, Head of the Department, Electrical and Electronics Engineering, Mr. M. Balaji, Dr. V. Arun, Mr. M. Manikandan, Co-coordinators for their constant support to make this event a grand success.