Summary of the activities during January-March 2025 in IC Center of Excellence

1. **7 students received fellowship in VLSID 2025**. They have interacted with several ETCE alumni and participated two days of extensive tutorial sessions.
2. Extension to VLSID activity, **two second year MTech VLSI students got offline internship in Thales.**
3. Extension to VLSID activity **Prof. Utsab Banerjee, faculty IISC visited IC CoE** on 28th March and interacted with students. Subsequently 7 students have shown interest to work in IISC during summer internship. List has been finalized and sends to Prof. Banerjee. He assured that next year he will do this same event during January so that more students can be accommodated.
4. **Final Year MTech VLSI students are on the verge of thesis submission** during May 31st 2025. Among them 1 dissertation (**jointly with Philips**), 2 dissertations (**jointly with Ciyent**), 2 dissertations (**partly with Vertiv**) are among the top of the lists.
5. **WPT work:** 4 UG EE students showed interest on wireless power transfer activities and initially they have started the design of power transfer circuit for low current fast charging which is to be useful for mobile charging. They have showed a basic board level model to switch on a LED. Most important design challenge is to have proper integration of coils with suitable turn's ratio. Subsequently, students have presented their work to lead designer of Antoric IC (Santanu who help us during c2s proposal preparation by providing EV specification). Now this team has been mentored every week by Santanu to demonstrate a table top model. Soon students will show detail list of BoM which needs to be purchased.
6. **CMOS inverter design using Synopsys**: After discussions with Mrinal Das, a group of students has been assigned to design and demonstrate full FE and BE design of CMOS inverter using synopsys backend. It has been observed that our students are not well adversed in IC compiler and use of synopsys pdk. Students are working on this and VLSI club core team has communicated with Sankalp Singh for IC compiler training support.
7. **Industry driven problem statements:** Antoric IC lead designer provides me two problem statements, a) CMOS based PA design with a fixed specification, b) LDO design. One group of UG students has been provided the specifications of PA. Subsequently, a team, consisting of one MTech VLSI first year student (incidentally a sponsored candidate from SAMEER, Kolkata having good experience in MIC design) and 4 UG –III students have started design and regularly holds meeting to show the FE results at the earliest. The other design also has been taken care by 3 UG –III students. They have achieved a FE results on LDO. I am searching for good mentor for them.
8. **Paper submitted, presented in conferences.**

a. Paper published in IEEE journal

i. Mr. S. Mitra has published IEEE Transaction on ED entitled "Design of MoS2 NCFET Featuring Subthermodynamic Limit SS, No More Than 5 mV/V DIBR, and 0.8% Threshold Voltage Variation at 10-nm Channel Length: Modeling and Analysis" under the guidance of Dr. Chandrima Mondal.

b. Paper presented in difference conferences:

i. ASIC Design of an Interval type-2 Fuzzy Logic Engine for Control Application: A team of UG-III (Member of VLSI club) , CU student and mentored by Prof. Amit Konar; Presented in DevIC.
ii. Lightweight 64-bit AES-Inspired Symmetric Cryptographic Core for Low-Power and Resource-Constrained Systems, A team of UG EE students (Member of VLSI club) and mentored by Shaik Aleem Ur Rehaman (Microsoft); Presented in DevIC.
iii. Energy-Efficient 4-Bit Multiplier for High Performance and Low Power Consumption, A team consists of UG EE-III, MTech VLSI second year (Member of VLSI Club) and Mentored by Dr. Dibyendu Kayal (Intel); Presented in DevIC.
iv. Conference paper presented in DevIC: MOSFET based Biosensor by Indranil Banerjee, Kalyani University

c. Paper submitted to different conferences:

i. Collaboration with CGCRI on FPGA based neuromorphic works are taken care where three UG students (ETCE and EE) are sitting with scientists of CGCRI for FPGA based work. Initially image processing techniques in hardware are taken care. As a result, one paper has been submitted to *IEEE CAS sponsored VLSI SATA* and it is under review.
ii. conference paper accepted in IEEE GCON based on FinHEMT for RF application

d. Preparation of paper for upcoming conferences

i. Students are working on a paper for the next VLSID Conference in which students have employed DC compiler of Synopsis to implement an image restoration algorithm. This algorithm has been tested on the Raspberry pi board, Jetson Nano board and the PYNC board. The efficiency of algorithm execution in various systems will help us compare the performance of the boards.

ii. Real-time image dehazing has been implemented on a PYNQ FPGA by designing hardware-accelerated IP cores in Verilog for dark channel estimation and wavelet-based dehazing. These Verilog modules have been integrated into the Vivado Block Design environment and the corresponding bitstream for FPGA deployment has been generated. PYNQ Python APIs have been utilized to handle image data transfer and control the FPGA processing pipeline from the host processor. To achieve high performance, optimization techniques have been applied such as parallel processing, pipelining, and efficient memory access management, ensuring low-latency and high-throughput image dehazing in real time.

9. Submission of project proposal in WBDST FIST:

JU ETCE has prepared a proposal and submitted to WBDST on modification and augmentation of its existing fabrication facility in IC Center. Dr. Chandrima Mondal is the lead PI for this proposal. Accordingly an extensive survey has been conducted about the functioning of existing facility. Subsequently, Meeting has been arranged with Dr. Mainak Pal (Post doc fellow IACS), Dr. Arijit Majumder (Officer in Charge, SAMEER Kolkata) and Prof. H Saha(Past Coordinator IC Center and Professor JU ETCE).

a) Dr. Pal highlighted about training of existing lithography facility and found that using 5 inch chuck 1 and 2 inch work is possible, however with our present expertise we are unable to produce mask suitable for 1 and 2 inch. Hence mask aligner instrument is assumed to be non-functional. Also there has been a problem of leakage in vaccum table which need fund for maintenance.
b) Dr. Mazumder suggested complete overhauling of the fabrication facility starting from clean room. He mentioned that we need a small region for creating clean room and in that special instruments need to be kept. However for that the starting point should be floor and ceiling overhauling which need good amount of financial support.
c) Prof. Saha suggested that it is not always possible to do everything in our existing system as it needs good amount of instrument purchase. Hence he suggested that we can create a team and use the facility of IIEST shibpur and do fabrication from its center. For that, he suggested a formal collaboration agreement between IIEST and IC Center.

10 **Work done from students group (under the supervision of Prof. Sheli Sinha Chaudhuri) on VLSI hardware**:

Students have worked on a malaria detection system where they have developed a computer-assisted diagnostic method using a lightweight deep-learning model for malaria detection. They have implemented a hardware synthesis system-based deep neural network which is operated by using Resistor Transistor Logic (RTL) through the Xilinx 2019.0.1 present in the Computer Vision and Data Analytics lab (procured from RUSA 2.0 project fund). The Malaria cell image dataset from the official NIH database has been used.

11. **Participation in Anveshan 2025** :

A group of 3 students consisting of 1 PhD scholar and 2 UG final year students participate AIU (All India University Association) international research conclave, and exhibited their project: AI driven weed detection and crop disease monitoring rover, and won the 3rd prize in zonal round (East zone) and also participated in the final round held at Chitkara University, Punjab.

12. **ICORT 2025 participation**: A group of 4 students consisting of 1 PhD scholar, 2 UG final year students, one UG II student participated in ICORT 2025 exhibition, hosted by DRDO ITR Chandipur. The team exhibited two models, the weed detection agrover and the water monitoring device for fish farming. These are the outcomes generated from IoT laboratory.

13. Work related to synthesis of Black Phosphorus

A team, consists of student of MTech VLSI, Final year student of MSc Electronics Sc, JU, faculty member of GNIT and JU have started work on Black Phosphorus for gas sensor and neuromorphic related sensor activities.

Method 1: Aqueous Solvent (DI Water)

- 0.30 g of red phosphorus was grinded in a crucible.
- Mixed with DI water and stirred for 2 hours.
- Given an ultrasonic treatment.
- Transferred to an autoclave and heated at 175 °C.

Observations:
We conduct three trials:

Trial No. 1 (24 hrs):

- Remained wet, not fully dried.

Trial No. 2 (48 hrs):

- Very small amount of black-colored material formed.
- It was too low for analysis.

Trial No. 3 (48 hrs):

- Upon opening autoclave, smoke was released.
- Material ignited when exposed to air.
- Ignition occurred again when we touched the material.
- Likely formation of white phosphorus – highly reactive and flammable.
- Indicates incorrect synthesis method or unstable conditions.

Method 2: Organic Solvent (Ethylenediamine)

Same steps as above, but DI water was replaced with ethylenediamine as solvent.
Two trials conducted:
Trial 1: 24 hours at 175 °C
Trial 2: 48 hours at 175 °C

- Observations:
  Both Trials (24 & 48 hrs):
- Product turned brown instead of black.
- Material was sticky in texture.
- Stickiness increased upon exposure to air.
- Required to place in a vacuum chamber.
- No satisfactory formation of black phosphorus observed.

Conclusion:

- Both methods failed to synthesis stable and sufficient black phosphorus—the aqueous route formed reactive white phosphorus, while the ethylenediamine method produced a sticky brown material.
- Further changes of temperature, pressure, and solvent system are necessary for successful synthesis.
- Characterization reveals similarities between the material and black phosphorus, indicating that a small amount of the material has transformed into black phosphorus.