Introducing High Performance Computing Concepts into Engineering Undergraduate Curriculum : A Success Story

B. Neelima[†]
Department of Computer Science and
Engineering
NMAM Institute of Technology, Nitte
Udupi District, Karnataka, India, 574110
reddy_neelima@yahoo.com

Jiajia Li
School of Computational Science and
Engineering
Georgia Institute of Technology
266 Ferst Drive, Atlanta, GA 30332-0765
jiajiali@gatech.edu

ABSTRACT

This paper discusses a successful story of introducing High Performance Computing (HPC) concepts in an engineering curriculum over a period of the last 6 academic years at various levels of the undergraduate program. The paper also elaborates about the state of the stake holders and infrastructure available at the initial stage, issues and challenges addressed year after year and the current state of the art scenario in the author's institute. HPC introduction is started with shared and distributed memory programming concepts, added with accelerator programming concepts and enhanced using hybrid programming concepts along with the theoretical concepts. The paper also explains the process of teaching and evaluating the students with respect to HPC concepts. It concludes with the direct and indirect benefits to the institutes' stake holders through the introduction of HPC concepts.

Keywords

High Performance Computing (HPC), Engineering Curricula, Undergraduate Program, Shared and Distributed Programming, Accelerator Programming, Hybrid Programming, Teaching, Evaluating Students, Institute, Stake Holders.

[†]Corresponding Author

1. INTRODUCTION

Newly introduced concepts can be established through the process of evolutionary and incremental changes. The process of introducing HPC concepts at the NMAM Institute of Technology (NMAMIT), Nitte, Udupi District, Karnataka State, India, is continuously evolving and strengthened through incremental changes. NMAMIT, Nitte is a private engineering college affiliated to a state university, named, Vishveshwaraya Technological University (VTU), Belgaum, Karnataka. The university gives the curricula for various programs and conducts examinations. Meanwhile, NMAMIT, Nitte got academic autonomy from the academic year 2007-2008. Under this academic autonomy, NMAMIT, Nitte has got the freedom of developing its own curricula for all its programs and can conduct and design the process of evaluating students. This academic autonomy has given a platform for students to learn and teachers to teach and enhance new concepts on par with the latest trends in technology and industry requirements in various streams of engineering. The same opportunity is used to introduce HPC concepts into the computer science and engineering undergraduate curriculum. The following are the key points for describing the environment in which the HPC concepts were introduced

- The department of Computer Science and Engineering has an intake of 180 students per year apart from lateral entry students from polytechnic course and 40 teaching faculty.

- For the HPC concepts introduced at NMAMIT, Nitte focuses on parallel computing and instead of super computing. Therefore, the theoretical and practical knowledge required for scientific parallel computing is given focus while preparing the syllabus [1, 2, 3].

- As NMAMIT, Nitte has no access to Exa-scale or Peta-scale machines, most of the teaching and learning is carried out on modern PC machines.

- The syllabus is continuously updated in each course at each level once a year and approved by the Board of Studies (BOS).

- The curriculum development has taken inputs from various online resources including resources from universities which share the learning material online [2, 3, 4, 5, 6].

- The online courses in HPC concepts and industry assistance to upgrade the knowledge have helped strengthen the HPC curricula every year [7, 8, 9].

- This paper considered undergraduate students' exposure to HPC concepts, level of their learning, student's feedback and outcome but did not include graduate and research students who are also part of the HPC-Lab at NMAMIT, Nitte.

The paper is organized as follows: Section 2 describes the evolution of HPC-based curricula throughout the academic years from 2009 to now. Section 2 describes the state of the stake holders and infrastructure for each academic year and issues that are solved from the previous years and also described the achievements of the students. Complete details of the outcomes of the HPC based curriculum are summarized in Section 3. Section 4 gives the direct and indirect benefits of the HPC curricula to different stake holders of the system, and conclusions are summarized in Section 5.

2. CURRICULA EVOLUTION OVER THE ACADEMIC YEARS

Though NMAMIT, Nitte has academic autonomy, at the first step it could not deviate or bring in too many changes into the curricula with the concern for the time required for the teachers to adapt to the new curriculum and for the students to adjust to the system slowly and systematically. Most of the changes and additions are very small and incremental over the years. Similar to other concepts, HPC concepts are also added systematically one after the other over the years. This entire process is explained here for each academic year (AY) starting from 2009-10.

2.1 AY-2009-10

The students who were admitted into the first year engineering program for the academic year 2009-10 were the first batch of students exposed to HPC concepts through Introduction to Computer Concepts and Programming (Course Code: CS-101) course. The first year engineering program is a common course for all the branches of engineering and the students study common subjects such as engineering mathematics, physics, chemistry and basics of electronics and computers. Introduction to computer concepts and programming (Course Code: CS-101) has theory and practical teaching hours. This addition was done for Fall-2009 and continued up to date. Simple OpenMP programs were introduced into the CS-101 laboratory work to start with parallel programming concepts. This exercise includes creating and using threads with OpenMP, understanding its environment variables, using reduction operator, programming with different types of scheduling (static, dynamic and guided) and using parallel directives. The students were excited to see their computation done by many threads and their programs getting executed faster than the serial version. The students were eventuated through continuous assessment menthols and a final assessment through a laboratory exam for parallel concepts along with the other topics of the lab. At the same time, the following issues were noticed

- The students were not exposed to Linux environment and did not know command line based execution of programs. For CS101 lab, the students were using Codeblocks IDE to execute their programs.

- Students were not exposed to the architecture of systems and were not able to visualize the thread concept.

- Only a few programs are added and students did not have a chance to write a parallel code by themselves using the concepts of parallel programming other than the list of programs taught to them.

- The teachers to whom parallel computing was the first exposure also had problems in visualizing the big picture to teach it to the students with basic or no knowledge of computers (As there are more than 10 first year classes to be taught by 10 different faculty).

But the introduction of OpenMP at the first year of an undergraduate course is continued with an intention that all other programming labs will also add related parallel programming concepts soon.

2.2 AY-2010-11

The same Multi-core concepts and OpenMP programming introduction was continued for this academic year also for the first year undergraduate students. For the second year of computer science undergraduate curriculum, there was little chance to add any HPC concepts as there are no extra credits available for new subjects as electives and existing subjects are not flexible to introduce HPC concepts.

For the Spring 2011, there was another opportunity that attracted us to expose parallel programming and computing concepts to the eighth semester students who have no exposure to HPC concepts. The final semester students for Spring-2011 have to submit their major project synopsis and most of the students were searching for problem statements. The author did a campaign by going to senior student's class room about using HPC and parallel computing concepts to design their projects and could attract four students to enroll for parallel computing based major project. The four students have teamed up and could complete "Video to Cartoon Conversion using Parallel Computing". But the author had to teach the four students about the parallel architectures and programming paradigms as these batch of students do not have any formal training on HPC or exposure to parallel computing. The batch of students could successfully execute their work. Meanwhile, these students were already placed into non HPC based companies and they have decided to go ahead with their placements. The outcome was not so good but gave us a few thoughts on how to plan and proceed for the next academic years. These experiences gave a thought of introducing summer internship program within the institute and attract the interest of the students towards HPC concepts.

2.2.1 Details of Internship Program

The internship program floated in the institute does not earn any credits for the students towards bachelor degree. There is neither a fee collected from the students nor they are paid for their internship. Outside industries and other faculties are not involved with this internship program. Even for the faculty offering the internship, there is no teaching unit

consideration or payment done for the internship program. Both the faculty and the students have volunteered a good amount of summer vacation time to learn new, challenging and interesting topics within HPC. At the same time, the internship is not mandatory for all the students. The period of internship varies from two to three months based on the summer vacation announced. Students were allowed to take a few days off based on the progress of their targets. The internship starts with a week of introduction wherein the faculty gives the broad picture of how to start research based work, where and what to do etc. The second to fourth week gives introduction to HPC concepts in the morning sessions and the students need to work in the afternoon session on assignments based on the inputs from morning session.

The next two weeks are given for the students to read several selected papers and summarize them and present in front of all other internship students and the faculty. Next two weeks the students have to implement the work from papers that fascinated them. During this period the faculty interacts one to one with student to help them understand the process and motivate them continuously to work towards the goal they have set. In the process, if any student comes up with a new idea, that is evaluated and assisted by the faculty to shape into a poster or paper presentation. During the presentations the students are also encouraged to interact to generate ideas through a kind of brain storming discussions on selected topics. As the internship is continued over the years, the successful stories of the previous internship students are also presented to the current students by the individual past interns. At the end of the summer, a formal valedictory program is conducted and students are given internship certificate from the faculty. In some cases, the students continued their work even during their next Fall semester and worked in their free hours to bring the summer work to a logical conclusion. Many students carry on their internship work with additional objectives as their major project, out of passion for the kind of work they performed in the summer.

2.2.2 2011 Summer Internship
For the first time, the author floated the summer internship program during 2011 summer and did campaigning for the third year undergraduate students. 32 students turned up for the internship. With great enthusiasm the parallel computing concepts were introduced to the students starting from shared to distributed memory programming to accelerator programming using GPUs. It was very well received by the students. The students also started learning the concepts by working with many more examples. At the end of the three months internship, 24 students successfully completed all the tasks given during the summer internship program. They also expressed in their feedback that internship and HPC-based courses should be continued. The summer internship program gave a confidence to both the teachers and students and could influx more HPC concepts in under-graduate curricula. Though the HPC and research are very much new to the undergraduate students, the free summer time of two to three months made them focus on, learn new concepts and understand them. Some of the issues faced during summer internship program are:

- Students expect teachers to teach programming, installation of various software's like a regular academic laboratory.

- The given assignments such as reading published papers in a specific area of interest only attract few students as it is very hard to inculcate research culture at the undergraduate level.

These issues of summer internship program were solved by some useful changes in the subsequent academic years.

2.2.3 Details of HPC courses
Meanwhile, Multi-core architecture and programming (MAP) with course code CS726 and Heterogeneous parallel computing (HetPC) with course code CS822 were approved by the Board of Studies (BOS) of NMAMIT, Nitte as elective subjects for seventh and eighth semester students for Fall-2011 and Spring 2012. HetPC is a continuation course for MAP.

Multi-core architecture and programming (MAP) consists of five units. The first unit gives the introduction to evolution of multi-core architecture, Moore's, Amdahl's and Gustafson's laws, Flynns classification, Data dependencies and architecture case studies. The second unit tells about basic threading concepts including programming with pthreads (POSIX Threads) and win-threads (Windows Threads). The third unit gives introduction to shared memory programming and OpenMP (Open Specification for Multiple Processing). The fourth unit introduces distributed programming and Message Passing Interface (MPI). The fifth unit covers loop level optimizations and other compiler level optimizations along with study of parallel implementation of some applications such as Matrix multiplication. MAP is an elective course of three credits. The students are evaluated with two internal assessment exams, two mandatory tasks and a semester end examination. The task includes writing summary of "Free lunch is over" article by Herb Sutter, quiz and programming assignments.

Heterogeneous Parallel Computing (HetPC) is also an elective course of three credits and evaluated in the same way as MAP. HetPC includes evolution of GPU for scientific computing, GPU pipelining evolution and the study of NVIDIA and AMD GPU architectures in the first unit. The second unit covers the programming model of GPU giving the concepts of thread launching, warp design etc. The third unit covers Compute Unified Device Architecture (CUDA) constructs and programming. The fourth unit covers Open Specification for Compute Language (OpenCL) and programming. The debuggers, performance analysis tools, basic libraries and their usage is covered along with suitable applications in unit five.

2.3 AY-2011-12
The students who have undergone summer internship during 2011-summer presented their work in the beginning of the next academic year, in front of all interested students as a showcase of work. The presentation attracted many students for the MAP course floated for Fall-2011. This course consists of shared and distributed memory computing concepts along with OpenMP and MPI programming concepts,

as mentioned in the previous section. At the same time, a call for student research symposium (SRS) co-located with IEEE High Performance Computing (HiPC-11), held in India, has attracted our attention. All the teams have submitted their work and three papers got selected for poster presentation for that year. The details are given in Table 2.

The students also got scholarship for attending HiPC-11 and were highly motivated by attending the conference and interacting with many researchers who come from different countries. This boosted the confidence of the students and many students have defined their major project as research based work and teamed up for the next semester. The students whose paper was not short listed and did not receive the scholarship also attended the conference by bearing all the expenses personally. A total of 16 undergraduate students have attended HiPC-11 for showcasing their work and participating in the conference (Figure 1). This gave them a new way of thinking towards their career planning and many students started their preparation for their higher education and creating career in HPC domain.

Figure 1: Undergraduates Students at IEEE HiPC-11 Conference, India

Spring 2012 was a very successful start for HPC courses as we finished one major course in the previous semester i.e MAP. Most of our laboratory machines were dual core machines so could execute OpenMP and MPI programs using them. Heterogeneous Parallel Computing (HetPC) course was also well received by the students and helped them to create projects with combination of CPU and GPU. At the same time, the author has applied for Professor Partnership Program with NVIDIA for hardware donation to establish GPU lab. With the support from NVIDIA under GPU Education Centre, GPU based infrastructure is established at the department of computer science and engineering at NMAMIT, Nitte. With this, GPU based scientific computation and programming was taught to the students using CUDA and OpenCL in full-fledge. The debugging and performance monitoring tools study were also included in the syllabus and gave full-fledged inputs to the students for carrying out GPU programming based work. The list of major projects carried out under the author's guidance is given in

Table 2.

At the end of the academic year, three students were placed in HPC domain through off-campus interviews and three students have opted for higher studies with a focus on HPC domain. The rest of the students continued with their regular placements. The students who ended up in non-HPC companies also moved to HPC based organizations or opted for higher education to enter into HPC later, after approximately two years. These choices of the previous students show the continuous learning and passion towards learning inculcated into students through research based work in HPC. Further, industry requirements play a major role in continuing the manpower in HPC field apart from higher education opportunities.

The internship program for the 2012 summer is also continued. The summer internship program was adopted as a best practice by the institute and offered from various departments and centralized from Deans office for registration and certifications. Hence, there were many similar summer internships floated such as Android programming that attracted the young minds. HPC summer internship program got 10 applications for the internship and 8 students turned up and 4 could successfully finish the tasks for the summer 2012.

2.4 AY-2012-13
The syllabus is updated every year and approved in the Board of Studies meeting. The MAP and HetPC subjects were moved to 6th semester and 7th semester electives from 7th semester and 8th semester respectively during this academic year. The MAP syllabus was more rigorous with the introduction of major parallel computing applications such as Monte carlo simulation etc. The HetPC syllabus also added a mini project concept to implement simple applications using CUDA and OpenCL.

The students started looking at bigger problems such as implementing black-hole simulation using GPU and CUDA. Though they were not successful in full implementation of black hole simulation, they have learned many internal concepts of CUDA programming such as memory optimization, thread load balancing etc. They successfully implemented AERMOD simulation using CUDA and submitted it as their major project. They have presented the AERMOD based papers at various Indian conferences and forums. The details are given in Table 1. The summer internship program was not successfully floated for the 2013 summer as many students find it easy to work with C# and Android programs etc. Further, many industries that come to NMAMIT, Nitte, expect good knowledge with C# and Android programming etc., from undergraduate students. But the HPC lab was active with M. Tech. and Ph. D. students as well as faculty from different streams of engineering. The work of these people does not fall in the scope of this paper and is not discussed.

2.5 AY-2013-14
The courses that falls under the HPC umbrella from NMAMIT, Nitte are First year OpenMP based Lab along with CS-101 course, MAP and HetPC subjects are continuously given ev-

ery academic year and hence continued for the AY-2013-14 also. MAP subject has a very good feedback from the students, which introduces OpenMP, MPI and OpenMP+MPI extensively. HetPC as a sequel course to MAP also received a very positive feedback from the students. Many students gave a feedback at the end of their final year that they would have benefited more if they were introduced early to HPC concepts. With all these inputs, NMAMIT, Nitte is in the process of making MAP as a mandatory credit course at the undergraduate level and in the process of adjusting the credits and designing the course structure. Further, the alumni students from the the summer internship batch who are working in various HPC domains and in higher education are invited or requested when they visit the campus, to talk to the current students in the college about their experience with HPC and suggest them on how to start and plan a career in HPC.

2.6 AY-2014-15

During this academic year, the author observed that NMAMIT students started looking for HPC based summer internship programs within and outside the college and they start their preparation much earlier for the entire process. This year is very special to HPC lab, the students had significant research achievements through their work. The details are given in Table 2. The students have worked on improving the performance of multi-key quick-sort algorithm using CUDA on GPU.

NMAMIT, Nitte has a strict policy of sharing its network with outside world due to various reasons, and because of this the servers were not accessible from outside the college network. The students found it difficult with this and this problem was solved by the support from GPU Centre of Excellence (GCOE), Indian Institute of Technology, Bombay (IIT-B) and NVIDIA support. GCOE has given server access to all our students who are working on GPU based projects. Further, GCOE have the latest GPU cards than what we have in our HPC-Lab that helped us to learn, work and solve problems using the latest GPU hardware.

Coming out with a research idea at the undergraduate level is a challenging job especially under Indian academic environment, while they have significant academic load. The students put in these extra efforts for projects using HPC out of passion they created for HPC and motivation they got from small appreciations in terms of conference papers etc. This observation is well noted by the author and also got personal feedbacks from the students from different instances.

The students of the this academic year presented their work as posters on multi-key quick sort at ACM-International Conference on Principles of Parallel Languages (POPL-15), India event with scholarship form ACM. They were also awarded by the best undergraduate poster. The students also submitted their work to Student Research Symposium (SRS) co-located with IEEE International Conference on High Performance Computing (HiPC-14) and IEEE- International Parallel and Distributed Processing Symposium (IPDPS-15) to showcase their work. All these students are moving ahead with their higher education programs in the area of HPC.

The summer internship program has a huge participation for the 2014 summer and students started looking into graph theory optimizations, string matching algorithm optimizations and interdisciplinary work in terms of bio-informatics algorithms optimizations through hybrid programming. A new addition to the summer internship program is to give some recognition to the students' efforts by introducing credit based summer audit course. The course is like any other regular course in terms of framing the syllabus, conducting classes and evaluating the students. The HPC based audit course that is floated is Introduction to Parallel Programming and CUDA (Course code: AU006). This is open to all year students and students of all the departments. The credit earned through audit course is additional credit apart from that is required for the degree requirement and hence is not mandatory for all the students.

The audit course also had continuous evaluation in terms of formative assessments and tasks along with the a final exam. A good number of students enrolled for the course and finished the course successfully for the 2015 summer.

NMAMIT also has Parallel and Distributed Computing (PDC) courses as electives. But this information and the other HPC lab work carried out by M. Tech. and Ph. D. students is not reported in this paper. This paper focused on how HPC concepts introduction was received by the HPC under-represented community, i.e. undergraduate students.

3. OUTCOME OF HPC INTRODUCTION

As the computer education is given very early at the secondary school level, many students are already good at basic programming concepts. Hence, introducing parallel computing at the undergraduate level is well received by the students. Table 1 represents various major projects carried out by the undergraduate students using HPC concepts under the guidance of the first author, given academic year wise.

Apart from this, the students get a broad overview of research in similar topics by reading various papers, importance of professional bodies, better career planning in terms of higher education or job selection. A few achievements in terms of conference participation etc., by the students worked in HPC-Lab are given in the table 2.

4. BENEFITS TO THE STAKE HOLDERS

There are direct and indirect benefits to the institute and to the stakeholder's of the institute if the curriculum is updated every year and is on par with the industry requirements. Introducing HPC concepts is one such initiative taken at NMAMIT, Nitte for the benefit of many of its stake holders. A few significant benefits are listed below:

The following are the significant benefits to the students:

- It adds a new specialization to the learning stack of the students.

- The students understand the importance of studying Science and Engineering course as HPC subject emphasizes inter-disciplinary problem solving and learn from outcomes of many researchers beyond text books.

Table 1: List of major projects carried out by the undergraduate students using HPC concepts

S. No.	Academic Year	Names of the Students	Title of the Project
1	AY-2010-11	Mr. Krishna, Ms. Leena, Mr. Abhishek and Ms. Nanditha	Improving the Performance of Video to Cartoon Conversion
2	AY-2011-12	Mr. Konchady Adarsh, Mr. Rayan Victar DâĂŹsouza, Mr. Shashikiran and Ms. Brenda Olivia Martis	A Code Optimization Pass in LLVM [10]
3	AY-2011-12	Ms. Nayak A Swathi, Ms. Nayana Upadhyaya and Ms. Nivedita Nayak N	Accelerating Pedestrian Detection using GPUs [14]
4	AY-2011-12	Mr. Sandeep Nayak, Mr. Sujith Kumar, Mr. Shrinidhi Rao and Mr. Sushanth K	Compiler Based Optimizations for High Performance Architecture
5	AY-2011-12	Mr. Adarsh HV, Mr. Amit Anil Poojary, Mr. Bhat Rohit Shreepathi and Mr. Dineshchandra	Communication and memory optimizations in Heterogeneous systems based on GPUs [13]
6	AY-2011-12	Ms. Rashmi, Ms. Akshaya L Bhat and Mr. Ashik Kumar	GPU device optimization tool
7	AY-2011-12	Mr. Jayavanth Shenoy U, Mr. Madhu Sagar, Ms. Pooja Patankar and Ms. Sapna	BLAS level2 and level 3 optimizations for GPUs
8	AY-2011-12	Mr. Ishan Alok, Mr. Srinivas Prabhu, Mr. Ranjith and Mr. Tanmay Shetty	Multi Device/ GPU programming using OpenCL
9	AY-2012-13	Mr. Anirudh Udupa G., Ms. Jane Shailoh Quadras and Mr. Gururaja Rao P	Application Performance Acceleration using Multi-processors [11]
10	AY-2014-15	Mr. Anjjan S. Narayan, Mr. Rithesh R. Prabhu, Mr. Bharath B. S. and Ms. Crystal Gomes	Accelerating Multi-key Quicksort on GPU [12, 15]

- It helps the students plan their career in terms of higher education or employment opportunities to be looked into.

- Most of the concepts of HPC lead to research thinking and imbibe continuous learning to the students.

The following are the key benefits to the faculty who teach HPC concepts:

- It helps in knowledge up-gradation in latest technologies, which leads to defining new research problems and build latest infrastructures based labs.

- The faculty feels immense satisfaction in seeing his/her student in better career profile.

The following are the benefits to the Institute that incorporates HPC concepts into the curricula:

- Strong curricula and research culture are the pillars for any institution.

- The institute profile increases as alumni are in better career paths.

- Institute flag is placed high wherever the students and alumni performs high.

- As most of the industries are moving to HPC based infrastructure to meet computational needs, many industries welcome mutual support with the institutes, helping in better industry-institute relationship.

- Industries recognize the institutes with HPC concepts uniquely based on the requirement.

The following are the notable benefits to the Industry:

- Industry will have the opportunity to employ the best trained candidates, so reduction of cost and time on training of employees is possible.

- Better networked employees are always an asset to the organization.

The following are the consequential benefits to the Professional Community:

- It leads to the availability of technology experts for sharing the knowledge.

- It leads to the usage of new technologies for solving significant problems that are addressed by the community.

5. CONCLUSIONS

The success path given in this paper reviews the outcome of introducing HPC concepts into undergraduate engineering curriculum along with the struggles and challenges one need to address. The curriculum development and resource material collection are done from various national and international organizations, books and research papers. The laboratories required for the HPC subjects are established

Table 2: List of Achievements of the students from HPC-Lab at NMAMIT, Nitte

S. No.	Academic Year	Name of the Student(s)	Achievement	Other Information
1	AY-2011-12	Ms. Rashmi	Scholarship for IEEE HiPC-11	Poster Paper
2	AY-2011-12	Mr. Adarsh Konchady	Scholarship for IEEE HiPC-11	Poster Paper
3	AY-2011-12	Mr. Jayavanth Shenoy	Scholarship for IEEE HiPC-11	Poster Paper
4	AY-2011-12	Mr. Adarsh HV, Mr. Amit Anil Poojary, Mr. Bhat Rohit Shreepathi and Mr. Dineshchandra	Conference Paper Publication	National Conference on Emerging Trends in Engineering and Technology (NCEET-12). 26th to 27th, April, 2012.
5	AY-2011-12	Ms. Nayak A Swathi, Ms. Nayana Upadhyaya and Ms. Nivedita Nayak N	Conference Paper Publication	National Conference on Emerging Trends in Computer Engineering and Technologies. Bangalore, India. 11th to12th April, 2012. ISBN: 978-93-80406-72-5 [14].
6	AY-2011-12	Mr. Konchady Adarsh, Mr. Rayan Victar DâĂŹsouza, Mr. Shashikiran and Ms. Brenda Olivia Martis	Conference Paper Publication	National Conference on Emerging Trends in Computer Engineering and Technologies. Bangalore, India. 11th to12th April, 2012. ISBN: 978-93-80406-72-5[10].
7	AY-2011-12	Mr. Madhu R. Sagar and Mr. Deepesh Shetty.	Conference Paper Publication	National Conference on Emerging Trends in Computer Engineering and Technologies. Bangalore, India. 11th to12th April, 2012. ISBN: 978-93-80406-72-5[13].
8	AY-2011-12	Ms. Rashmi, Ms. Akshaya L Bhat and Mr. Ashik Kumar	Best Project of the Year	EXPRO-12, NMAMIT, Nitte
9	AY-2012-13	Mr. Anirudh Udupa G., Ms. Jane Shailoh Quadras and Mr. Gururaja Rao P.	Conference Paper Publication	2nd International Conference on Recent Advances in Sciences and Engineering-ICRASE-2013. 29th to 30th April, 2013 [11].
10	AY-2012-13	Mr. Anirudh Udupa G., Ms. Jane Shailoh Quadras and Mr. Gururaja Rao P.	Best Project of the Year	EXPRO-13, NMAMIT, Nitte
11	AY-2012-13	Mr. Anirudh Udupa G., Ms. Jane Shailoh Quadras and Mr. Gururaja Rao P.	Scholarship for IEEE-HiPC-12	Poster Presentation
12	AY-2014-15	Mr. Anjjan S. Narayan, Mr. Rithesh R. Prabhu, Mr. Bharath B. S. and Ms. Crystal Gomes	Poster Presentation	ACM-POPL-15, India
13	AY-2014-15	Mr. Anjjan S. Narayan, Mr. Rithesh R. Prabhu	Scholarship for ACM PoPL-15	Poster Presentation
14	AY-2014-15	Mr. Anjjan S. Narayan, Mr. Rithesh R. Prabhu, Mr. Bharath B. S. and Ms. Crystal Gomes	Best Under Graduate Poster	ACM-PoPL-15, India
15	AY-2014-15	Mr. Anjjan S. Narayan, Mr. Rithesh R. Prabhu, Mr. Bharath B. S. and Ms. Crystal Gomes	Scholarship for IEEE-HiPC-14	Conference Participation
16	AY-2014-15	Mr. Anjjan S. Narayan, Mr. Rithesh R. Prabhu and Mr. Bharath B. S	Scholarship for IEEE-IPDPS-14	Conference Participation
17	AY-2014-15	Mr. Anjjan S. Narayan and Mr. Rithesh R. Prabhu	Conference Publication	International Conference on High Performance Computing and Applications. (ICHPCA-2014), Bhubaneswar, India. 22nd to 24th December, 2014. ISBN: 978-1-4799-5957-0 [12].
18	AY-2014-15	Mr. Rithesh R. Prabhu and Mr. Anjjan S. Narayan	Conference Publication	International Conference on High Performance Computing and Applications. (ICHPCA-2014), Bhubaneswar, India. 22nd to 24th December, 2014. ISBN: 978-1-4799-5957-0 [15].

by interactions and support from related industries. Apart from this, bringing awareness among the students about the importance of HPC topics is very important to make the manpower continue working in this area of specialization. Making a student feel achieving something keeps him/her motivated to work further. These can be as simple as a lab programming that works after self-coding in a new programming language to a paper publication. Students at NMAMIT, Nitte were introduced to HPC topics through regular courses, mini and major projects, summer internship program and summer audit course. With this it can be concluded that HPC concepts add value to the present education of undergraduate engineering program. Introducing HPC concepts at UG level is beneficial to an individual as well as to the institute. NMAMIT, Nitte looks forward for further enhancements and adding more courses in the future academic years.

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