Department of Electrical & Electronics Engineering

Report

Five-Day International Online Faculty Development Program (FDP)
on
"Application of Renewable Energy in the Growth of Electric Vehicle (EV) Technology (AREGEVT-2021)"
Organised by
Department of Electrical and Electronics Engineering
Duration: 23rd– 27th November 2021

Organized in association with: **Institution Innovation Council**

Submitted by: Dr Pratap Ranjan Mohanty, Associate Professor., Dept. of EEE

Attendance: 30 participants from different institutions of INDIA and abroad

Day 1 (23.11.2021)

Session 1 (10 AM – 11.30 AM): Inaugural Session & Lecture on "Power Factor Correction Converter for Electric Vehicles" by Dr. Naveen Yalla, Assistant Professor, Department of EEE, NIT Tiruchirapalli, INDIA

The session was started at 10 AM. Dr. A V Pavan Kumar, Associate Professor & Head, EEE Dept. (Convener, AREGEVT-2021) initiated the inaugural session and welcome the dignitaries and the participants to the Five-Day International Online Faculty Development Program (FDP) on Application of Renewable Energy in the Growth of Electric Vehicle (EV) Technology (AREGEVT-2021)" Dr.C. Yuvaraj, Principal (Patron, AREGEVT-2021) addressed the meeting and signifies the efforts of MITS, Madanapalle for making platform like research interaction and knowledge sharing even in pandemic situation. Besides, he indicated in brief regarding the importance of programs like FDP and formally announced the opening of the international FDP AREGEVT-2021. The objective and diversity of AREGEVT-2021 was mentioned by Dr. Pratap Ranjan Mohanty, Associate Professor, Dept. of EEE (Coordinator, AAIEEPIVS-2021). The Chief Guest & Resource Person for tht session-1 Dr. Naveen Yalla, Assistant Professor, Department of EEE, NIT Tiruchirapalli, INDIA was introduced by Dr. Pratap Ranjan Mohanty, Associate Professor, Dept. of EEE (Coordinator, AREGEVT-2021).

The resource dignitary addressed the power factor correction (PFC) requirement and its importance in interconnection of EV–Grid. The different categories of PFC with respect to types of charging station are being discussed. The working principle and operation of 1-ph Tolem Pole PFC, Interleaved Tolem Pole PFC, Neutral Point Clamped PFC, Two Level PFC, Vienna Rectifier, 3-ph 3-level NPC, 3-ph 3-level ANPC and 3-ph 3-level TNPC. The speaker concluded with the pros & cons of PFC topologies in G2V:V2G.

Session 2 (2.30 PM – 4.00 PM): Lecture on "Electric Vehicle Charging & Grid Interconnection" by Dr Ritesh Kumar Keshri, Assistant Professor, Department of EE, VNIT Nagpur, INDIA

The eminent speaker focused on both the environmental and operational concerns with the EVs. Also, he discussed the key challenges and solution in EV technology. Besides, the different types of charging are being discussed in brief. The issues of DC bus voltage

regulations is being also addressed. The speaker updated the difference in wireless and conductive charging with result discussion of different experimental prototypes.

Day 2 (24.11.2021)

Session 1 (10 AM – 11.30 AM): Lecture on "Electrical Propulsion System Design with Electrical Motors" by Dr. Ranjan Kumar Behera, Associate Professor, Dept. of EE, IIT Patna, INDIA

The prominent speaker focused on the control of drive system for EV/HEV. He described the sensorless induction motor drive using indirect vector controller for EVs. Also, the asymmetrical multilevel inverter for traction drive is being discussed with experiment prototype. Besides, with experimental result the performance of open end winding induction motor (OEWIM), dual OEWIM based differential four-wheel drive (D4WD), EV fault tolerant control (FTO) of OEWIM applied to D4WD and dual battery power balancing linked to dual OEWIM based D4WD EV are analysed.

Day 3 (25.11.2021)

Session 1 (10 AM – 11.30 AM): Lecture on "Electric Vehicle Battery Management System (EV-BMS)" by Dr A V Pavan Kumar, Associate Professor & Head Department of EEE, MITS, Madanapalle, AP, INDIA

The prominent speaker focused on the requirement, construction and function of BMS. The session was details about the BMS architecture and its functionality. The eminent speaker addressed on the Battery-pack sensing (voltage, temperature, current), ADC architecture, Chipset selection different protection zone and interfacing. The challenges and solution on the performance management of BMS have been focused during the session. The resource person also classified the SOC estimation methods. Besides, he focused on the Kalman filter based estimation with algorithm.

Session 2 (2.30 PM – 4.00 PM): Lecture on "Wireless Power Transfer for Electric Vehicle Battery Charging" by Dr Dharavath Kishan, Assistant Professor, Department of EEE, NIT Surathkal, INDIA

The session included the charging infrastructure for EV (Conductive EV Battery charger & EV Battery Charger Standard). The prominent resource person highlighted concept and basic theory of wireless power transfer (WPT). The impact of mutual inductance and its estimation was also discussed in the session. Besides, the resonant topologies of WPT was deliberated. Also, the resource speaker focused on the experimental prototype of the complete inductive wireless EV charger systems with result discussion. The session was concluded with safety of WPT and scope of future research development.

Day 4 (26.11.2021)

Session 1 (10 AM – 11.30 AM): Lecture on "Silicon Carbide Converters for Electric Vehicles: Prospects and Challenges" by Dr. Santosh Kumar Singh, Associate Professor, Department of EE, IIT (BHU), Vanaras, INDIA

The resource speaker focussed on the importance of wide band gap (WBG) devices. The design consideration, fabrication challenges, packaging of SiC device were discussed. The prominent speaker highlighted on the difference between high efficient vs high power density

converters. Also, he briefed the SiC diode, SiC transistors, SiC JFET and SiC cascade. The concept of voltage and current source gate-drive circuits with their protection was discussed in the session. The experimental investigation of the temperature testing of Boost converter, 3-ph VSI fed PMSM drive, SiC AC-DC-AC converter (10 kW) are being discussed during the session.

Session 2 (2.30 PM – 4.00 PM): Lecture on "Solar Powered Electric Vehicles" by Dr. Nishant Kumar, Assistant Professor, Department of EE, IIT, Jodhpur, INDIA

The resource speaker focussed on history of the solar power electric train/vehicle. He described on the challenges on the control of solar powered EV, charging scheme, solar pv system for MPPT testing. Also, the speaker highlighted optimization algorithm even in partially shaded conditions, running conditions. Besides, he focused on the designing of curved structure of the vehicle's upper body.

Day 5 (27.11.2021)

Session 1 (10 AM – 11.30 AM): Lecture on "Solar EV Charging Station" by Mr Ashhar Ahmed, Co-Founder & Director, SkillShark EduTech, Hydrabad, INDIA

The prominent speaker briefed the electrification of mobility and hybridization. The voltage levels and voltage ranges for different EV products/parts, battery charging, electric vehicle supply equipment, charging modes are focussed during the presentation. The charging of EV and level of charging are highlighted. Including the types of Indian charge connectors, the different varieties/ranges of charge connectors are underlined in the session.

Session 2 (2.30 PM – 4.00 PM): Lecture on "Multi-phase Induction Motor Drive for Heavy EV Application" by Dr. Manaranjan Sahoo, Assistant Professor, Department of EEE, NIT Tiruchirapalli, INDIA

The prominent speaker focussed on the drive system for heavy EV applications. He discussed about the required drive characteristics for electric traction applications. The speaker briefed on the standard motor that are being used in EV and then underlined the importance of multiphase induction motor (MIM) drives. The performance of dual inverter using open end winding concepts and MLI configurations for 9-phase PPMIM drive with four DC sources in fault condition are being discussed with experimental results.

Dr. Pratap Ranjan Mohanty, Coordinator, AREGEVT – 2021 open the valedictory session with an appreciation note to all the participants for their persistent of attending the five-day long FDP AREGEVT – 2021. The coordinator of the program shared his view and experience regarding the success of the program. Many participants shared their experience, valuable comments about the FDP. Dr. A V Pavan Kumar, Convener, AREGEVT- 2021 proposed a vote of thanks and announced the successful completion of the FDP.

Feedback: The participants were moreover passionate to participate in every sessions and interacted with resource persons to enhance their research contribution ahead.

Participation Certificate: Participation E-Certificates are distributed to all the active participants through their email.

Photos:

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(UGC-AUTONOMOUS)
Affiliated to JNTUA, Anantapuramu& Approved by AICTE, New Delhi
Recognized Research Center, Accredited by NBA for CE, CSE, ECE, EEE, ME, MBA & MCA,
Recognized by UGC under the sections 2(f) and 12(B) of the UGC act 1956

Five-Day International Online Faculty Development Program (FDP)
on
Application of Renewable Energy in the Growth of Electric Vehicle (EV) Technology
(AREGEVT-2021)

Organized by the Department of EEE
23rd – 27th Nov 2021

- No registration fee for the FDP **(AREGEVT-2021)**
- **Registration Link and QR Code for "AREGEVT-2021"**
- shorturl.at/iltuO

- Link to join the sessions will be send to the participants through their registered **Email/WhatsApp** number
- 80% attendance, 60% marks in the Test and submission of feedback is compulsory to receive e-certificate.

Resource Persons & Schedule

Date	Session-1 10 AM – 11.30 AM		Session- 4 02.30 PM – 04 PM	
23.11.21 Tuesday	**Inaugural Session** Lecture on "Power Process Configurations for Renewable Energy Sources to EV Applications"	 Dr Naveen Yalla Assistant Professor Department of EEE NIT Tiruchirapalli, INDIA	Lecture on "Electric Vehicle Charging & Grid Interconnection"	 Dr Ritesh Kumar Keshri Assistant Professor, Department of EE VNIT Nagpur, INDIA
24.11.21 Wednesday	Lecture on "Electrical Propulsion System Design with Electrical Motors"	 Dr. Ranjan Kumar Behera, Associate Professor, Department of EE IIT Patna, INDIA	Lecture on "Electric Vehicle: An Overview"	 Dr. Premalata Jena Associate Professor Department of EE IIT Roorkee, INDIA

Date	Session-1 10 AM – 11.30 AM		Session- 4 02.30 PM – 04 PM	
25.11.21 Thursday	Lecture on "Electric Vehicle Battery Management System (EV-BMS)"	 Dr A V Pavan Kumar Associate Professor & Head Department of EEE MITS, Madanapalle, AP, INDIA	Lecture on "Bidirectional Wireless Power Transfer for EV for V2G and G2V"	 Dr Dharavath Kishan Assistant Professor Department of EEE NIT Surathkal, INDIA
26.11.21 Friday	Lecture on "Silicon carbide Converters for Electric Vehicles: Prospects and challenges"	 Dr. Santosh Kumar Singh Associate Professor Department of EE IIT (BHU), Vanaras, INDIA	Lecture on "Solar Powered Electric Vehicle"	 Dr. Nishant Kumar Assistant Professor Department of EE IIT, Jodhpur, INDIA
27.11.21 Saturday	Lecturer on "Solar EV Charging Station"	 Mr Ashhar Ahmed Co-Founder & Director SkillShark EduTech Hydrabad, INDIA	Lecture on "Multi-phase Induction Motor Drive for Heavy EV Application"	 Dr. Manaranjan Sahoo Assistant Professor, Department of EEE NIT Tiruchirapalli, INDIA

Organizing Committee

Chief Patron
Dr. N. Vijaya Bhaskar Choudary, Ph. D
Secretary & Correspondent, MITS, Madanapalle, AP

Patron
Dr. C. Yuvaraj
Principal, MITS, Madanapalle, AP

Convener
Dr. A V Pavan Kumar
Associate Professor & Head, Dept. of EEE

Coordinators
Dr. Pratap Ranjan Mohanty,
Assoc. Prof. Dept. of EEE

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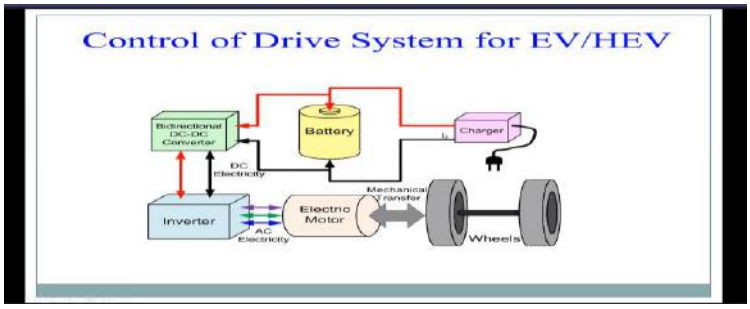
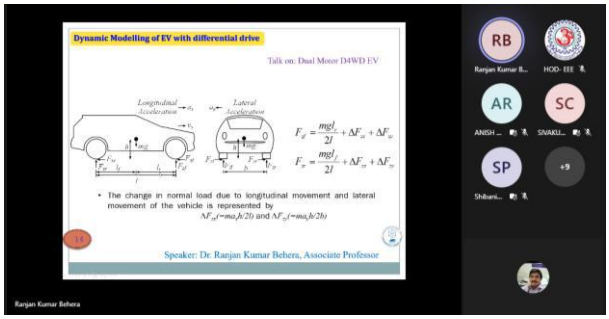
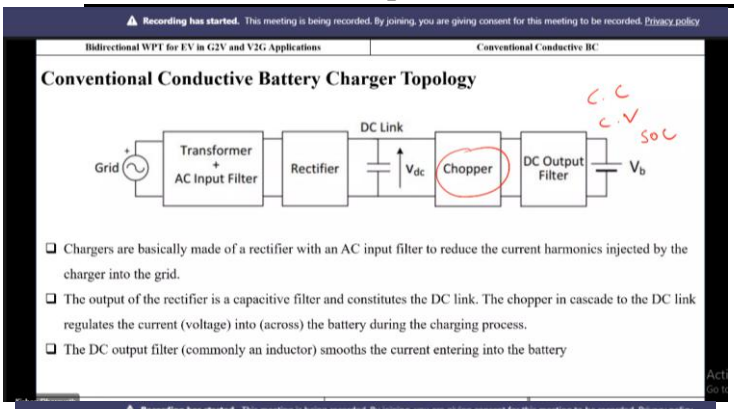
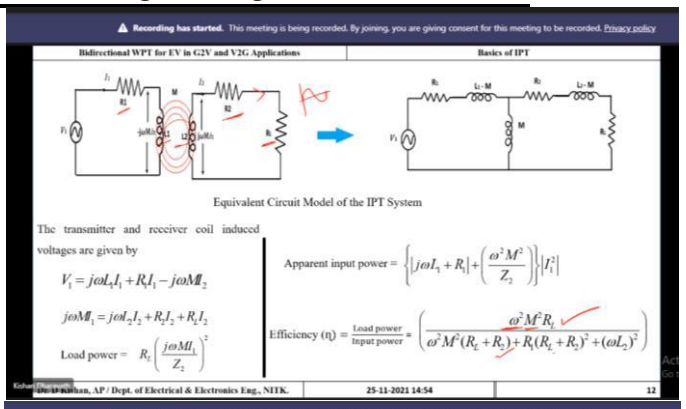





Recording has started. This meeting is being recorded. By joining, you are giving consent for this meeting to be recorded. Privacy policy
Bidirectional WPT for EV in G2V and V2G Applications
Conventional Conductive BC
Conventional Conductive Battery Charger Topology
Grid
Transformer + AC Input Filter
Rectifier
DC Link
Vdc
Chopper
DC Output Filter
Vb
C.C
C.V
SoC
Chargers are basically made of a rectifier with an AC input filter to reduce the current harmonics injected by the charger into the grid.
The output of the rectifier is a capacitive filter and constitutes the DC link. The chopper in cascade to the DC link regulates the current (voltage) into (across) the battery during the charging process.
The DC output filter (commonly an inductor) smooths the current entering into the battery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Bidirectional WPT for EV in G2V and V2G Applications
Basics of IPT
Equivalent Circuit Model of the IPT System
The transmitter and receiver coil induced voltages are given by
$V_1 = j\omega L_1 I_1 + R_1 I_1 - j\omega M I_2$
$j\omega M I_1 = j\omega L_2 I_2 + R_2 I_2 + R_L I_2$
Load power = $R_L \left(\frac{j\omega M I_1}{Z_2}\right)^2$
Apparent input power = $\left\{\left|j\omega L_1 + R_1\right| + \left(\frac{\omega^2 M^2}{Z_2}\right)\right\}\left|I_1^2\right|$
Efficiency (η) = $\frac{\text{Load power}}{\text{Input power}} = \left(\frac{\omega^2 M^2 R_L}{\omega^2 M^2 (R_L + R_2) + R_1 (R_L + R_2)^2 + (\omega L_2)^2}\right)$
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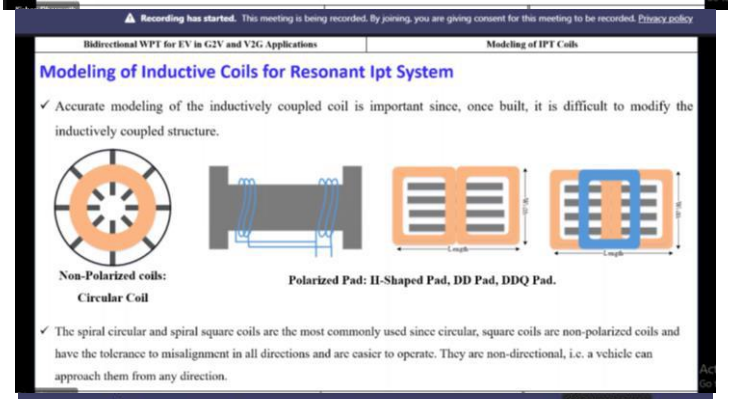
12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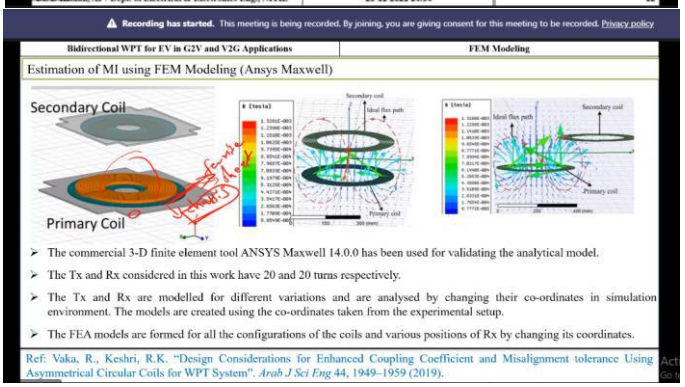
Bidirectional WPT for EV in G2V and V2G Applications
Modeling of IPT Coils
Modeling of Inductive Coils for Resonant Ipt System
Accurate modeling of the inductively coupled coil is important since, once built, it is difficult to modify the inductively coupled structure.
Non-Polarized coils:
Circular Coil
Polarized Pad: II-Shaped Pad, DD Pad, DDQ Pad.
The spiral circular and spiral square coils are the most commonly used since circular, square coils are non-polarized coils and have the tolerance to misalignment in all directions and are easier to operate. They are non-directional, i.e. a vehicle can approach them from any direction.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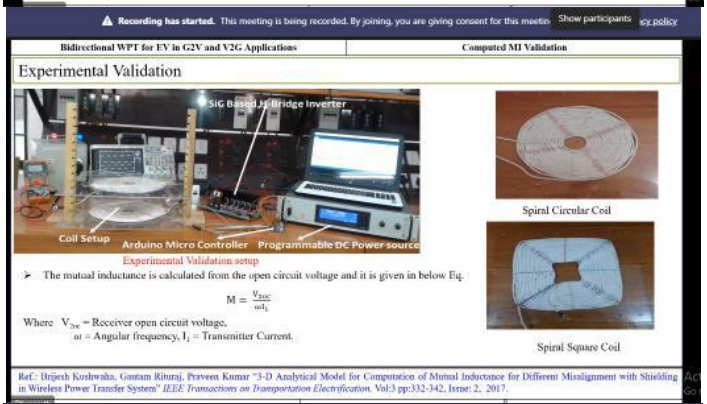
Bidirectional WPT for EV in G2V and V2G Applications
FEM Modeling
Estimation of MI using FEM Modeling (Ansys Maxwell)
Secondary Coil
Primary Coil
The commercial 3-D finite element tool ANSYS Maxwell 14.0.0 has been used for validating the analytical model.
The Tx and Rx considered in this work have 20 and 20 turns respectively.
The Tx and Rx are modelled for different variations and are analysed by changing their co-ordinates in simulation environment. The models are created using the co-ordinates taken from the experimental setup.
The FEA models are formed for all the configurations of the coils and various positions of Rx by changing its coordinates.
Ref: Vaka, R., Keshri, R.K. "Design Considerations for Enhanced Coupling Coefficient and Misalignment tolerance Using Asymmetrical Circular Coils for WPT System". Arab J Sci Eng 44, 1949–1959 (2019).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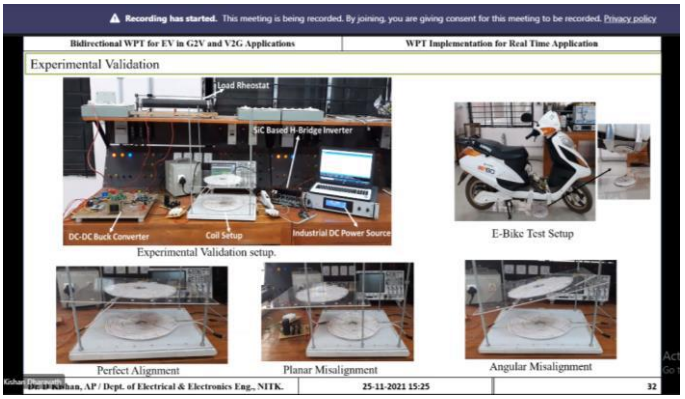
Bidirectional WPT for EV in G2V and V2G Applications
Computed MI Validation
Experimental Validation
SiC Based H-Bridge Inverter
Coil Setup
Arduino Micro Controller
Programmable DC Power source
Experimental Validation setup
Spiral Circular Coil
Spiral Square Coil
The mutual inductance is calculated from the open circuit voltage and it is given in below Eq.
$M = \frac{V_{2oc}}{\omega I_1}$
Where V_{2oc} = Receiver open circuit voltage, ω = Angular frequency, I_1 = Transmitter Current.
Ref.: Brijesh Kushwaha, Gautam Rituraj, Praveen Kumar "3-D Analytical Model for Computation of Mutual Inductance for Different Misalignment with Shielding in Wireless Power Transfer System" IEEE Transactions on Transportation Electrification. Vol:3 pp:332-342, Issue: 2, 2017.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Bidirectional WPT for EV in G2V and V2G Applications
WPT Implementation for Real Time Application
Experimental Validation
Load Rheostat
SiC Based H-Bridge Inverter
DC-DC Buck Converter
Coil Setup
Industrial DC Power Source
Experimental Validation setup.
E-Bike Test Setup
Perfect Alignment
Planar Misalignment
Angular Misalignment
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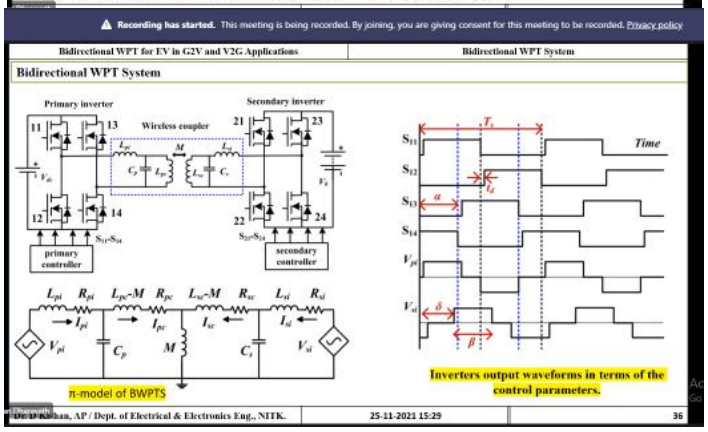
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Bidirectional WPT for EV in G2V and V2G Applications
Bidirectional WPT System
Bidirectional WPT System
Primary inverter
Secondary inverter
Wireless coupler
primary controller
secondary controller
π-model of BWPTS
Time
Inverters output waveforms in terms of the control parameters.
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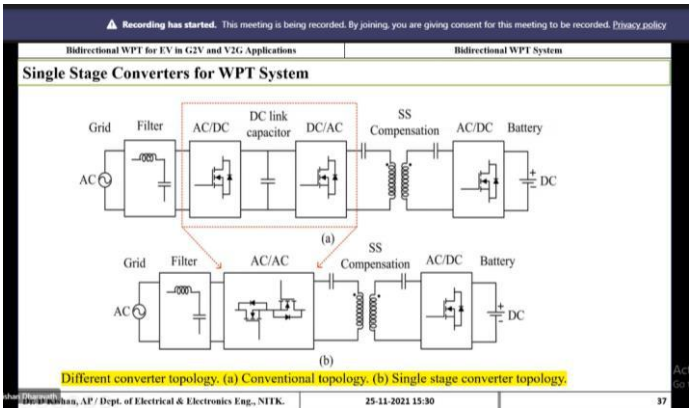
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Bidirectional WPT for EV in G2V and V2G Applications
Bidirectional WPT System
Single Stage Converters for WPT System
Grid
Filter
AC/DC
DC link capacitor
DC/AC
SS Compensation
AC/DC
Battery
AC
DC
(a)
AC/AC
(b)
Different converter topology. (a) Conventional topology. (b) Single stage converter topology.
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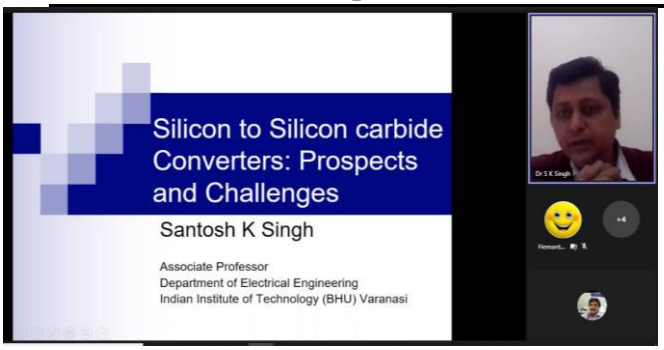
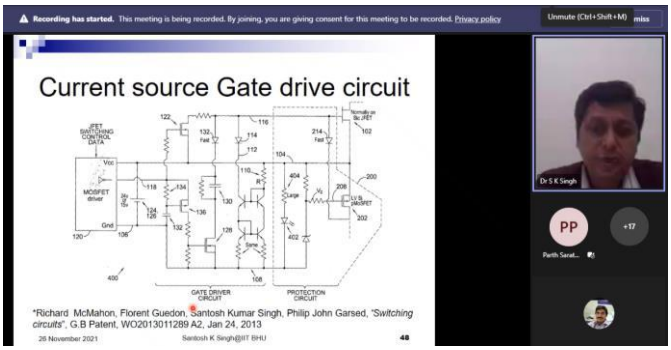
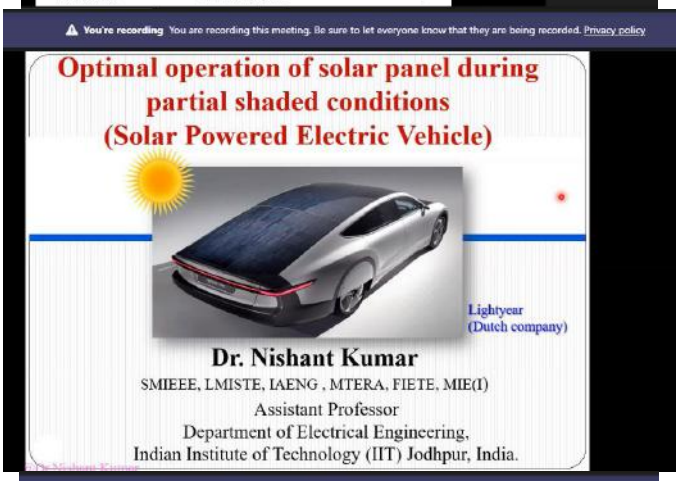
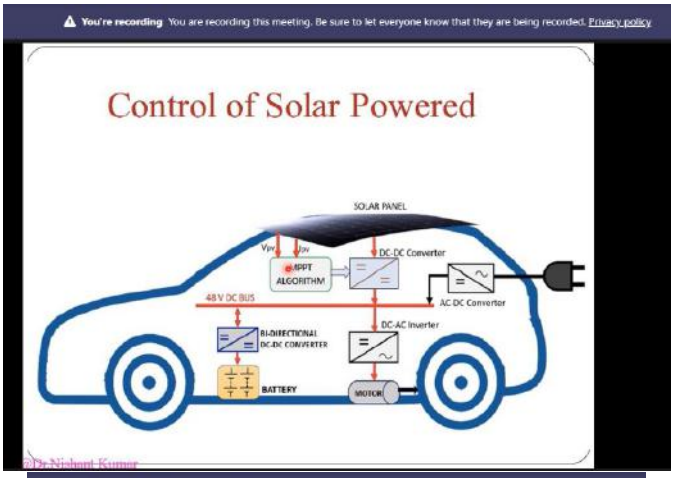
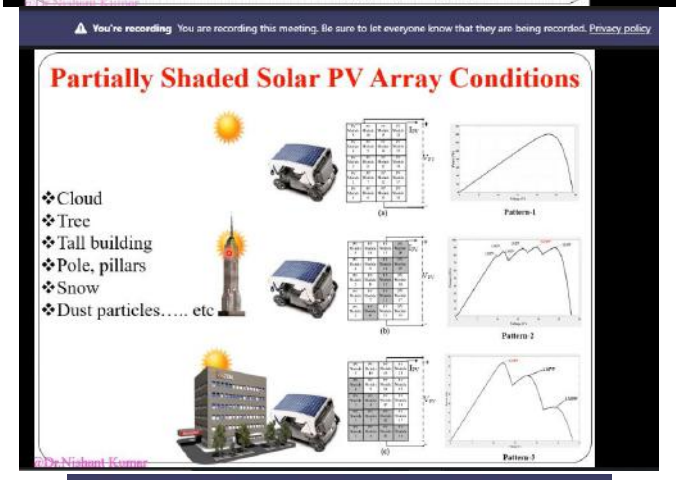
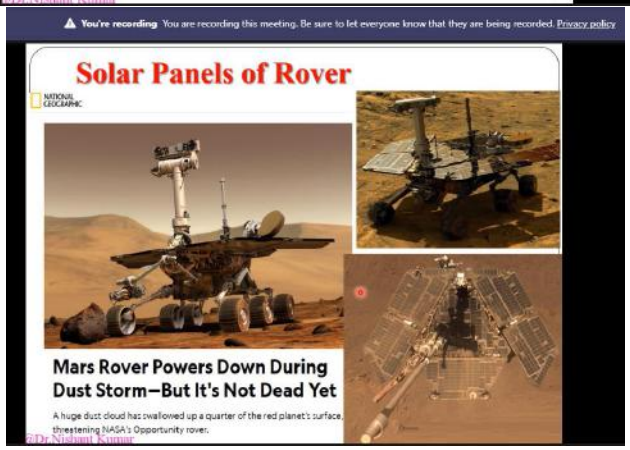


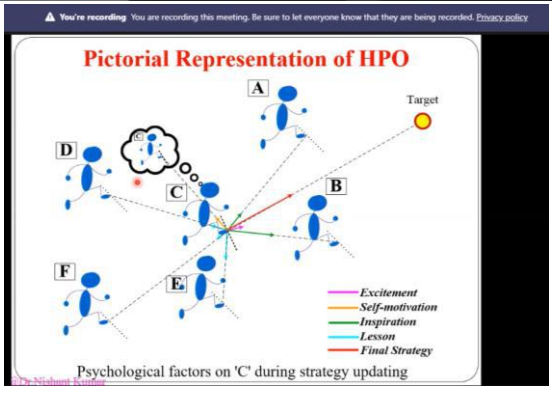


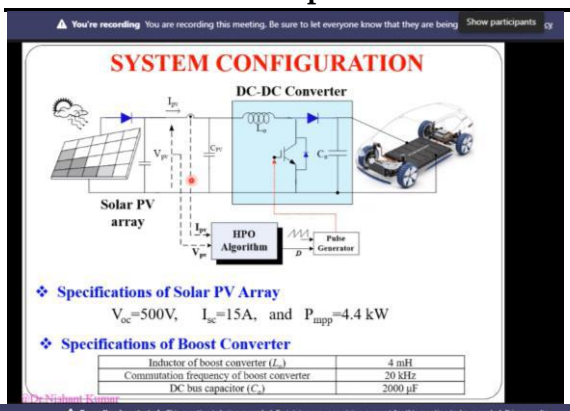


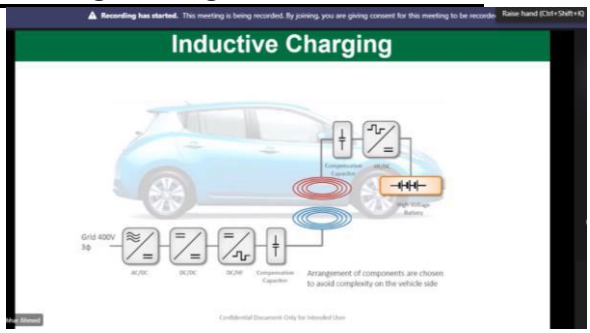






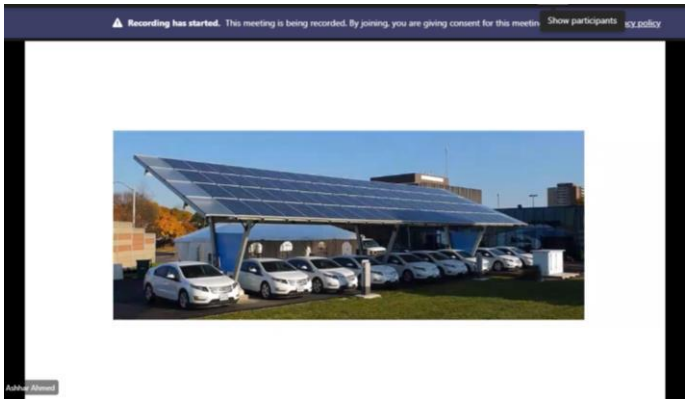


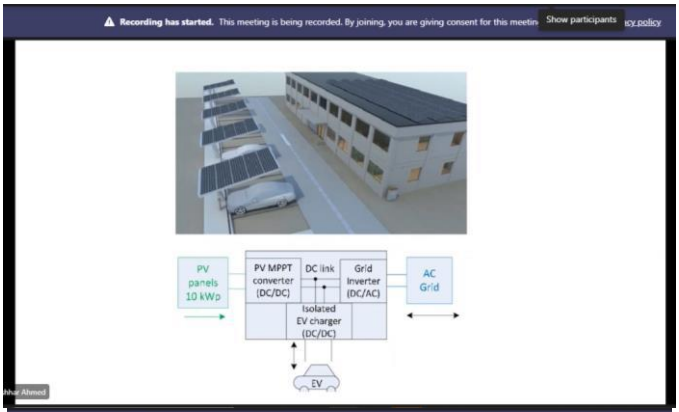

SYSTEM CONFIGURATION
DC-DC Converter
Solar PV array
HPO Algorithm
Pulse Generator
Specifications of Solar PV Array
V_{oc}=500V, I_{sc}=15A, and P_{mpp}=4.4 kW
Specifications of Boost Converter
Inductor of boost converter (L_o) 4 mH
Commutation frequency of boost converter 20 kHz
DC bus capacitor (C_o) 2000 µF


Inductive Charging

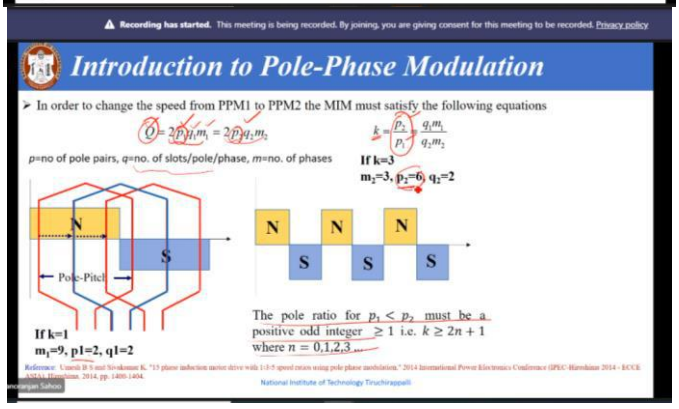

Charger Connectors
Type-1 with Yazaki Socket
Japan, USA (uses separate standard – JSAE 1772 due to 110 Voltage)
Up to 7.4 kW (32 Amps, Single Phase)
Type-2 with Mennekes Socket
Europe (Germany) – many European cars
Up to 44 kW (63 Amps, 3 Phase)
Type-3 with Le Grand Socket
France and Italy – some European cars
Up to 22 kW (32 Amps, 3 Phase)

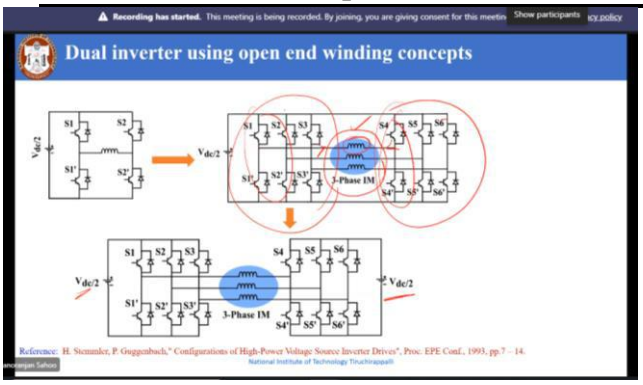

Indian Charger Connectors

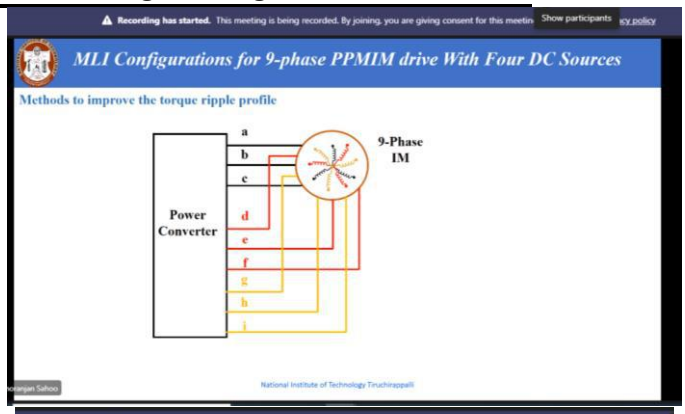


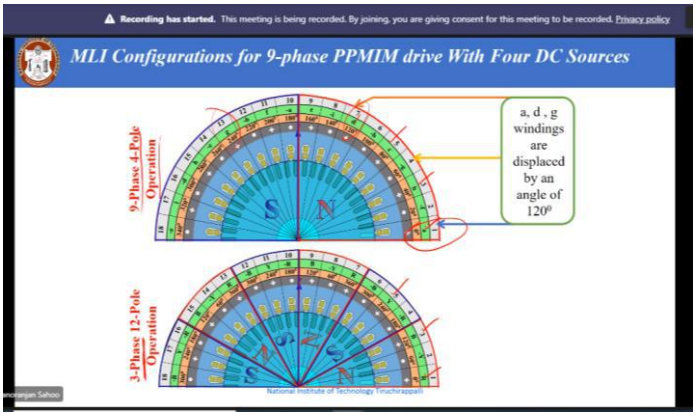

PV panels 10 kWp
PV MPPT converter (DC/DC)
DC link
Grid Inverter (DC/AC)
AC Grid
Isolated EV charger (DC/DC)
EV

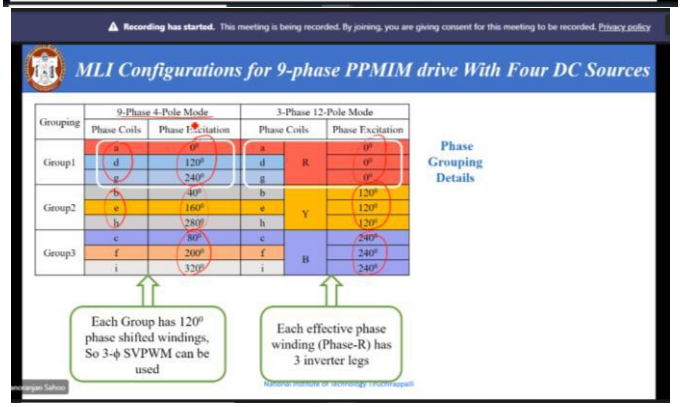

राष्ट्रीय प्रौद्योगिकी संस्थान तिरुचिरापल्ली
தேசிய தொழில்நுட்ப நிறுவனம் திருச்சிராப்பள்ளி
Multi-Phase Induction Motor Drive for Haevy Electric Vehicle Application
Dr. Manoranjan Sahoo
Assistant Professor
Department of Electrical & Electronics Engineering
National Institute of Technology Tiruchirappalli
National Institute of Technology Tiruchirappalli - 620015


Introduction to Pole-Phase Modulation
In order to change the speed from PPM1 to PPM2 the MIM must satisfy the following equations
p=no of pole pairs, q=no. of slots/pole/phase, m=no. of phases
If k=3
m_2=3, p_2=6, q_2=2
Pole-Pitch
If k=1
m_1=9, p1=2, q1=2
The pole ratio for $p_1 < p_2$ must be a positive odd integer ≥ 1 i.e. $k \geq 2n+1$ where $n = 0,1,2,3 \ldots$







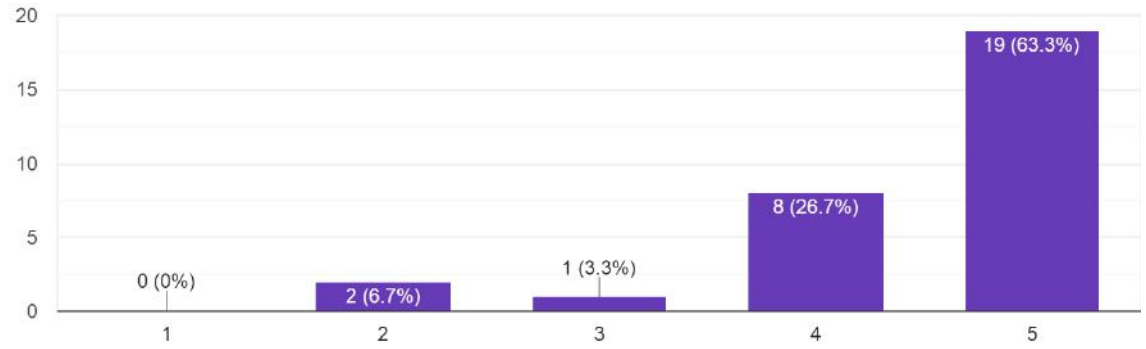


Sample Certificate

Feedback Analysis

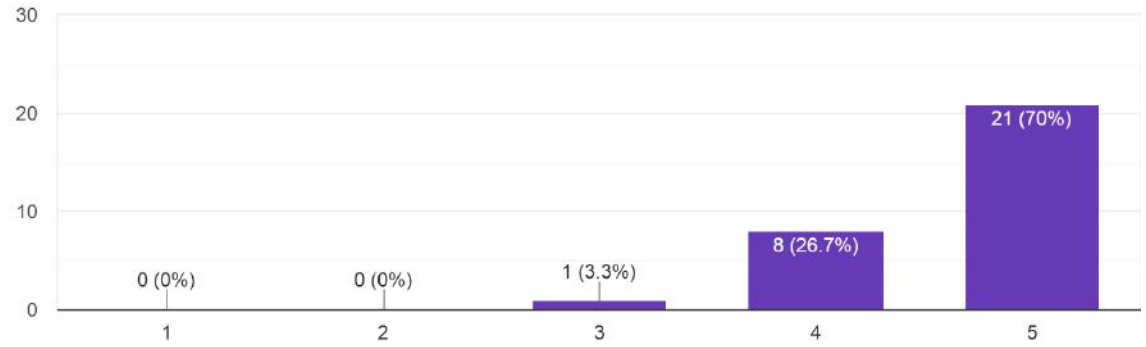
1. The interactive session was scheduled at a suitable time

30 responses



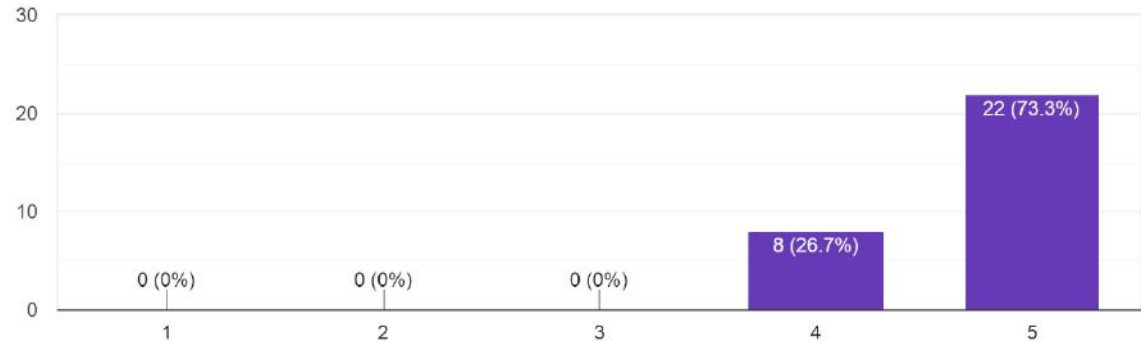
2. The interaction was useful and resource person explanation.

30 responses



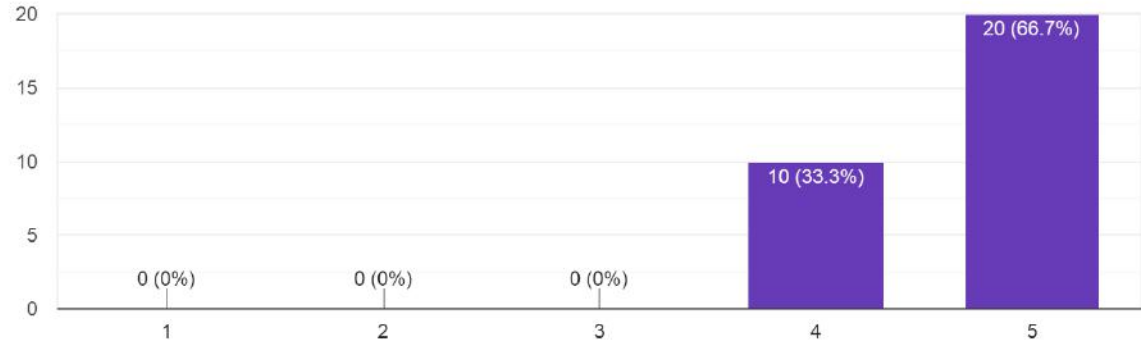
3. The information in the interaction was presented in a clear and organized manner.

30 responses



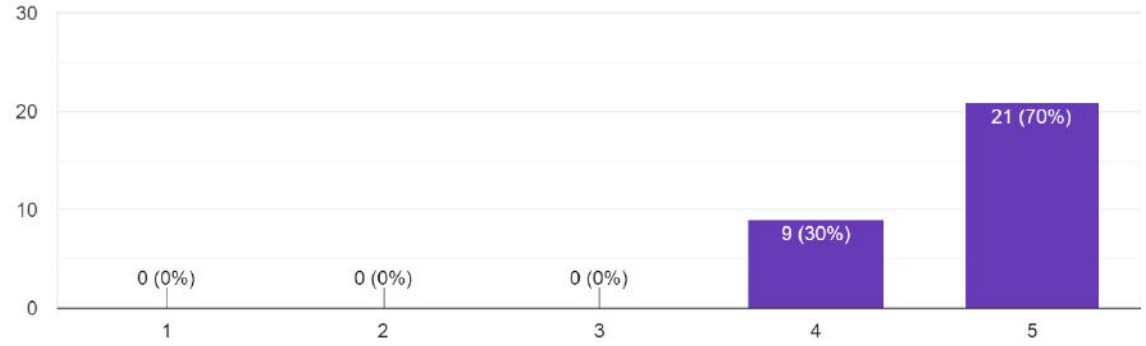
4. The presenter responded to questions an informative, appropriate and satisfactory manner.

30 responses



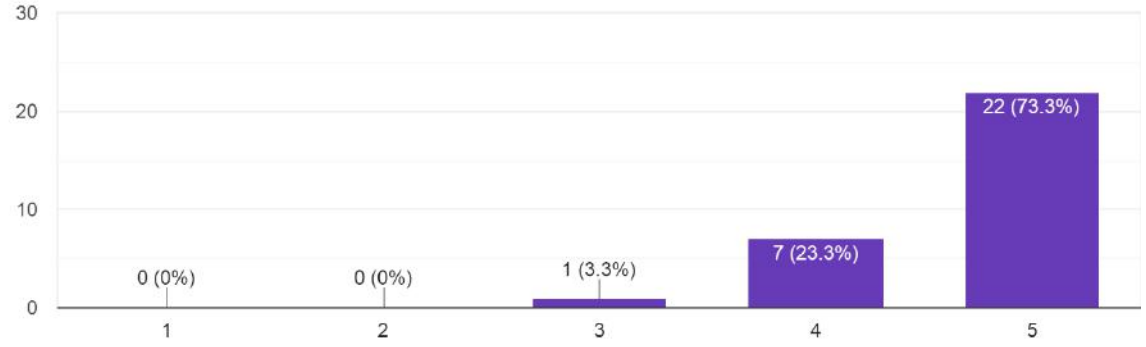
5. your impression of facilities provided by the institute for interaction.

30 responses

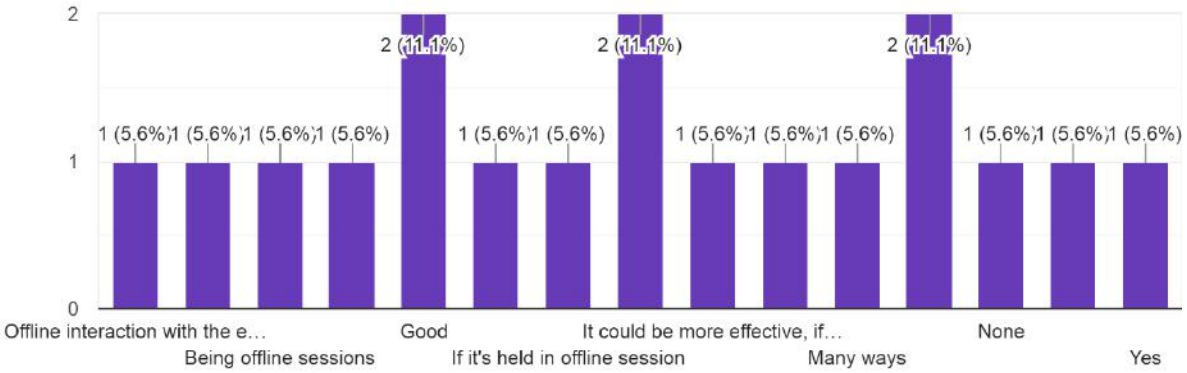


6. Overall, the session was informative and valuable.

30 responses



7. In what ways could this interaction have been improved to better suit your needs?
18 responses



8. Any Other Comments15 responses

No
Good
Very useful session
Nice sessions organised
Well program
Informative Sessions
Very useful and informative FDP. Thanks for the Resource Persons and Esteemed Organizers
No comments

Signature of the Coordinator

Signature of HoD