AGENDA

Eighteenth (18th) Meeting of SENATE of

Indraprastha Institute of Information Technology, Delhi

Date: **19th April, 2012**

Day: **Thursday**

Time: **02.00 PM**

Venue: **Conference Room**
3rd Floor, Library Building
NSIT Campus,
Sector-3, Dwarka,
New Delhi-110078

EIGHTEENTH (18TH) MEETING OF SENATE OF IIIT-DELHI
INDEX

Sl. No	Description
1.	**Agenda Items**
	18.1 Opening remarks of the Chairman
	18.2 Confirmation of minutes of the 17th Senate meeting
	18.3 Items for information
	18.4 SG/CW requirement for BTech 2008 batch
	18.5 Leveraging web based delivery for courses
	18.6 Making name of MTech and PhD consistent with BTech– calling it all CSE
	18.7 Allowing a PhD student to earn MTech on the way
	18.8 Some Changes in the BTech program
	18.9 MTech program in ECE
	18.10 MTech (ECE) specialization in VLSI+Embedded Systems and Communications Engineering
	18.11 PhD program in ECE
	18.12 Status of PhD/MTech (CSE) admissions
	18.13 Recommendation/Report by UGC
	18.14 Recommendation/Report by PGC
	18.15 Any other item
2.	**Annexure No.** **Item No.**
	Annexure 1 – 18.2
	Annexure 2 – 18.5
	Annexure 3 – 18.8
	Annexure 4 – 18.9
	Annexure 5 – 18.10

EIGHTEENTH (18TH) MEETING OF SENATE OF IIIT-DELHI

Minutes of the Meeting

18.1   Opening remarks of the Chairman

18.2   Confirmation of minutes of the 17th Senate meeting
The minutes of 17th Senate meeting were circulated among the members, which may be considered for confirmation. A copy of the same is placed at **(Annexure 1).**

18.3   For information

The Chairman (BOG) has approved the following selection committees:

- **Selection committee for faculty selections in Georgia Tech on April 23, 2012** includes eminent and senior Professors of Computer Science, GaTech i.e. Prof. Ahamad Mustaque *(Chairman's nominee)*, Prof. Navathe Sham, Prof. Ramachandran Kishore, Prof. Mary Jean Harrold, Prof. Pankaj Jalote – IIITD.

- **Selection committee for faculty selections at UCLA on May 2, 2012** includes Prof. Sumit Roy, Professor, Electrical Engineering, University of Washington *(Chairman's nominee)*, Prof. Mani Srivastava, Professor, Electrical Engineering, UCLA, Prof. Raghu Raghavendra, Professor Electrical Engg and Computer Science, and Vice Dean for Global Academic Initiatives, Viterbi School of Engineering, USC, Prof. Viktor K Prasanna, Professor, Computer Engineering, Director, Center for Energy Informatics, ED USC-Infosys Center for Advanced Studies, Prof. Pankaj Jalote – IIITD.

18.4   SG/CW requirement for BTech 2008 Batch

Self Growth and Community Work are requirements for graduation, though they contribute credits for graduation. Generally, these are done by students in the summer vacation after first year. For the first batch (2008), the requirements were not fully clear as they became clearer when the BTech curriculum was revised sometime in 2009 (when total credits for graduation were also revised.) Also, while many students did do them in their first summer, proper recording of their effort was not done, as the Institute was not well organized at that time to handle it. As a result, it seems that in record many students (about half the batch) show up as not having done one or both of these.

As this is not an academic requirement and due to the reasons mentioned above, it is proposed that the CW/SG requirements may be considered as necessary for 2009 batch onwards, and optional for the first batch. This will allow those 2008 batch students who in record have not done CW/SG to graduate.

18.5   Leveraging web based delivery for courses

Attached note gives two related but distinct proposals for leveraging web delivery in education at IIIT Delhi. These are both enablers - one enables the faculty to use web based delivery in courses they teach, the other enables the students to take approved courses from other sources and request credit transfer for the same. **(Annexure 2)**

18.6   Making name of MTech and PhD consistent with BTech - calling it all CSE

Our BTech program was earlier BTech(IT) and now it has been named as BTech(CSE). To keep a consistent terminology, the MTech and PhD programs in Computer Science be now called as programs in Computer Science and Engineering (CSE).

18.7   Allowing a PhD student to earn MTech on the way

IIITD is following the approach of getting students into PhD program directly after BTech. While there is an "exit clause", it will help if students are allowed to earn a MTech on way to PhD. In India, MTech degree is required for some types of jobs, hence it is useful to have this degree also. It is proposed that:

A PhD student may be granted an MTech, provided he/she applies for it and fulfils requirements for the same. While the course credits earned during PhD can count towards MTech also, work done for MTech thesis/scholarly paper may not be considered as part of the PhD thesis. A PhD student can apply for earning an MTech (while remaining a PhD student) through his/her PhD adviser only after passing the comprehensive exam and after completing at least 5 semesters in the PhD program. After getting approval he/she may register for MTech thesis/scholarly paper credits. If such a student leaves without completing the PhD, he/she may be asked to refund the difference in stipends and tuition fees between PhD and MTech, as per rules of converting from PhD to MTech.

18.8   Some Changes in the BTech (ECE) program
BTech (ECE) program, which has been approved earlier and is starting from Monsoon 2012, has been changed a little based on further inputs and discussion. The main change is that the common Electronics course between ECE and CSE in 2nd semester is now a common "Engineering Design" course, which is pre-requisite to no other course and hence allows trying different models. Due to this, the remaining core courses of ECE are now scheduled in a different manner. Attached note describes the modified structure. **Annexure 3**

Core program of 1st year - the following changes will effect CSE also:

- Math 1 is now proposed to be Linear Algebra (as we really had no real requirement from CSE's perspective for Math1, this seems OK - in fact it is better for CSE.)
- The Electronics course in 2nd semester, which was not a pre-requisite to anything in CSE, is now replaced with "Introduction to Engineering Design" - some hands on type of course which is to be designed.

From the earlier approved document for ECE, some changes have been made, besides the above:

- Some changes in ordering
- Signal Processing, Operating Systems, are now mentioned as "committed electives" - i.e. these courses will be made available to students and so a student can take it if he/she wants, though a student may not take.

18.9 MTech program in ECE

Attached note gives the regulations for the MTech in Electronics and Communications Engineering (ECE). These regulations are largely similar to those of MTech in CSE – the main difference is that for specialization in a stream 20 credits must be done from that stream. This program structure, like for CSE, allows for new specializations to be offered within ECE. **Annexure 4**

It is proposed that the MTech(ECE) be started from Monsoon, 2012.

18.10 MTech (ECE) specialization in VLSI+Embedded Systems and Communications Engineering
The attached note gives the initial description of the specialization in VLSI and Embedded Systems. It is proposed that this specialization be started from 2012. **Annexure 5**

18.11 PhD program in ECE
With about half dozen ECE faculty members, and some applications at advanced stage of processing, it is important to have a PhD program in ECE so the ECE faculty's research programs can get started immediately.

For PhD in ECE, all regulations as stated in the PG Manual and which are currently applicable to the PhD program in CSE, will apply. No special regulations are needed.

It is proposed to start this program from Monsoon 2012.

18.12   Status of PhD/MTech (CSE) admissions:

➢ **Rolling PhD admissions:**
- As per the provision of rolling PhD admission, Mr. Nipun Batra joined in the program this semester.
- Recently, offer of admission has been issued to Ms. Sonal Aggarwal.
- PGC is processing the rolling admissions on a case-by-case basis with a sub-committee consisting of Dr. Raja Sengupta, Dr. Anirban Mondal and Dr. Gaurav Gupta. Externally sponsored candidates, Sathish V from ABB, and Jayaprakash and Kanduri from Infosys, have also applied and are at various stages of the interview process - which is expected to conclude by the end of this month.

➢ **PhD admissions:**
- Total valid applications: 314
- Total screened candidates (non-sponsored candidates): 111 (General) and 4 (SC/ST)
- Total number of sponsored candidates (handled separately by the PGC): 10
- Total candidates who have confirmed to attend written test to be held on 21st April, 2012 (as of now): 100

➢ **M.Tech admissions:**
- New admission process model is finalized after circulating the same to faculty for their opinion.
- Web page and application forms are updated (various dates are freezed) and ready.
- M.Tech Flier is ready and will be printed and circulated in next few days.
- Newspaper advertisement is being planned for later this week.

18.13   Recommendation/Report by UGC:

- Pre-registration should become part of the academic registration for non-first semester students
- with regard to Nikita Dagar, 3rd year student, who has to clear TOC which is not offered in the academic year 2011/2012, UGC suggests that Nikita Dagar may also choose Information Retrieval to replace the failed TOC course.
- Report to be tabled during the meeting.

18.14   Recommendation/Report by PGC:

- To be tabled during the meeting.

18.15   Any other item.

<center>************</center>

Minutes of the 17th Senate Meeting of IIIT-D held on 13th January, 2012 at 03.00 PM in Conference Room, IIIT-Delhi, Library Building, NSIT Campus, Sec-3, Dwarka, New Delhi

Following members were present:

- Prof. Pankaj Jalote   -   Chairman
- Prof. K. K. Biswas   -   Member (from IIT Delhi)
- Dr. Astrid Kiehn   -   Internal Member
- Dr. Debajyoti Bera   -   Internal Member
- Dr. Gaurav Gupta   -   Internal Member
- Dr. Vinayak Naik   -   Internal Member
- Mr. Vivek Tiwari   -   Secretary

Following members participated via telecon:

- Mr. C. Anantaram   -   Member (from TCS)
- Mr. Mukesh Mohania   -   Member (from IBM)
- Mr. Sanjay Bahl   -   Member (from Microsoft)
- Mr. Saugat Sen   -   Member (from Cadence)
- Prof. Dheeraj Sanghi   -   Member (from IIT Kanpur)
- Prof. M. Chelliah   -   Member (from Yahoo!)

Special Invitees:

- Dr. Raja Sengupta   -   Faculty IIIT-D
- Dr. Srikanta Bedathur   -   Faculty IIIT-D

17.0   Opening remarks of the Chairman

The Chairman extended a warm welcome to all the members to the meeting. The members who could not attend the meeting were granted leave of absence.

17.1 Confirmation of minutes of the 16th Senate meeting
As there were no comments from anyone, the minutes were confirmed.

17.2 Granting MTech to Sangeeta
As per the input provided by Prof. Dheeraj Sanghi (IIT-Kanpur), the provisional degree certificate has been accepted. It is suggested not to mention CGPA in certificate/provisional degree as the transcript will be showing the same and to have the full name of the Institute mentioned in the certificate.

17.3 Admitting students in PhD through the direct admission from MTech route
The move was well appreciated by all the members. Dr.Raja Sengupta (PGC Chair) requested for inviting one more student Mr. Robin Kumar Verma for direct admission into PhD program, as he fulfills all the criteria and is also recommended by a faculty.

17.4 Rolling PhD admission
Dr. Srikanta Bedathur informed that some more candidates will be evaluated for admission as per this provision.

17.5 Panel of names for selection committee in US:
The Senate approved the panel. However, some members suggested that Associate Professors and above should be from top 05 universities all around. In particular, it was agreed that Assoc/Full Professors from the following Institutes can be empanelled: Georgia Tech, UCLA, USC, UC Irvine, Northwestern, UIUC, Purdue, U Wisconsin.

17.6 Change the name of the BTech (IT) program to BTech (CSE)
The agenda was discussed in length. Dr. KK Biswas, Mr. Saugat Sen and some members said that it is a good idea to change the name as most of the courses being taught is mostly of CSE branch.

However, it was pointed out that changing the name in between can be viewed negatively, and messaging has to be done properly as so far everywhere the IT program was promoted.

It was also suggested that proper buy-in of students should be taken to avoid any legal conflicts later on.

After assessing the views of all the members, Senate agreed that academically it is a CSE degree and may be named as such. For changing the name of the degree for the current students, it may be desirable to have a formal acceptance of current students.

17.7 Changes in regulations for BTech (IT)

The Chairman informed the committee of the changes in the regulations and the committee members gave their consent to accept the same.

17.8   Starting the BTech ECE program
This was discussed in length and the chairman informed the committee that the committee constituted for ECE programme did due diligence and gave its recommendations, proposals accordingly. The program depends upon the strength of the faculty and also can allow second year students to choose the program. On doubts raised by some members about naming the program, the Chairman clarified that the nomenclature is picked up as per the approved programs by AICTE. A student can do courses of CSE and/or ECE streams or vice versa. On being pointed out about the semesteral credit requirement, the chairman assured that the ECE program will also be having uniform credits as mentioned in the manual.

17.9   Changes proposed to the PG Manual and MTech regulations
The Senate accepted the changes in the manual.

17.10   Fellowship model for MTech
The recommendation of the committee is accepted by the Senate.

17.11   Changing admission criteria to the BTech program
The idea of including class XII marks was accepted. It was suggested that for normalization across Boards, method followed by DU or ISERs should be examined and if found suitable one of them may be adopted.
Regarding giving bonus marks for "excellent school programmers", it was agreed that the idea is good and worth trying. However, the Senate felt that the following measures be adopted for this:
- The number of students who can get these bonus marks be limited, and the maximum bonus marks should also not be too large.
- Math Olympiad may also be included in the "contests" – while it is not a programming contest, students in this are likely to be extremely bright and suitable for CSE.
- Other contests that may be included should be clearly identified in the admission information.
- Evaluation for bonus marks must happen before the admission test results are declared.

17.12   Formation of the UG Committee (UGC)

UGC Chair, Dr. Astrid Kiehn placed the recommendations of the UGC on table.

the recommendations of UGC as per annex have been approved apart from:

It was not approved that a BTP may be converted into an IP (on advisor's recommendation) as that would imply the change of transcript for that semester which should be avoided.

Second, counting an ESC course as a CSE math course for the "at least two CSE/Math" rule was rejected.

17.13 Proposal to start an MTech Specialization in Mobile Computing:
Senate members welcomed the idea to start the specialization and suggested that the course should be well defined as per the industry need. Meetings should be conducted with industries to take further inputs.

17.14 Any other item, with the permission of the chair.
Ishita Jain, student representative, suggested for a provision to provide direct admission to BTech students of IIIT-D into M.Tech. program. The motivation of some students for this was that they can get the MTech in a shorter time, as they have done most of the courses. It was explained that even the current program, being credit based, can be completed in a shorter duration if the student plans and works hard for it.

****

Leveraging web based delivery for courses

Exploiting Web Based Delivery for Courses

Many universities across the world are now using web based delivery methods in education. And some studies have indicated that f2f lectures are often as effective as those delivered over the web with mixed mode being superior to both. After the success of Stanford's online AI course, there seems to be many more full semester online courses in the offing. This proposal is to start using web-based delivery internally in courses offered by our faculty, as well as leveraging such courses being offered by reputed universities for the benefit of our students. The proposal has two distinct, but related, parts.

Allowing web-based delivery in IIIT-D courses taught by IIITD faculty

Allow faculty members of IIITD to use web lectures, either self lectures taped earlier, or lectures by others, as material for the course for which they are the instructor. Specifically:

- The instructor remains fully responsible for delivering the course including giving assignments, exams, projects, etc and ensuring that post conditions are delivered, and finally giving the grades to students enrolled in the course.
- The instructor can decide how to use these lectures effectively, ensuring that the post conditions of the course are met. However, the amount and nature of use of such lectures should be announced at the start of the course, as part of the course description. If external lectures are to be used, their sources should also be identified in the course description.
- When using web lectures significantly, a mid-semester feedback from the students should be taken to assess their effectiveness, and if the feedback so indicates, their usage should be reduced/stopped /modified for the remainder of the course.
- The scheduled lecture hours for the course will still have to be maintained – however, their use, in light of the use of web delivered lectures can be suitably determined (e.g. an instructor can deliver the "lecture" through the web and then use the scheduled lecture hour for discussion.) Again, this should be announced as part of the course plan.
- Initially, this can be used only for elective courses and PG courses. (Limited use in core courses may be allowed with permission of the UGC.)
- If offering a course which primarily uses lectures of others, the "load" may not count fully and the Instructor should discuss this with concerned authorities regarding the load.
- The UGC/PGC may build further guidelines to ensure effectiveness is maintained.

Note that this also allows the Institute to offer a course in a new area by using primarily lectures on the web, perhaps in areas in which capability of offering the course does not exist within the Institute (though some faculty member has sufficient understanding of the

subject to be able to offer the course by using lectures of experts from the web.) This may be used in particular for specialized areas in which there may be a small group which cannot offer the variety of courses needed to prepare a PhD student well for research, or may be used by the Institute to provide options to students which it is not able to provide through the faculty it has. It should be pointed out that this proposal is for using full video lectures and in substantial quantity, and not about using short video clips, or using a couple of lectures to supplement the material, which instructors are always free to employ.

Leveraging free full-semester Courses now being offered by Top Universities

After the success of Stanford's online AI course, there seems to be many more online semester courses in the offing. This type of education – full semester courses by top experts which have assignments, exams, etc – looks ready to explode. This proposal is to have the ability to leverage this material for education at IIITD, by allowing students to take such online courses from "Cyber University" (a name we are giving to all the courses available through the web) and then requesting transfer of credits. Further details of the proposal:

- A student can apply to UGC/PGC to take some course(s) from "cyber university" for which he/she will seek transfer of credits, providing full details about the course he/she plans to take including the assessment and grading methods the course. The UGC/PGC may approve the course if the subject matter is appropriate (e.g. it would have been approved for offering in IIITD), the course length and the amount of work/knowledge is commensurate with the credits being sought, the assessment methods employed are acceptable, the course is being offered by competent people/university, etc. The UGC/PGC may also stipulate the conditions under which the transfer of credits will be granted (e.g. what minimum grade is necessary, what conditions must be fulfilled for submission of assignments, etc), and may set suitable measures to ensure integrity (e.g. appoint some IIITD observer who may even conduct an exam to ensure that the course is being done with academic integrity by the student, ask student to submit a copy of all the assignments, etc.)
- A student may take the approved course, and after completion, if the criteria established for credit transfer are fulfilled, can apply for the same. If the criteria are not satisfied, credit transfer may not be granted.
- A student can earn no more than 8 credits by taking courses from the "cyber university", and no core course may be done through this means.
- UGC/PGC may establish other guidelines to ensure effectiveness of this mode.
- Transfer of credit rules of the Institute will apply. I.e. while the credits are counted, the grade earned in the course from Cyber University is not considered for the CGPA computation.

BTech (ECE) Curriculum – Some Revision
(ECE: Electronics and Communication Engineering)

Background

IIIT-Delhi's objective is to become a globally respected Institution for research and education in IT and allied areas. Information Technology is a broad area which uses Computing and Communication technologies to solve problems. The two major disciplines to nurture these are Computer Science and Engineering (CSE) – which covers computing science and its applications, and Electronics & Communication Engineering (ECE) – which covers science and engineering of communication technologies and computing systems

IIIT-Delhi started with programs in computing science, and plans to now launch its ECE programs. This not describes the overall structure of the BTech(ECE), and the main courses in the core part of the curriculum.

Program Objectives

- To produce students prepared for Indian industry with necessary initial skills to enter and succeed in a long-term engineering/entrepreneurship careers (post B.Tech), and
- Ready for PG studies and research careers

Some General Guidelines

- It is desirable to have the first year program which is common with CSE – this will allow flexibility to students in moving from one to the other.
- After the first year common program, the second year program can be relatively fixed, comprising mostly of core courses for the program. 3rd year onwards the program can be mostly flexible comprising of electives, which may be organized as streams. This will make the structure similar to that of the current CSE program.
- It is desirable to have flexibility, so students have a greater degree of control on their program of study and what they want to learn.

ECE Program Structure

Common 1st year for both EE and CS/IT degree Student

An exercise was done earlier to identify a common program for the first year for CSE/ECE students – the common first year program is given below. Each of the two semesters, all students do one course each in maths, software, hardware, systems/practice, and HSS/Commn.

	Sem 1	Sem 2
Hardware	Digital circuits	Computer Organization
Software	Intro to Programming	Data structures and Algos
Systems/Practice/Engg Sci.	System Management	Intro to Engineering Design
Maths	Math 1 (Linear Algebra)	Math 2

		(Probability and Statistics)
Communication Skills / HSS	Com 1	HSS 1

Core Courses for ECE in 2nd Year

In 3rd and 4th semesters, the course load will be same as in CSE – 5 courses, including one HSS/Communication skills. (In CSE, one of the slots is used for "Engineering Science elective" in each semester – the ECE courses are likely to be made available to CSE students for their Engineering Science slot.) In addition to the core courses in 3rd and 4th semesters, there is one core course in 5th semester also (CSE also has one). The following structure is proposed for ECE:

Sem 3	Sem 4	Sem 5 and 6
Electrical circuits	Principles of Commn. Systems	[Operating Systems]
Embedded Systems*	Integrated Electronics	[Computer Networks]
Signals & Systems	Electromagnetics	[Signal Processing]
Math 3	Math 4	
Com 2	HSS 2	

* Embedded systems may be later renamed to a more appropriate name like (Embedded Logic Design)

Program Structure in 3rd/4th Years, and Graduation Requirements

The main aspects of the program are:

- Most courses in Sem 5-8 are electives. Some electives are specifically mentioned in Sem 5 and Sem 6 indicating that the Institute will generally always make these courses available to students in these semesters.
- For a BTech (ECE), a student has to do 9 courses in each of these two years. That is, for graduation, the number of credits required is 4 * 38 = 152 credits (a total of 38 courses of 4 credits each – 10 courses each in first and second years, and 9 courses each in the final two years.) However, a student may also graduate with honors, which requires additional 12 credits (equivalent of 3 more courses.) (The idea is to allow "challenge" the bright student, but not overload the average student. Also, as the full time load is 5 courses, it allows upto 2 backlogs to be cleared without taking an overload.)
- There is a compulsory course "Technical Communication", typically done in 6th semester.
- The HSS requirement is same as in CSE – i.e. three courses (i.e. 12 credits).
- Streams – In the last two years, various streams will be offered. A stream is a set of courses in an area, and a student completes a stream by doing at least three courses

of the stream (some streams may require at least four courses). Streams allow the student to focus on some area of ECE – as ECE is too diverse it is not possible for a student to gain a decent mastery in all. Streams allow the student to focus on a chosen area to gain a level of depth, and gain some understanding of other areas by doing some courses from other streams. A student will be strongly encouraged to ensure that at least one stream is completed, though is not required to do so.

- BTech project is optional – but for Honors, it is necessary. BTech project can be taken for equivalent to 2 to 4 courses.

Suggested "Streams" for ECE

Some common streams that are possible are given below. Then nature of streams will evolve with time depending on the interests of faculty as well as relevance/importance of the areas.

1. Signal & Image Processing
2. Communications Systems/Networking
3. Circuits/Electronics
4. Computer Engineering
5. Energy Systems
6. Embedded Systems/Controls

The concept of streams and the courses in each will be evolved later.

Program Overview: Overall Program for the BTech(ECE) Program

Sem 1	Sem 2	Sem 3	Sem 4	Sem 5	Sem 6
Intro to Programming	Data structures and Algos	Embedded Systems	Principles of communication Systems	[Operating Systems]	[Computer Networks]
Digital circuits	Computer Organization	Electrical circuits	Electromagnetics	[Signal Processing]	
System Management	Intro to Engineering Design	Signals and Systems	Integrated Electronics		
Math 1 (Linear Algebra)	Math 2 (Probability and Statistics)	Math 3 (Complex variables, Differential equations)	Math 4 (Modeling)		
Com 1	HSS 1	Com 2	HSS 2		

Courses mentioned in "[ ]" are electives. Some electives are specifically mentioned in Sem 5 and Sem 6 indicating that the Institute will generally always make these courses available to students in the respective semesters.

Regulations for MTech in Electronics and Communication Engineering (ECE)

Preamble

IIIT-Delhi subscribes to the view that a Masters degree is primarily industry-focused, though it can be used as a stepping stone for research as well. And the decision whether the degree is to be pursued for skill and knowledge up-gradation or also for building research skills should rest with the student. The Institute also believes that a student should also be given an option of pursuing MTech without assistantship so he/she can focus full time on the program, and possibly finish the program MTech sooner, as compared to a student who is on Assistantship and so has to do part-time work in lieu of the assistantship.

The Institute also feels that to address the needs of the industry, which today requires more specialized manpower as each field is getting more complex, it is desirable to provide specializations within ECE in the MTech program. For this, the Institute permits a student to do either an "MTech in Electronics and Communications Engineering" without any specified specialization, or an "MTech in Electronics and Communications Engineering with specialization in <area>".

Overall Requirements

1. MTech(ECE) may be done with a thesis, or without a thesis but with a scholarly paper. In both options, students have to do certain amount of course work. In addition, students doing MTech *with thesis* will have to do a thesis. Students in *without thesis* option have to do additional courses, and instead of a thesis will have to do a scholarly paper.

2. The overall requirements are as follows
    a. **MTech with thesis.** 32 credits of course work + 16 credits of thesis. At most 4 credits may be earned by doing 300 and 400 level courses.
    b. **MTech without thesis .** 40 credits of course work + 8 credits for a scholarly paper. The scholarly paper may be a suitable project with a report on it. At most 8 credits may be earned through doing 300 and 400 level courses.

3. For the thesis or the scholarly paper credits, though the student has to register, he/she need not be physically present and can do the work while being outside the Institute.

4. A student admitted to the MTech program will give his/her choice regarding whether he/she wants to pursue the thesis or without thesis option. However, this choice can be changed at any time during the program by suitably informing the PG Committee.

5. Each MTech (ECE) student has to satisfy the Core Requirement by doing at least 12 credits from courses in the core buckets, and doing courses from at least three of the core buckets (e.g. by doing one course each from three of the buckets). Current core buckets and courses in them are given below – additional courses and buckets may be added later by consent of the faculty:

   a. Theory:
      {Topics in Mathematics, Stochastic Processes}
   b. Communication Engineering:
      {Digital Signal Processing, Communication Networks}
   c. Electronics:
      {Introduction to VLSI, Basic Analog Design}
   d. Computer Systems:
      {Operating Systems, Computer Architectures}

6. All other courses are electives. In electives, at most 4 credits of "Independent Study" and 4 credits of "Minor Project" can be taken.

Requirements for Specialization

1. For "MTech in ECE with specialization in <specialization area>", from among the areas in which specializations are offered by the Institute (currently "VLSI & Embedded Systems"), the student must:

   a. Complete at least 20 credits of courses in the chosen specialization area.
   b. Do his/her thesis/scholarly paper in that specialization area. The advisor will certify this fact.

2. If a course is in the list of courses for a specialization, as well as in one of the core buckets, that course can be counted towards satisfying both the Core Requirement and the specialization requirements. However, the overall credit requirements remain unchanged.

3. The lists of courses for each specialization are specified separately.

4. If a student completes all requirements for the MTech, but not the requirements for specialization, he/she will be eligible for "MTech in Electronics & Communication Engineering".

Assistantship and Fee Waiver

1. Limited number of Assistantships will be available for MTech students. As specified in the Regulations for MTech/PhD Programs, a student who is offered an Assistantship will be required to do 10-15 hours of academic work per week in-lieu of the Assistantship.

2. Limited number of partial or full fee-waivers may be provided.

Proposal for an MTech in ECE with Specialization in VLSI and Embedded Systems

Background

Last few decades have witnessed tremendous growth of semiconductor devices and integrated circuit (IC) technology. Recent trend indicates that very large scale integration (VLSI) has entered into an era of more than billion transistors on a single chip. This has facilitated miniaturization of ICs (general as well as application specific) which are pervasive in almost all areas of computing – mobile, automotive, medical diagnostics, scientific application etc. With large volume of transistor real estate and low cost (per IC cost is significantly lowered due to high volume of production), VLSI technology has opened up opportunities for custom design in many application specific domains. Embedded system designers in these domains leverage the off-the-shelf ICs (hardware chip as well as soft IPs) to build systems that meet specific functional and other requirements. One can conceptualize embedded system designer as the mediator who act as a link between VLSI technology and the end user / consumer of the technology. Therefore it becomes quite imperative to augment the knowledge of VLSI design and fabrication with the embedded system design concepts. In this context, a post graduate program in VLSI and Embedded Systems Design (VESD) fits.

It is projected that India will spend more on electronics import than on oil import within a few years. It is therefore necessary for India to establish a manufacturing base for electronic goods in the country. But to be able to compete in the world market, that has to be backed up with world-class design, and a design-oriented postgraduate program like this one will help this goal in a major way.

The VLSI and Embedded Systems MTech program will cover the fundamentals and engineering aspect of designing and developing IC based systems. Traditionally VLSI technology has emerged out as a successful conglomeration of two streams: material science and electrical engineering. The state of the art VLSI technology requires research in physical devices as well as novel design and development of electrical circuit. The program will focus on developing hands-on skill of designing semiconductor devices and circuits, architecting systems using embedded components such as, CPU, memory and peripherals. Students will be trained in several topics that cut across different domain, starting from lowermost level of physical devices to the top level of application development.

Main faculty in the program

The following members of faculty will be offering courses and guiding thesis and scholarly papers in this specialization.

- Amarjeet Singh
- Mohammad Hashmi
- Saket Srivastava

- Subhasis Banerjee
- Sujay Deb
- M. Satyam (visiting faculty)
- R. N. Biswas (visiting faculty)

Besides these, it is envisaged that there will be guest faculty from ST Microelectronics, NOIDA, and from Cadence, NOIDA, who will offer specialized technology-oriented courses.

Students in the Program

Students admitted in this program are required to have undergraduate degree in EE or ECE. Therefore, it is assumed that they have prior knowledge of some of the relevant topics, viz. Circuit Theory, Signals and Systems, Calculus and Linear Algebra.

Specialization Courses

As per the MTech(ECE) regulations, a student in any specialization will be required to complete the Core Requirement of 12 credits (3 courses) by doing one course each from three of the core buckets (the current buckets are: Theory, Communications, Electronics, Computer Systems – courses in each of these buckets are given in the MTech regulation. The buckets and the courses in each will also evolve.) For a specialization, a student has to do at least 20 credits from the list of courses specified for that specialization.

For this specialization (in VLSI and Embedded Systems), the list of courses is given below – along with the faculty members who can teach the course. Not all of these courses will be offered all the time, and the list will change with time as new faculty join or as new courses are required. If a course here is also mentioned in some of the core buckets, then it can also be used to satisfy the core-course requirement of MTech (of course, the total number of credits to be taken still has to be fully met.)

1. **ECExxx: Introduction to VLSI Design:** Sujay, Saket
2. **ECExxx: Stochastic Processes:** Sanjit
3. **ECExxx: Digital Hardware Design:** Sujay, Saket, RNB
4. **CSE511/ECExxx: Computer Architectures:** Saket, Subhasis
5. **CSE537: Embedded Systems:** Amarjeet
6. **CSExxx: Advanced Architectures:** Subhasis
7. **CSExxx: Algorithm Analysis and Design:** CSE faculty
8. **CSExxx: Image Processing:** CSE faculty
9. **Basic Analog Design:** Mohammad, RNB
10. **IC Fabrication and Layout:** Satyam
11. **Semiconductor Device Theory:** Satyam
12. ***Memory Design and Testing:** ST Micro Faculty
13. ***Advanced Analog Design:** Mohammad, ST Micro Faculty
14. ***Interface Circuits Design:** ST Micro Faculty
15. ***Broadband VLSI Design:** ST Micro Faculty
16. ***ASIC Design Flow and Synthesis:** ST Micro Faculty

17. ***Low Power VLSI Design:** ST Micro Faculty
18. ***Design for Testability:** ST Micro Faculty
19. ***Network on Chip:** ST Micro Faculty
20. ***Multimedia Processing:** ST Micro Faculty
21. **Multi Core Systems:** Subhasis
22. **Performance Modeling:** Subhasis
23. **RF Circuit Design:** Mohammad
24. **System Design for Wireless:** Mohammad

(Courses prefixed with * are likely to be taught by our industry partners of this program – currently ST Microsystems is our main industry partner.)

Where graduates will be desired: The market for embedded and VLSI electronics is growing at the fastest rate (22% per year) within the Information Technology field. According to India Semiconductor Association (ISA) the estimated business of Indian semiconductor design industry (includes VLSI design, embedded software development and hardware design) is USD 7.5 billion in 2010. Top 10 global fabless companies and top 25 semiconductor companies operate from India. The talent pool in India in this sector is estimated to grow at 20% YoY. To sustain the growth in this industry, the talent pool needs to be strengthened further. One of the key challenges for this industry is to get quality talent in forthcoming years. This program focuses on preparing the students with necessary skills to tap into the job market. Following is a representative list of companies which will be interested in the graduates of VLSI and Embedded Systems Design and hence are potential employers of this program.

- Research labs
  - Nokia Research
  - Intel Research
  - GE Research
  - Samsung Research
  - Qualcomm Research
  - GM Research
  - Xerox Research
- Analog and Mixed IC Design Companies
  - ST Microelectronics
  - Texas Instruments
  - Altera
- EDA Companies
  - Cadence
  - Xilinx
  - Mentor Graphics
- Semiconductor and Soft IP Companies
  - ARM
  - AMD
  - Intel
  - Freescale

- ○ Nvidia
- ○
- Systems Design and Manufacturing Companies
  - ○ ABB
  - ○ Bosch
  - ○ HP

Further we also believe that the graduates of this program will have a good foundation that will aptly prepare them to start their own ventures in this new domain that shows a lot of promise in the future.

Members of the Advisory Board:
Possibilities for members of the advisory board are given below.
- ∉ Sunil D Sherlekar (Intel Research India) (tentative)
- ∉ Rakesh Malik (Someone from ST Micro - RNB to identify) (Anshul has suggested: Dr. Kaushik Saha Microelectronics NOIDA kaushik.saha@st.com)
- ∉ M Balakrishnan or Anshul Kumar from IITD (to learn from their experience)
- ∉ Dr. Sanjiv Narayan, Calypto NOIDA snarayan@calypto.com
- ∉ Dr. Alok Jain (or Saugat Sen), Cadence NOIDA alokj@cadence.com
- ∉ Mr. Rajiv Sehgal, Mentor Graphics NOIDA Rajeev_Sehgal@mentor.com
- ∉ Dr. C.P. Ravikumar, Texas Instrumnets Bngalore ravikumar@ti.com
- ∉ Dr. N.S. Murty, NXP Semiconductors Bangalore nagavolu.murty@nxp.com

Appendix: Some possible sequences for further specialization
Even within VLSI and embedded systems, a student can specialize further, if he/she wishes. Given below are examples of further specialization, and the type of courses students should do for these specializations. Some of these courses may not be available immediately and may be offered in due course. These examples are only illustrative.

Sem.	Analog Design Track	Digital Design Track	Embedded Systems Track
1	Intro. to VLSI Design*	Introduction to VLSI Design*	Data Structures & Algorithms
	Topics in Mathematics*	Topics in Mathematics*	Topics in Mathematics*
	Basic Analog Design*	IC Fabrication & Layout*	Digital Hardware Design*
2	Computer Architectures*	Computer Architectures*	Computer Architectures*
	Digital Signal Processing*	ASIC Design Flow & Synthesis	Digital Signal Processing*

	Advanced Analog Design	Design for Testability	Operating Systems*
	Memory Design & Testing	Low-Power VLSI Design	Embedded Systems
3	Broadband VLSI Design	Network on Chip	Real Time Systems
	Thesis	Thesis	Thesis
4	Thesis	Thesis	Thesis

* Courses marked with asterisks are out of the Core Buckets