Industry Linked Projects as Tools for Improving Employability of Budding Engineers

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Abstract: Technology is an ever-advancing field at par with scientific and technological innovations. Technical higher education policy always tries to adopt and implement these changes in their scheme and curriculum in line with industry requirements. The present paper briefs about the latest indications on the teaching/learning methods and technical change in academia of countries on the path of development, and its effects in the applying the enhanced employment of students in core industries. Here the tool for successful enhancing of employment in related industry over the years is discussed. Exploration of the corporate working environment with focused design orientation is addressed through specific industry guided projects. The proposed plan of industry supported (Prakalp) projects are implemented at our institution, starting from pre-final year to final year UG scheme over past three years. Key benefits observed through the implementation of the proposed scheme are enhanced employment of students in related industries, improved skill development of the students and peer learning among student fraternity through group discussions. Industry guided projects can help to reduce the technological gap between industry and academia. Teaching fraternity can communicate in progressive and meaningful way with team of students and industry mentors for the implementation of set objectives of the projects.

Keywords: Core industries, Employment enhancement, Prakalp, Best Practices, VLSI

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1. Introduction

Every course of higher technical education involves a set of theory and laboratory courses, followed by an internship program or project work. It is evident that the students can learn better by the way of experiential learning, which involves understanding by the way of “doing” or “implementing” the solutions to different engineering problems. Project work offers one such opportunity. Many universities and institutions have adapted the notion of introductory project work, mini project work and major project works to enhance the learn ability of students.

Project work involves the individual work contribution as whole teamwork representing planning of work, budget estimation, implementation and then presentation or demonstration. Project work may be sponsored by government agencies or private sectors. The students can carry out non-sponsored project works at their institutions. In respect of industrial sponsored projects, multiple learning avenues are provided, which would enable the students to realize the gap between classroom interactions and real-world scenario. The modern day Engineer faces newer set of challenges, and hence requires more than the conventional methods. They are expected to comprehend newer ways of functioning in teams working on various domains of engineering. They also need to be pro-active. Acquisition of interdisciplinary knowledge and working on such themes has become the order of the day. This is also aligned with the spirit of the newly proposed National Education Policy (NEP-2020). The engineers in the modern society are to be handling the latest problems of value to society, which would then be converted into real-world opportunities for business. This is also reflected in the Course Outcomes (CO) being mapped to the Program Outcomes (PO) and Program Educational Objectives (PEO), and hence this study.

2. Theoretical Framework

An unique joint work, involving three major universities in the USA are discussed (John S. Lamancusa et. al., 2013). The learning factory is described as the product of the Manufacturing Engineering Education Partnership (MEEP). The reported work describes a novel way of designing the courses. It is mentioned that the learning resources are made accessible in the electronic form though the internet. The problem identification is provided by the industry partners. The students would have these industry partners as their customers during the higher-level design courses. More than 200 multidisciplinary projects have been reported as completed. The implementations involve multiple teams from various disciplines of engineering, including the business team. The implementation has seen a large number of faculty members participating from five different time zones.

The opinion of most of the industries is that lessons on critical thinking skills, must be included to help students to access the credibility of resources and come up with multiple alternatives before arriving at the optimal solution (Boje D. 2001). Traditional case study approach does not develop skills completely, hence resulting into incomplete solution to the problem (De Bono E., 1970). In project development phase, it is necessary to understand client expectations prior to defining deliverables. The students involved in industry sponsored projects were compelled to behave as professionals in (Gloeckler G., 2008). In experiential learning based on projects, the students gain a chance to design, develop multiple strategies for a real-life problem-based definition. Such an approach provides ways to involve significant live business consulting. The main objective is to provide a means with which the students can leverage the access to business opportunities. This would enable the students in a smoother change over from a conventional academic situation to a more professional field.

The research findings in developing the student attitudes for careers of multiple types by means of project-based learning are reported (Martinich J. A, et al., 2006). Standard cost benefit appraisals found difficulty in satisfactorily incorporating dynamically with change in technical learning changes. The evidence provided in (Gorman M., 2010) is about the importance of learning effects and technical change in industrial projects providing qualitative support for Cost Benefit Analysis(CBA).With the background it seems to be true that student project with industry depends upon a set of relationships involving students, faculty, an industry liaison and the educational institution. Business strategies are at the core of a course which is designed keeping in mind the student consulting abilities. They involve an actual customer. The brief guide (John Weiss, 2012) reports that the industry-sponsored student projects help in improved long-term collaborations, and they are also reported to involve important stake-holders like the undergraduates, teaching fraternity, business customers in a given geographic locations, an industry connection, and the educational institution.

The recently launched National Education Policy (Nandini, (2020), Aithal P. S. et al (2019)) NEP-2020 by the honorable Government of India also has suggestions to inculcate professional values and ethics, while emphasizing on the need for inter-disciplinary nature of solutions to real-world problems.

This paper proposes one of the best practice implemented at our institution, getting industry project guidelines and assessment for set of selected students of departments of E&EE, E&CE of our institution. The aim of this program is to establish relationship involving VLSI industry project guidance, faculty and students of our institution under the banner of Prakalp program. Further aiming at development of improved academic progress of the departments in the VLSI field and hence institutional improvements and quality standards as measurable deliverables. Establishing benchmark through best practices is one of the good concepts practiced by most of higher technical institutions. The accreditation bodies like, National Assessment and Accreditation Council (NAAC), National Board of Accreditation (NBA) and University Grant Commission(UGC) etc. are assessing performance level of different institutions through best practices (Lakshmi T. K. S. et al (2007), Pillai Latha (2006), Sawant D. G. (2016), Dutta Sawant (2017)) as one of the evaluation criteria.

Many self-financed private colleges in India have started implementation of skill-based practices. This helps in providing a budding engineer with multiple options of career in early part of life. The top 15 of such colleges have been identified and listed with their unique best practices by Outlook magazine and these unique practices are studied (Srinivas Rao Potti et al, 2014). The opinion of authors in (Srinivas Rao Potti et al, 2015) narrate implementing the best practices for the quality enhancement that could be adapted by other engineering colleges nationally and globally. It is found that the 44-page document released from AICTE is a good source of measures to be implemented for enhancing the eminence aspects in technical education. The report also narrates that these best practices are implemented by over 30 institutions all over country (2018). To prepare the students for getting success in most globally connected engineering education, the article discusses about engineering programs with best practiced formats (Alan Parkinson, 2007). Also it elaborates the challenges faced and outcome impacts with best practices implementation. The five years implementation of best practices of top 20 Engineering universities in Russia is reported (Julia Ziyatdinova et.al., 2015). The statistical list of students is prepared through analysis of their international delegations: best practices, international conference and their academic exchange program and project grant approval and its utilization. Affiliated engineering colleges with fixed syllabus do not have freedom to adopt the changes in their curriculum. In such cases the innovations can be incorporated through best practices and some project-based teaching and by solving open ended problems. The research article (Shaker Meguid, 2017) describes those best practices in engineering education could be new learner or digital natives(who are familiar with operating smart phones) nowadays can be thought by digital immigrants or engineering faculty.

To summarize, it can be observed that the best practices can be in multiple forms. Each form offers its own advantages. Practices like project-based learning, solving open ended problems etc. will make the student to think and come up with multiple solutions. This enhances the capabilities of students to propose multiple solutions, and implement them for the real-world problems.

All these above discussed best practices have been instrumental in us, initiating projects of high impact through the Prakalp program at our Institution. The Prakalp program is successfully implemented for the last three years at our institution. Implementation of this program has yielded encouraging results. The program context, planning. implementation and benefits to students, industry and institution are discussed in further sections.

3. Methods

The method section covers how the Prakalp program is envisaged and executed at the Institution.

3.1. Context of Prakalp Program

Technological changes in the VLSI field are occurring very fast in accordance with Gordon Moore's law which is stated as "number of transistors on the square meter area is doubled for every 18 months". To bridge the gap between these fast-growing field at industry and academia, the subjects called Basic Very Large-Scale Integration (VLSI) Design, Analog VLSI Design, Application Specific Integrated Circuits (ASIC) Design, CMOS VLSI Design etc. courses were introduced at undergraduate program. This has been done keeping in view the guidelines issued by the various competent authorities like AICTE and Visvesvaraya Technological University (VTU, Belagavi). The subjects are introduced with due weightage being given to various sub-fields in Electronics and Communication engineering discipline. This is of paramount importance, since an Electronics engineer is expected to gather knowledge in the allied fields also. These courses are focused towards theoretical concepts and execution with available resources. The real-time or industrial problems require additional knowledge and resources to offer feasible solutions. As a result, with a wider alumni-base, our Institution could establish good linkages with the industries, specifically in the field of VLSI. Hence, in the year 2016, the Prakalp program was initiated in association with M/s Sankalp Semiconductor Pvt. Ltd (now, a part of HCL after merger). Under the banner of Prakalp program, the Sankalp engineers were allocated to be mentoring our institution students for the implementation of projects in VLSI field.

3.2. Program Objectives

The teaching/learning process is given utmost importance in the educational institutes. Our institute continuously motivates and facilitate the needs of the teachers and students to learn and execute new methods and outcomes. Hence, the Prakalp program got approval to start at our institution during the year 2016. The objectives of this program execution being:

Stimulating young and energetic students mind towards industry environment and making them to be ready professionals

Promoting the teaching faculty with project-based learning and research skills, thus instilling responsibility in faculty for enhancing the quality of teaching-learning process and publications

Establishing relationship between students, faculty, institute and industry to transfer knowledge in the VLSI field

Training the potential upcoming VLSI engineers who would be industry-ready, so that they could be assigned with a given task on day one in the industry

Program Planning and Practice

The program execution is planned in consultation with all the stakeholders and the program started during the academic year 2017-18. Nominated group of engineers from M/s Sankalp semiconductors with group of faculties at our institution had planned the program execution. The planning phase included the following:

- selection of students for final year project implementation through written test (Objective questions on core subjects & general knowledge based)
- project title finalization
- review meetings with industry and institute mentors on weekly basis
- evaluation of projects by mentors and review committee constituted by institute.

The Prakalp program is executed at our institution successfully for three years from 2017-18 to 2019-2020. During the academic year 2017, four students of department of Electronics & Communication engineering were selected to carry out VLSI industry relevant project. Students were allowed to visit the industry, work and interact with engineers of Sankalp semiconductor Pvt. Ltd. During this course of one-and-half year time, a series of review meetings with mentors were held, thus providing valuable insights into the project definition and solutions. The initial brainstorming sessions induced the students with a sense of how to identify a problem definition that could have feasible implementation and value. The minutes of all meetings were approved and documented. The project evaluation by mentors and review committee at the institution were carried out during the above said course of time. At the end of the project, all students are employed in VLSI industry.

Similar approach continued for the academic year 2018-19 with modification as written test is conducted to departments of E&E and E&CE students with CGPA score of 8.5. Three batches of department of E&CE, one batch of department of E&EE were selected during their pre-final year. Each batch consisted of four students. After the selection, they were trained by their senior batch students with respect to working environments. The project titles were finalized for all the batches by the mentors. During the project implementation phase, reviews and evaluation were done. The minutes of the meeting were documented. During the end semester, the project evaluation process of the students took place. From this batch, most of the students were employed in VLSI industry. During the subsequent academic year 2019-20, the process continued and five batches of our institution from department of E&CE, E&EE were selected in the written test during their pre-final year. This time, as per the suggestions of industry mentors, a set of five heterogeneous batches with students from E&EE and E&CE department students was formed. Thereafter, continuous review process and project evaluation by mentors and review committee took place. The results of industry guided projects helped most of Prakalp students for the employment in VLSI related industry.

3.3. Problems Encountered and Resource Required

Recent technology changes have been incorporated in project-based learning with suggestions from industry mentors to solve the problems of the society on time lines. Even though the mentors from industry were involved continuously over online/offline modes for the project execution/evaluation, with their busy working schedule most of the time the students expressed their non-availability to solve the practical difficulty during the project execution. Further, initially the peer teaching/learning meetings were a rare feature in the institution. Most of the time faculty at the institution were engaged in the routine work, and could not have sufficient time to interact with industry mentors.

The resource required to execute this program is VLSI Cadence software. This facility and other infrastructural facility were made available at our institution. The students were suggested to make use of software existing at our institution.

3.4. Impact of Program Execution

The Prakalp program was executed successfully for three years using resources of our institution and industry. The results of implementation of industry guided projects with reviews and final examination are turned into valuable outcomes for the students and to our institution.

The advantages to students upon carrying industry guided projects over the years are:

a) increased number of employments in VLSI industry
b) enhanced opportunities to explore to the industry environment
c) fruitful interactions with people in industry at all levels of employers
d) student behavior changed slowly into professionalism
e) improvement in analyzing and applying skills
f) peer group teaching and learning experience, and boosting student's confidence level in VLSI subjects are observed.

The Prakalp program execution has advantages to the mentors and to the institution. They are listed as:

a) mentors at the institution are exposed to more practical aspects of industrial type working
b) it helped them deliver lectures more effectively quoting more industry relevant problem-solving skills
c) relations with industry were developed.

The advantages to industry are industry-ready trained engineers will be available from institutions and they can be employed directly with start of projects. The training time and training needs will be saved. In this context, institution also gets benefits directly or indirectly by industry guides projects. Their teacher skills and placement rate will be improved. Institution's ranking grade will also be improved and good relations will be established between industry and institution. Above all, industrial people may become part of academic activity, involving them with syllabus framing, question paper scrutiny and also in valuation related works. This helps us to identify ourselves uniquely in comparison with other institutions in the specific domain field.

4. Results and Discussions

The Prakalp program started in 2017-18 academic year at our institution. Pre-final students who have CGPA score of 8.5(80 students of department of E&CE) attended qualifier written test. Out of which only four students were selected to carry out their project work under guidance of Sankalp mentors along with mentors at our institution. With lot review meetings and assessments students completed their project work. Very soon all the four have got employment in VLSI industries. So carrying industry guided project during the year 2017-18 has resulted in 100% employment. This is shown in the Table 1.

Table I Employment Details of Prakalp Students During 2017-18

No of Students Selected for Prakalp in 2017-18	Employment in VLSI Industry
4	Sankalp-2
	INTEL-2

During the next year 2018-19, twelve students of departments of E&CE and E&EE have selected out of 120 eligible students with CGPA score of 8.5. Among these students three project batches were formed, two batches consisting of department of E&CE students and one batch of department of E&EE students. All three batches were assigned with projects and they have been guided and assessed by mentors at institution and industry. Finally, ten students have got employment in VLSI industry after completion of their project work. The impact of these industry guided projects has added values to the institution and to the students. This resulting impact is shown in the Fig.1.

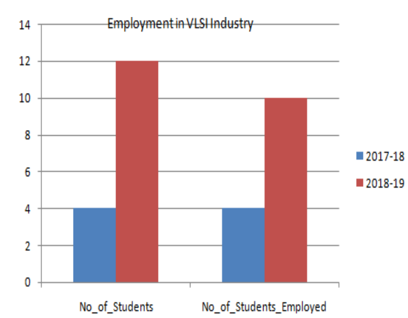

Fig.1 Employment Details of Prakalp Students During 2017-19

The results of the Prakalp program have been very encouraging. Table 2illustrates the employment details for a period of three years.

Table 2 Employment Details for Three Years

S.No.	Academic Year	Number Students Selected for Prakalp Program per Year	Number of Students Employed in VLSI Industries
1	2017-2018	4	3
2	2018-2019	12	10
3	2019-2020	16	12

The results of employment success over three years have shown that the students at colleges or universities will be employable if their theoretical and practical skills are enhanced through the help of industry sponsored project implementation. Higher technical education is the field, if nourished with right technical skills the wonders or creative environment will result from budding engineers. Fig. 2 shows the employment details of Prakalp students in VLSI industry.

The Prakalp program students' employment improvement results over three years are also discussed using Pie chart shown in Fig.3. During 2017-18, 15%, out of total (32) Prakalp students are employed. In the next year 2018-19, 38%, out of total 32 selected Prakalp students are employed. Similarly, in the year 2019-20, employment improvement is 46%, out of total selected Prakalp students over the three years.

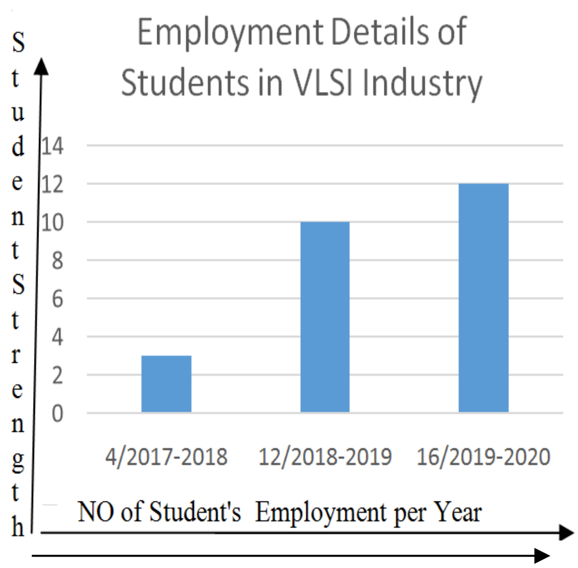

Fig. 2 Employment Details of Prakalp Students in VLSI Industry

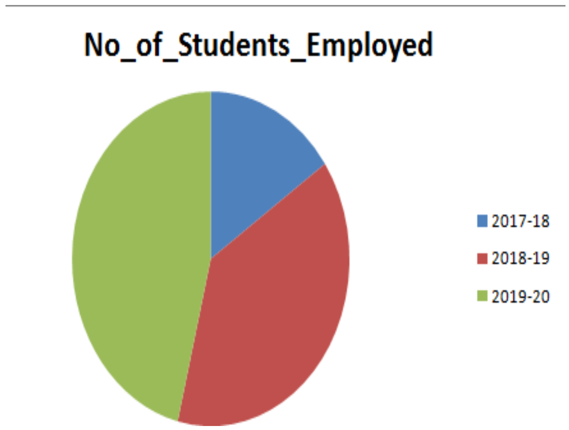

Fig.3 Employment Information in Percentage over Three Years

The results of Prakalp program execution have initiated lot of technical changes at our institution. Junior students also wish to be part of Prakalp program. Results of these kind of programs help to bridge the gap between industry and academia. Students will get to know the real-life requirements and problem-solving mechanisms in the professional way. They start thinking and behave as professionals in comparison with other students of their peer group.

With the implementation of this Prakalp program, we the mentors at institution felt that such industry collaborations programs with institutes should be more in number. This will enable the academic institutes to participate in recent technological trends as per changing needs of real-world.

Having industrial relations with institutes will help execution of quality assured projects, question paper setting and evaluation processes. This quality check helps the institutions to look for their stand among many other institutions.

The success of Prakalp program execution is compiled and compared with neighboring institutions where, such best practice is not in practice in-terms of enhanced employment in core VLSI domain and value-added courses credited to our institution. The information details of such success are indicated in Table 3.

As indicated in Table 3, we compare various parameters related to the students' placement and syllabus modification, since these are the key performance indicators. The host institution is being compared with one premier autonomous institution and one premier non-autonomous institution. These institutions have same student intake in department of E&CE. Anonymity is maintained for the obvious reasons. Our students' employment in VLSI industry shows the success of Prakalp program implementation. Some modifications suggested by mentors of industry in our VLSI courses have also played key role in enhancing employment in VLSI domain.

4.1 Evidences of Program

The evidences of the program are very simple to understand. The Prakalp program is carefully planned and executed over the period of three years. The list of projects executed by Prakalp team are listed in appendix as evidence of program success.

A total of 6 projects of high quality were carried out by the students, with regular interactions from the industry. The final findings of the project work were documented and presented as report for evaluation.

The department has also calculated the cumulative attainment of Course Outcomes (CO) for the above said three academic years. The attainment levels are measured with respect to the attainment benchmark being 80%.

The project listing is mentioned here.

1) Design of Low Voltage CMOS 18(LVCMOS 18) I/O device
2) Design of Double Data Rate Two (DDR2) I/O Transmitter Block
3) Design of Double Data Rate Two (DDR2) I/O Receiver Block
4) Design of CMOS LVDS Transmitter
5) Design of CMOS LVDS Receiver
6) Design of Power Converter

Table 3 Students Placement and course modification

S.NO	Type of Institution	Student Intake	Prakalp Program	No of Students Employment in VLSI/Year	Courses	Modification in Course
1	Autonomous - Institue1	120	NO	10	CMOS VLSI-V Semester AMMVLSI-VI Semester ASIC-VII Semester LOW Power VLSI VLSI-LAB-VI Semester	Syllabus as per affiliated University
2	Non Autonomous-Institute-2	120	NO	5	VLSI -VII Semester-VIII Semester VLSI-LAB-VII Semester	Syllabus as per affiliated University
3	**Autonomous - Our Institute**	**120**	**YES**	**15**	CMOS VLSI-V Semester AMMVLSI-VI Semester ASIC-VII Semester LOW Power VLSI-VIII Semester VLSI-LAB-VI Semester	**Process Corners estimation &** **Value added techniques for amplifier deign**

5. Conclusion

There are ever changing technologies, an industry is one of the beneficiary units to execute the changes in the form of implementation. Most of the engineering colleges include best practices as part of their curriculum development. During the orientation program for undergraduate students, the awareness about best practices is created by most of autonomous and non-autonomous engineering colleges. The gap between industry and academia is developed as per the new technology implementation based on customer requirements. The implementation of Prakalp program in our institution has been very vital to reduce gap between academia and industry in the VLSI domain. The case study through Prakalp program has shown that to implement advancing technologies for institutes/academia, a minimum of a couple of years of timeline is required. To bridge the gap, there should be collaborative workforce. As a part of it we, at our institute have worked together for project implementation of final year students over three years. Another advantage can be cited here. The students have carried out these industry projects, which were also evaluated for partially fulfilling the academic requirements for the grant of degree in engineering. This means that while the students carry out a project, they also get benefitted immensely. The Prakalp program implementation has created new initiative at our institution. The VLSI course syllabus is reframed as per the suggestions of industry mentors through which all our students get advantage, not only Prakalp students. Overall, the Prakalp initiative has shown value-addition to our institution and to our students. Hence, it is strongly felt that such increased Institution-Industry collaborative efforts may help to solve real- problems. And these kinds of best practices need to be compulsorily included in academic curricula as a part of new education system.

Appendix

The following is a list of projects implemented through Prakalp program at our institution over the duration of three years:

1. Design of Low Voltage CMOS 18(LVCMOS 18) I/O device:

   LVCMOS 18 is an industry protocol which specifies the input and output standards for transmission of the signal from low-voltage to high-voltage domain and vice-versa. This project is implemented as LVCMOS 18 transmitter block which involves the design of level shifter, pre-driver and driver circuits as per the mentioned specifications. Expected outcomes are verified with Cadence software.

2. Design of Double Data Rate Two(DDR2) I/O Transmitter Block:

   The I/O interface design for a DDR2 memory is an important part in preserving the voltage levels in the range of 0.9V to 1.8V. DDR2 SDRAM transfers the data synchronously. Both rising and falling edges of the input clock frequency are considered. The design is related to consumption of least amount of power. The high-speed design principles are employed here. The speed of the data bus is twice that of internal clock. Project is implemented by designing the basic building blocks by using Cadence Virtuoso tool with gpdk 180nm feature size of transistors.

3. Design of Double Data Rate Two (DDR2) I/O Receiver Block:

   This project is the implementation of signal computability issues on the receiver side of I/O interface block. This project implementation includes design of Schmitt Trigger, driver circuits as per mentioned specifications.

4. Design of CMOS LVDS Transmitter:

   Low-Voltage Differential Signals (LVDS) is approved signaling standard for transmitter boards of IEEE Std 1596.3-1996. The LVDS transmitter is able to transmit data over differential lines. This LVDS standard deals with conversion of analog data into digital data and it transmitted with a minimum swing of 100mV with common mode input range from 0V to 0.25V of differential driver circuit. The project implementation includes the design of basic components with mentioned specifications. LVDS transmitters are to design high performance analog to digital converters (ADCs). LVDS transmitter is used to design faster sampling rate applications. LVDS interface is used in software defined radio (SDR) devices. LVDS transmitter consumes less power with reduced amount of noise emission.

5. Design of CMOS LVDS Receiver:

   Low-Voltage Differential Signals (LVDS) is approved signaling standard for receiver boards of IEEE Std 1596.3-1996. The LVDS receiver circuit is designed with objective of achieving sufficient gain and bandwidth to receive complete transmitted signal. The design of receiver block includes the design of differential amplifier, level shifter and double ended to single ended output differential amplifier. The major design parameters like gain and bandwidth have been satisfied.

6. Design of Power Converter:

   This project is implemented to provide the designer with method of converting voltage level by modeling a buck converter both in current and voltage modes. Modeling of power converters is necessary to understand the working of each parameters of power converters. This helps to discover the errors in any circuit early stages system level defects can be reduced.

All these projects were implemented using our institutional resource such as Cadence Virtuoso and Assura, analog digital environments. During these three years, the final year students have been enabled to demonstrate the Cadence working environment effectively. This practice also saw peer-to-peer enabled learning, by having the final year students to teach the pre-final year students. It is observed that student can think beyond the current context if all the concepts were illustrated with more practical approach. Many a times, industry mentors expressed such feelings and shared with mentors at our institution. They have suggested to incorporate more project-based or practice-based teaching/learning process in curriculum.

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