



# Muhammad Zarkab Farooqi

Nationality: Indian

Age: 28 Years

Marital status: Single

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I am Muhammad Zarkab Farooqi, currently pursuing a doctoral degree from the department of electrical engineering at the Indian Institute of Technology, Delhi. I am part of the PGML Lab, and working under joint supervision of [Prof. Bhim Singh](#) and [Prof. B.K.Panigrahi](#). My specific focus is on pioneering the development of novel integrated electronic capacitors with the aim to minimize the reliance on semiconductor switches and V/I sensors, all the while ensuring optimal system efficiency. I have dedicated significant effort to the development of both non-isolated and isolated DC-DC converters, focusing on implementing soft-switching techniques to enhance overall efficiency. Additionally, I have been involved in the analysis and design of integrated EV chargers, which involves combining both the traction and charging infrastructure into a unified entity. I have also put forth a modulation and control technique for these integrated systems to achieve improved performance and validated these advancements using ANSYS MAXWELL. Furthermore, I have developed 1.5kW all SiC based integrated isolated AC-DC-DC converter, dual-active bridge, dual-half bridge, totem-pole based series-stacked buffer for charging/ discharging a 120V battery using isolated Gate Driver card operating at 200kHz using TI-UCC21750QDWQ1 IC. I also developed a unified sensor+control board that incorporates the TMS320F28379D micro-controller for control of various converters.

My primary research interests include integrated EV chargers, electronic capacitors, wide-bandgap semiconductor based soft-switched converters, and advance control techniques in power electronic converters. My long term goal is to be a research oriented academician, dedicated to advancing sustainable solutions within the ongoing technological revolution in power electronics.

## EDUCATION

- [2019(Jan) - 2023(Dec)] Doctor of Philosophy in Electrical Engineering  
**Department of Electrical Engineering**, Indian Institute of Technology, New Delhi, India  
Advisors: [Prof. BHIM SINGH](#), [Prof. B.K.PANIGRAHI](#)  
Thesis Title: **Improved Power Electronics based Solutions for AC-DC Converters**  
CGPA: 8.75/10
- [2014 - 2018] Bachelor of Technology in ELECTRICAL ENGINEERING  
**Department of Electrical Engineering**, National Institute of Technology, Srinagar, India  
Advisors: [Dr. TABISH NAZIR MIR](#), [Prof. ABDUL HAMID BHAT](#)  
Thesis Title: **Comparative Analysis Of Modulation Strategies For Three-Phase Voltage Source Converters**  
CGPA: 8.61/10 (4<sup>th</sup> Position)

## RESEARCH INTERESTS

Integrated Chargers, Electronic Capacitors, Wide-bandgap Semiconductor based Soft-switched Converters, Non-linear and Planer Inductors, and Advance Control Techniques in PE Converters

## WORK EXPERIENCE

OCT 2021 ONGOING	TEACHING ASSISTANT Department of Electrical Engineering IIT Delhi, Delhi, India
DEC 2018 OCT 2021	RESEARCH FELLOW Department of Science and Technology (DST), and IIT Delhi- (Project Code: RP03631)
JAN 2019 ONGOING	TECHNICAL ASSISTANT <a href="#">PGML Lab</a> IIT Delhi, Delhi, India
AUG 2018- DEC 2018	ASST. MANAGER Tata Projects Ltd., Telangana, India

## PROFESSIONAL EXPERIENCE

2022-23	<p>DEVELOPMENT OF INTEGRATED-ISOLATED DC-DC CONVERTER-<b>SERB-NSC</b></p> <ul style="list-style-type: none"><li>• The development of 0.85 kW based isolated integrated DC-DC converter to reduce the capacitor requirement while delivering desired output power to battery without using any extra switch.</li><li>• SiC based full-bridge DAB was developed and integrated with a unfolding bridge to perform active power decoupling in multilevel converters, which have applications in ultra-fast EV charging stations, large-scale solar PV systems, railway traction system and split-battery energy storage system.</li></ul> <p>Submitted to <a href="#">IEEE Transactions on Industrial Electronics</a>, <a href="#">IEEE IAS-2023</a></p>
2020-23	<p>CONTROL AND MODULATION STRATEGIES FOR BUCK-BASED ELECTRONIC CAPACITOR-<b>GoI-DST</b></p> <ul style="list-style-type: none"><li>• Developed a control strategy for 1kW SiC based electronic capacitor of which entitles the design of a faster decoupling control in CRM modulation, while ensuring the system stability and efficiency during dynamic periods.</li><li>• A hybrid continuous and critical conduction mode which minimizes power loss attributed to buck-based electronic capacitor, over a wide power range, making it suitable for high-power applications. The modulation technique was verified by using specially designed low-noise immunity current sensor board integrated with Texas Instruments microcontroller (TMS320f28379D).</li></ul> <p>Published in <a href="#">IEEE Transactions on Industrial Informatics</a></p>
2021-22	<p>MULTI-FUNCTIONAL INTEGRATED PMSM BASED ON-BOARD CHARGER <b>GoI-DST</b></p> <ul style="list-style-type: none"><li>• A higher gravimetric and volumetric power density in the on-board charger was attained by employing a integrating set of components for charging the HV battery, LV battery, and traction purposes.</li><li>• Components employed for charging a LV battery were reutilized for active power decoupling in grid connected mode.</li><li>• An improved control and modulation was derived for input power quality and EMI improvement for proposed integrated charger and verified on 1kW hardware prototype.</li></ul> <p>Submitted to <a href="#">IEEE ECCE-2021</a>, <a href="#">IEEE Transactions on Transportation Electrification</a></p>
2019-21	<p>CURRENT/ VOLTAGE SENSOR-LESS TECHNIQUES IN VARIOUS ELECTRONIC CAPACITORS.<b>GoI-DST</b></p> <ul style="list-style-type: none"><li>• Development a 1kW IGBT based experimental setup to validate sensorless operation of buck based active power decoupling converter using fixed frequency based modulated-model predictive control.</li><li>• Formulated a control technique based on adaptive non-linear current observer for current sensorless operation of series-stacked buffer.</li></ul> <p>Published in <a href="#">IEEE Transactions on Transportation Electrification</a></p>

2020-23	<p>MENTORING STUDENTS FOR MASTER THESIS AND BACHELOR'S PROJECTS</p> <ul style="list-style-type: none"> <li>• Project 1: Transformer Design using Finite Element Analysis (FEA).</li> <li>• Project 2: Control and Design of high frequency unfolded based isolated DC-DC converters.</li> <li>• Project 3: Planar Inductor Design using ANSYS MAXWELL.</li> <li>• Project 4: Single-stage isolated AC-DC converters for railway traction application</li> </ul>
2017-18	<p>COMPARISON OF DIFFERENT MODULATION STRATEGIES FOR 3-PHASE VOLTAGE SOURCE CONVERTER <b>PE Lab, NIT Srinagar</b></p> <ul style="list-style-type: none"> <li>• Various modulation techniques of a three-phase voltage source converter were compared, analyzed and examined for their performance in generation for a sinusoidal output. Modulation techniques include Sine-PWM, Space-vector PWM, Delta-Sigma, Model Predictive Control and Modulated Model Predictive Control.</li> <li>• MATLAB/Simulink and Hardware implementation of different modulation techniques was verified on 1kW IGBT based 3-Phase VSI using D-Space(RTI 1104)</li> </ul>

## INDIVIDUAL PROJECTS

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- DESIGN AND ANALYSIS OF NON-LINEAR PLANAR INDUCTOR USING ANSYS MAXWELL AND KICAD
  - DESIGN OF ISOLATION TRANSFORMER FOR FLYBACK CONVERTER USING ANSYS MAXWELL (PE-MAG)
  - DESIGN OF 100kW IPMSM USING ANSYS MAXWELL (RMXPRT)
  - 1 kW SiC BASED DUAL-ACTIVE BRIDGE FOR CHARGING A 120V, 24AHR BATTERY

## PATENTS

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- B. Singh, B.K.Panigrahi **M. Z. Farooqi**, *Single phase single stage isolated bidirectional converter for dc-link capacitor reduction*, Indian Patent Application No. 202111058797.
  - B. Singh, B.K.Panigrahi **M. Z. Farooqi**, *Electronic Capacitor based Full-bridge Integrated Isolated DC-DC Converter with Power Decoupling Unfolder Circuit*, Indian Patent (Submitted).

## PUBLICATIONS

### Selected Publications

- [J1] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "Robust Control for Enhanced Dynamic Performance of CRM based Active Power Decoupling Circuit," in *IEEE Transactions on Industrial Informatics*, Early Access (**IF:12.3**). [Link](#)
- [J2] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "Reduced Sensor-Based Model Predictive Control of Power Decoupling Circuit for On-Board EV Charger," in *IEEE Transactions on Transportation Electrification*, vol. 9, no. 2, pp. 2104-2114, June 2023. (**IF:7.0**). [Link](#)

### Journal papers

- [J3] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "Enhanced Control and Modulation of On-Board Integrated EV Charger with Active Power Decoupling Capability," in *IEEE Transactions on Transportation Electrification*. (**IF:7.0**)(Under Review: TTE-Reg-2023-03-0514.R1)
- [J4] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "Integrated Electronic Capacitors based Split BES-assisted Modular Multi-Port Power Electronic Transformer for Fast EV Charging Station," in *IEEE Transactions on Industrial Electronics*. (**IF:7.7**)(Under Review: 2023-TIE-2990.R1)

## Conferences Papers

- [C1] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "A Multiport EV-Fleet Charging Station Based on Modular Multilevel Converter," in *2021 IEEE 12th Energy Conversion Congress & Exposition - Asia (ECCE-Asia)*, Singapore, Singapore, 2021, pp. 1765-1770. [Link](#)
- [C2] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, "Bi-Directional Isolated EV Charger with Reduced Switch Count and DC-link Capacitance," in *2021 IEEE 6th International Conference on Computing, Communication and Automation (ICCCA)*, Arad, Romania, 2021, pp. 189-194. [Link](#)
- [C3] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, Rohit Kumar, "Single-Stage Isolated Bidirectional Soft-Switched AC-to-DC Converter with Active Power Decoupling," in *14<sup>th</sup> IEEE Energy Conversion Congress and Exposition (ECCE)*, Nashville, TN, USA, 2023, (Accepted-Oral Presentation).
- [C4] **M. Z. Farooqi**, Bhim Singh, B. K. Panigrahi, Rohit Kumar, "Active Power Decoupling in Cascaded H-Bridge Converter using Secondary-Stage Isolated DC-DC Converters," in *IEEE IAS Annual Meeting 2023 (IASAM)*, Omni Nashville, TN, USA, 2023, (Accepted-Oral Presentation).

## COURSES TAKEN

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- Digital Control of Power Electronics [Spring 2019]
- Switched-Mode Power Conversion [Spring 2019]
- Computer-Aided Design of Electric Machines [Spring 2019]
- Dynamic Modelling and Control of Grid Connected Converters [Spring 2019]
- High Power Converters [Fall 2019]
- Selected Topics in Power Electronics [Fall 2019]
- Selected Topics in Control Systems [Fall 2019]
- WBG based Soft-Switching Converters [Spring 2020]
- Resonant Power Conversion and Wireless Power Transfer [Fall 2023]

## COURSE PROJECTS

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- **HARDWARE IMPLEMENTATION AND ASSOCIATED CONTROL OF SOLAR PV BASED SINGLE-PHASE GRID CONNECTED DC-AC INVERTER [2019]**  
Hardware Design, and Micro-controller Coding of wide-band based d 2kW DC-AC Grid Connected Inverter with improved performance under weak grid conditions  
**Advisor:** Prof. Ramkrishan Maheshwari,
- **COMPARISON OF DIFFERENT MODULATION STRATEGIES FOR ENHANCED DC UTILIZATION [2018]**  
Different modulation techniques such as SPWM, SVM PWM, Hysteresis modulation technique, 3rd harmonic injection, Delta Sigma Modulation, Predictive Control Modulation & Modified Predictive Control Modulation implementation and verification on 1 kW IGBT based hardware prototype.  
**Advisor:** Prof. T.N.Mir
- **ANALYSIS & DESIGN OF INTERLEAVED BOOST CONVERTER FOR ELECTRIC VEHICLE CHARGING [2019]**  
Controller Design of 10kW EV charger operating at 100kHz in discrete-time domain  
**Advisor:** Prof. S.S. Nag

## TEACHING EXPERIENCE

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- Introduction to Electrical Engineering (ELL101)
- Introduction to Electrical Engineering Lab (ELP101)
- Electromechanics Laboratory Lab (ELP203)

- Electric Drive Systems (ELL752)
- Electrical Machines Lab (ELP850)
- Electric Drives Lab (ELP852)

## AFFILIATIONS

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- IEEE *Member*
- IEEE IAS *Member*
- IEEE PES *Member*
- IEEE Young Professional *Member*
- Reviewer *IEEE Transactions on Power Electronics*
- Reviewer *IEEE Transactions on Industrial Electronics*
- Reviewer *IEEE Transactions on Industry Applications*
- Reviewer *IET Power Electronics*
- Reviewer for Conferences: *APEC-2022, ITEC-2023, ECCE-2022-23.*

## TALKS AND SEMINARS

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|-------------|---|
| Oct, 2023   | <i>Poster Presentation at IEEE IAS-AM 2023</i> on Integrated-Isolated Electronic Capacitor for DC-DC Power Conversion in Multi-level AC-DC-DC Converters. |
| April, 2023 | <i>Invited talk at JNTU, Kakinada, AP</i> on Implementation and Design of Isolated DC-DC Converters.  |
| Feb, 2023   | <i>Invited talk at JNTU, Kakinada, AP</i> on Design and Implementation of Digital Controller for DC-DC & AC-DC Converters.                                |
| Oct, 2022   | <i>Invited talk at NITTTR, Chandigarh</i> on Control and Stability Analysis of Switched Mode Power Converters.  |
| Oct, 2021   | <i>Paper Presentation at IEEE ECCE-US 2021</i> on Reducing DC-Link Capacitance in EV Chargers.  |
| May, 2021   | <i>Paper Presentation at IEEE ECCE-Asia 2021</i> on Isolated Multilevel EV Chargers.  |
| Dec, 2020   | <i>Paper Presentation at IEEE PEDES 2020</i> on Model Predictive Control in Multilevel EV Chargers.   |

## AWARDS AND CERTIFICATES

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| 2023 | <i>Graduate Student Grant</i> in IEEE Industry Applications Society (IAS) Annual Meeting 2023. |
| 2023 | <i>Research Excellence Travel award (RETA)</i> in IIT Delhi-2023.                              |
| 2021 | <i>Research Scholar Travel Award (RSTA)</i> in IIT Delhi-2021.                                 |
| 2018 | <i>4<sup>th</sup> Rank</i> in the class of 75 students (B.Tech) in NIT Srinagar-2018.          |
| 2023 | <i>Ansys Maxwell: High Frequency Power Magnetics</i> by Udemy (Online)                         |

## TECHNICAL SKILLS

SILICON CARBIDE BASED PE CONVERTERS	<i>Single-phase PFC based AC-DC Converter for bidirectional Power Flow</i> <i>Dual-Active Bridge for EV Charging</i> <i>Power Electronics based Capacitors</i> <i>Soft-switching in DC-DC Converters for Improved Efficiency</i>
GATE DRIVER DESIGN	<i>Gate Driver Design with De-saturation, and Over-current Protection</i> <i>Triggering 5kW SiC based Converter with 100kHz Switching Frequency</i>
DSP, FPGA & DSPACE	<i>Implementation of advance techniques for controlling PE converters</i>
CURRENT/VOLTAGE SENSOR	<i>Sensors with 1MHz bandwidth for controlling PE Converters</i>
MODELLING AND DESIGN	Multiphysics modelling ANSYS MAXWELL, PEMag, RMXprt, Simplorer , Study of EMI and Thermal Issues
CIRCUIT AND PCB	Circuit designing and verification in Simplis, and LT-spice PCB designing in KiCad, Design Spark, and Altium Designer
PROGRAMMING	Proficient in C & Embedded C, Intermediate knowledge of Python

## REFERENCES

- **Prof. Bhim Singh (Ph.D. Supervisor)**  
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Department of Electrical Engineering  
**Indian Institute of Technology Delhi, India**
- **Prof. Bijaya Ketan Panigrahi (Ph.D. Supervisor)**  
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HOD, Centre for Automotive Research and Tribology  
**Indian Institute of Technology Delhi, India**
- **Dr. Tabish Nazir Mir (B.Tech Supervisor)**  
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**University of Nottingham, United Kingdom**