

# Interim Report

## The UG Program at IIT Kanpur

### Academic Programme Review Committee (ARC)

February 2009

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# ARC-2008

## Interim Report

### I. Introduction

It is nearly 50 years since the Indian Institute of Technology Kanpur (IITK) was established. During this period, the country has made rapid strides both in terms of industrial growth and its global outlook. The economic reforms of the early 1990s have transformed India into an economic power, firmly perched among the upper echelons of the global elite. As a result, the aspirations of the society as well as the demands on industry have witnessed a drastic change. In this scenario, the ARC assumes particular significance as it has to address the (i) need to be globally competitive, (ii) rapidly evolving technological needs, and (iii) rising expectations of students and their parents.

### II. Background

Designing a relevant curriculum requires an understanding of the evolving needs of all stakeholders, namely students, teachers, industry and R&D/academic establishments.

#### ***Students***

It is a commonly acknowledged fact that the IITs attract the cream of the country's students. Unfortunately, their professional objectives are guided more by societal pressures rather than a clear understanding of their abilities. Thus aiming for being an MBA or a software engineer becomes the ultimate goal, irrespective of whether the student has a better chance of excelling in academics or R&D. Consequently, the highly "technical" IIT education becomes secondary, which, in turn, leads to motivational deficit and a lack of intellectual curiosity. With such a mindset, the IIT experience is akin to a black box; the students use IIT to increase their employability without imbibing the essence and wholesomeness of IIT education. In addition, one glaring deficiency has been observed year- after-year in the IITK students: poor communication skills and a near-complete ignorance of the world around them.

#### ***Teaching***

IITK has a reputation of having a highly dedicated and knowledgeable faculty. It has been a pioneer in science and technology education in India and continues to be so. However, the following issues about our undergraduate education merit consideration:

- Unrealistic expectations
  - Need a proper understanding of maturity level of incoming UGs
- Teaching style
  - Packed content
  - Frenetic pace of instruction
  - Need to evolve a teaching style to capture students' attention
- Overemphasis on analysis
  - Very little synthesis
  - Connection to real engineering problems minimal
  - Scope for tapping students' creative potential is limited

### **Industry**

In this era of globalization, the pre-eminence and high growth rates of the Indian industry would depend on its ability to come up with significant value addition and cutting edge technologies, for which the academic curriculum must engender:

- Analysis and synthesis
- Innovation
- Interplay between science and engineering
- Interdisciplinary flavour
- Management skills
- Communication skills
- Cultural and social awareness

### **R&D Institutions**

In-house development of cutting edge technologies requires people with:

- Vision
- The ability to adapt technology to changing environment
  - Clean/green technology
  - Resource conservation/recycling
  - Harnessing non-conventional energy resources
- The ability to address the law of diminishing returns in technology development require:
  - Continuous up-gradation of skill sets
  - Sound fundamentals

Given the above scenario, the academic programme of IITK should be geared to provide the necessary human resource.

### **III. Focus of the Academic Programme**

A university has a choice of having academic programmes in many diverse areas such as science, engineering, social sciences, law, management, and medicine. On the other hand, a university can be highly focused, carving a niche for itself in a few selected areas by leveraging the available resources. Given the many new institutes of higher learning with whom we are going to share human resources, the academic programme of IITK should focus on producing highly-skilled technologists and scientists. However, it should also provide avenues for students who want to hone their managerial or entrepreneurial skills.

Given their brand equity, the expectations from IITs are not limited to producing world-class undergraduates. IITs are also expected to provide technological solutions to local problems. Moreover, despite the considerable economic progress made by India in the past decade, the economic benefits have not percolated adequately to the lower strata of the society. To increase the participation of the students in the nation building process through technology development, the academic programme should (i) make students sensitive to local needs, (ii) inculcate the spirit of team work, (iii) cultivate leadership qualities, and (iv) instill a sense of ownership and national pride among the students. The students should also have an awareness and appreciation of art, literature, and culture.

#### **IV. Product**

Humane, global Indians who are leaders in their fields.

#### **V. Skill-Sets**

The skills required to produce a model student, described above, may be classified as:

- Basic skills
  - Mathematical and computational skills
  - Analytical skills
  - Experimental skills
  - Hardware friendly
  - Scientific temper
  - Communication skills
  - Cultural and social awareness
  
- Advanced skills
  - Department-oriented skills
  - Interdisciplinary orientation
  - Synthesis
  
- Auxiliary skills
  - Management
  - Entrepreneurship

#### **VI. Current Curriculum**

Considering the focus of the academic programme and the required skill-sets, the strengths and weaknesses of the current curriculum are presented below:

- Strengths
  - Science-based education
  - Emphasis on fundamentals
  - Rigorous analysis
  - Humanities and social sciences as compulsory requirement.
  
- Weaknesses
  - Less emphasis on working with hands and tinkering
  - Too much content
  - Imbalance between breadth and depth
  - Content above the maturity level of a reasonably good student.
  - Lack of flexibility for students to select courses depending on their maturity, aptitude and interest.
  - Minimal connection between course content and real-life applications.
  - Not enough opportunities to explore for very good students.
  - Little scope for multi-disciplinary specialization.

- No emphasis on good written or oral communications skills in evaluation criteria.

## VII. Proposed Curriculum

- Truly credit-based curriculum
- Develop aptitude for experiment and exploration
  - Project-based laboratories
  - Required minimum laboratory credits
- Conceptually challenging and thought-provoking curriculum
- Emphasis on interdisciplinary education
- Cater to good, motivated student by facilitating:
  - UG research
  - Earning credits with universities of repute
  - Flexibility to take more courses through overload.
  - Project-oriented internships in industry/R&D laboratories for credit during vacations or a semester
- Provide safety net for weak students with the help of:
  - The slow pace programme, the possibility of modifying which needs to be looked into.
  - Underloading depending on intellectual capability

## VIII. Credits

The present and proposed methods for assigning credits to the courses are given below.

### **Present System**

- Students are expected to spend average 50 – 55 h/week, including exam/quiz preparation.
- Academic Load (AL) =  $3L + T + 1.5P + 0DH$   
Here L, T, P, and DH refer to the number of contact hours of lectures, tutorials, laboratories and discussion hours respectively. Thus academic load reflects the total contact and self-study hours per week that a student is expected to spend on a course.
- $5 \leq AL \leq 15$
- Typical AL = 10 – 11
- The AL was then converted into weightage according to the following table:

AL	Weightage
5 – 6	2
7 – 8	3
9 – 12	4
13 – 15	5

### **Proposed System**

- Academic load in the present system be directly converted into credits.
- Credits (C) should explicitly reflect contact and self-study (SS) hours.

- Discussion hour should be dropped or replaced with office hours manned by student tutors.
- $C = L + T + P + SS$ 
  - $SS = 2L + T + A$ , where A indicates additional work.
  - The value of A will usually be ZERO. However, in some courses with no tutorial there may be heavy assignment submissions or/and a big project. Similarly, in some lab courses there may be a need for too much preparation before experiment(s) can be conducted or individual projects (not in groups) etc. In such situations, to reflect the actual academic load of the course, A may be chosen as 1, or at most 2.
  - For example, a course with 3 Lecture Hours, 1 Tutorial Hour and 2 Hours of laboratory per week, and with  $A=0$ , will have 13 Credits ( $C=3*3L+2*1T+2P$ )
  - Any laboratory related material should be covered in regular lectures.
  - The number of quizzes in a course and the rigour of term papers must be consistent with the self-study hours in a course.
- 400 – 420 credits required for graduation.

## IX. Graduation Requirements

- Present
  - Passing grade = D (4)
  - Graduating CPI = 5.0
- Proposed
  - Passing grade = D (4)
  - Graduating CPI = 4.0

The proposed graduation requirement implements the credit-based system in true spirit. There is a concern that lowering the graduating CPI may further “de-motivate” students currently with a CPI below 5.0. Hence the reduction of graduating CPI must be accompanied by appropriate administrative measures such as minimum attendance requirements.

Additionally, academic progress of weak students will be monitored and the following warning mechanism is proposed:

- Warning:  $CPI < 4.5$
- Termination:  $CPI < 4.0$

## X. Degrees

- Present
  - B.Tech. (Engg.)
  - Integrated MSc (5 yrs)
  - MSc (2 yrs)

Post-graduate education should always be a matter of choice based on students’ quest for specialized knowledge in a field of their interest. It should not be forced down the throat of students during JEE counselling where, by-and-large, the choice of a dual degree (B.Tech./M.Tech.) is made out of compulsion. Instead, an academic

environment must be created by the academic programme which motivates students to voluntarily opt for a second degree. It is also felt that a Bachelors degree, irrespective of whether it is engineering, sciences, or economics, should be adequate to prepare the student for (i) respectable employment, and / or (ii) post-graduate studies. Hence the following degrees are proposed:

- All first degrees for students coming through JEE will be of 4 years duration
  - B.Tech. (Engg.) and B.S. (Sciences/Economics)
- Option for minors in a second branch, an HSS discipline or multi-disciplinary minors (including HSS)
- Option for a second degree at the end of III year
  - M.Tech. (Engg.), MSc (Sciences/Economics), MBA
  - Second B.Tech./B.S. degree
  - Switching allowed between science, economics and engineering
  - The second degree will entail taking all department compulsory courses
- MSc (2 years) will continue as before

There may be students who are interested in exploring different facets of engineering/sciences and would not like to be constrained by being in one department. For such students, we propose:

- B.Tech. in Engineering Sciences
  - Initially this branch will be offered as a “branch change” option
  - It will have a compulsory core like for all other students
  - Stress will be on engineering sciences
  - An engineering/science department or HSS discipline is selected as a minor

The student will have to suitably choose courses to correspond to the departmental credits. These may constitute multiple minors or an interest-based course stream. This will require proper (department level) curriculum counselling to the student, and designing of a proper sequence of courses to suit personal interest, and mandatory requirement of the academic programme. E.g. the course structure could have advanced mechanics, dynamics of continuous systems, nonlinear vibrations, random and deterministic vibrations, FEM, signals systems and networks, control system analysis, controls laboratory (or ME Lab. II), automation and control, bio-mechanics, composite materials, etc.

## **XI. Structure of Academic Programme**

### **A. Break-up**

In the following table the proposed break-up of the academic programme into HSS, Science,/Science electives, Esc, TA, Department courses and open/core electives is compared with the recommendations of the earlier UGRCs.

	HSS	Science/Sc. Electives	Esc	TA	Deptt	Open/Core Electives
Original <sup>1</sup> 1963	18.7	22.6	13.2	11.3	34	
I UGRC <sup>1</sup> 1970	16	20	10	10	32	12
II UGRC <sup>1</sup> 1981	10.9	12.9	15.2	6.5	41.3	12.9
III UGRC <sup>1</sup> 1992	10	15	15	5	42.5	12.5
IV UGRC <sup>1</sup> 2001	9.6	19.2	9.6	2.4	50.0	2.4
V ARC <sup>2</sup> 2008 Proposed	12-15 Includes Mgt.+ Comm Skills+ Foreign Lang.	20 <i>Compulsory+ Electives</i>	10 ESc + ESO	2-5 Manufact. + Engg. Drawing	35-40 Compulsory.: 25-30 Electives: 10	15 Room for a Minor

1: The break-up is based on the number of courses.

2: The break-up is based on total credits.

The proposed break-up is consistent with the need to provide broad-based education at the under-graduate level to produce a global Indian. The relatively higher proportion of core/open elective credits has also been made to facilitate a smooth transition to a second degree. A semester-wise template of the proposed curriculum is available in Appendix I.

## B. Core Programme

The desired features of the core courses are given below:

- Courses should not be department-centric
- Broad-based courses that are pitched at a level understood by students of less competitive branches
- Core programme, especially the sciences, should be more flexible:
  - Core slots should have compulsory and elective components
  - Total core credits to be completed in the first 2 years should be defined
  - Fix slots for compulsory courses that have to be taken by all students
  - Departments decide slots of some courses, as in ESOs
  - Students have freedom to choose slots for elective courses
- Participation from more than one department in teaching/tutorship of core courses should be mandatory. Engineering departments must participate in science courses and vice-versa.
- PE (Physical Education) should continue to be an integral part of the curriculum. The course should be offered in the first two semesters. The course structure and its functioning needs to be reworked. The course can have (potentially) two



two-hour slots in a week. A dedicated faculty could be made instructor-in-charge with a few tutors from the departments, the load being counted towards normal academic load. The coaches will assist the tutors in carrying out the classes. This will bring in seriousness in the conduct and attendance of this course. The course will be Pass/Fail, with credits assigned to it.

### **Science**

The proposed features of the science curriculum are given below:

- Science courses to have compulsory and elective components
- Compulsory courses cater to all departments
- Electives contain department-specific, advanced courses (SO). For example, SO can be an additional course on Mathematics, Physics, Chemistry, Life-science, Dynamics
- Compulsory curriculum
  - Basic courses
    - 2 Maths, 2 Physics, 1 Chemistry, Physics and Chemistry laboratories.
  - Exposure to emerging sciences
    - Introduction to Biology.
- Experiments should be made exciting, possibly by having projects which require thinking and innovation.
- Visual aids and animations must be used to explain difficult concepts wherever possible.

### **Engineering Science**

The recommendations for Esc are:

- Retain the courses on Electronics and Programming with modifications.
- Programming course
  - Scientific computing portion of the course should be increased substantially
  - It should not be treated as a first course for CSE students
  - Devise means to deal with students with below threshold exposure to computers
- Electronics
  - Course content should be reduced
  - Course should be simplified and pitched to an average student. It should not be treated as a first course for electrical engineers
  - Laboratory should be fun by introducing projects, for example fabricating an amplifier
  - Course should be moved to II year because of math pre-requisite

### **Engineering Science Option**

The format of ESOs in the current curriculum should be continued except for the fact that it should be taught at a level that is comfortable to the participating departments.

### **Technical Arts**

The two TA courses on Engineering Drawing and Manufacturing to be retained with the proposed modifications:

- Engineering Drawing
  - Sketching should be retained
  - Drawing board and drafters should be replaced with AUTOCAD or similar software
  - Incorporation of a laboratory project
- Manufacturing
  - The existing course was the addition of the old TA203 and TA204 courses. Both these courses had 2 lectures and one practical per week.
  - The present course format is heavy -- (2Lecture + 2Practical)/week + 2 projects – and should be discontinued
  - It is imperative that this course should not be viewed as a pre-requisite for manufacturing-related courses in ME and MME
  - There are two options for running this course:
    - Theory (2L/week) taught in 1st year with visual teaching aids. Both ME and MME laboratories combined together in II year as a single laboratory course with a composite project. The course on manufacturing theory in the 1st year can be a good substitute for the electronics course.
    - Two independent courses with separate ME and MME contents, each course having (1L + 1P)/week.
    - Advanced manufacturing processes should be introduced either as experiments or demonstrations.

### **HSS**

Apart from the courses in economics, psychology, philosophy, English, sociology and art, the HSS component should include the following:

- Communication skills (please see Appendix II)
- General management that introduces students to the basics of finance, marketing and human resource management
- Foreign languages
- Courses on Indian, world history

### **C. Modular courses**

To add more variety to the course basket and to eliminate “stretched” courses, it is proposed that half-semester courses with one mid-semester and one end-semester examination be allowed. A half-semester course will be assigned half the credits of a corresponding full course. This also allows the student the flexibility of taking two half-semester courses in lieu of a full course. The half semester courses will start either at the beginning of the semester, or after 7 weeks (mid-way) of start of semester.

### **D. Systems Engineering**

The concept of systems engineering -- using analysis and synthesis -- as a tool for problem solving is conspicuous by its absence in the present curriculum. A project-oriented course that illustrates some of the steps in systems engineering: (i) problem definition, (ii) analysis of alternatives, (iii) model building and evaluation could be introduced. The project must attempt to provide technological solutions to

local/national problems. An example could be the design of cheap, hygienic toilets in trains.

## **E. Administration**

An academic curriculum proposed by ARC is at best a statement of intent unless it is implemented in letter and spirit.

### ***Ethos***

One noticeable problem in recent years has been the lack of a vibrant academic atmosphere in the campus, especially the classroom and hostels. The general attitude of students towards academics is lackadaisical, with a surprising zest for organizing scores of festivals of various hues and colour. Therefore there is an urgent need to inculcate a sense of balance and discipline in the life of students at IITK. Some of the possible administrative steps could be:

- A minimum attendance level (say 80 %) should be compulsory for appearing in the end-semester examination.
  - Minor weightage for attendance does not seem to have the desired effect
- The number, scale, and funding of festivals should be restricted to a manageable level to ensure that academics is not unduly affected.
- Innovative measures should be thought of for increasing the interest of students in experiments and curbing rampant copying that takes place with laboratory reports.

The major responsibility for maintaining the academic ambience rests with the faculty. However, with the increasing emphasis on research there is a need to maintain the right balance between (i) teaching, (ii) critical corporate activities such as DUGC/DPGC and (iii) research. For example, it is important to plan outside visits so that most classes are held as scheduled.

Two other issues relevant to faculty are:

- Our inability to address the issue of “below average” teachers. A process of non-intrusive monitoring should be in place.
- Ensure that the course syllabus and the level of instruction are followed in letter and spirit.
  - The practice of maintaining course files must be implemented
  - A course monitoring group should be formed

### ***Time Table***

With increasing number of students, it will not be practically possible to accommodate the wishes of all students in terms of selecting electives and backlog courses. Hence it is highly desirable to have a time table where the slots for core, HSS, departmental compulsory and open elective courses must be fixed say for a period of five years.

### ***Examination and Evaluation***

There have been suggestions of moving from the present system to a one mid-term and an end-semester examination system of evaluation. The ARC is divided on this. The one mid-term and an end-semester examination will leave more

scope for project(s) and will be useful for implementing the modular/half-semester courses.

## **Salient Features of the New Curriculum Proposed by the ARC:**

1. A completely credit based system, with 400-420 credits required for graduation with a Bachelors degree. In this system, credit weightage will be calculated on the basis of the amount of student-time required for the course, using the following formula:

$C$  (credit) =  $L$  (lecture hours) +  $T$  (tutorial hours) + Practical (lab hours) +  $SS$  (self-study)

Where  $SS = 2L + T + A$  (Additional load due to assignments, projects),  $0 \leq A \leq 2$ .

2. Graduating CPI to be 4.0 (in line with passing grade being D)
3. Students may also opt for a B.Tech. in Engineering Sciences, an interdisciplinary degree not limited to any one department.
4. All students may opt for a Minor – a sub-specialisation in their own department, in any other department (including HSS), or a proposed interdisciplinary minor.
5. Increased flexibility for students through an increase in the elective component of the curriculum, with 10% as core electives (ESO / SO), 13.5-18% as open electives, and 4.5-9% as departmental electives.
6. The category of Science Electives (SE) is abolished. Instead, students will take a minimum of 10 credits (one full-semester course), or a maximum of 35 credits (approx. three full-semester courses) as their Science Option (SO) as part of their elective core programme.
7. In the compulsory core programme, students will be required to do only TWO Maths courses.
8. In the compulsory core programme, students will have the choice of doing EITHER CHM102 OR CHM103.
9. TA201 has been split into two courses – TA102 (ME) and TA 201 (MME)
10. HSS courses (except in the first semester) will not have tutorials. One HSS slot has been added, taking the total of HSS slots to five (12.8% of the curriculum). Students will have to take a minimum of 20 HSS Level I credits (two full-semester courses), and a minimum of 27 HSS Level II credits (three full-semester courses).
11. There is a provision for Modular courses which are short 20-lecture half-semester courses (with half the credit weightage of a regular full-semester course). Departmental courses and all Electives may be offered in this format.
12. DO (Introduction to Profession) has been deleted from the curriculum. Departments may choose to use one of their departmental core courses for this purpose.
13. The B.Tech Project (BTP) has been made optional. Students, however, may opt for UG research through three optional slots, and one extra slot for anyone who wants to take extra research credits in the final semester.
14. Two communication skills courses have been added as part of the required programme – a web-based composition skills course (in the third semester) , and a department

specific communication skills course (to be designed by individual departments) in the fifth semester.

15. Discussion Hour has been deleted from ALL courses.

16. 80% attendance is made mandatory in a course for a student to appear in its end-term examination.

17. The category of Academic Probation (AP) to be abolished; students with SPI less than 4.5 to be placed on Warning (W), while students with CPI less than 4.0 to be Terminated.

18. All JEE fresh entrants will be admitted only for a Bachelors degree (B.Tech. or B.S.). Students may later opt for a dual degree (one extra year), which may either be an M.Tech./ M.S. or a second Major in another department.

### **Questions for the Departments:**

1. A Minor – an area of sub-specialisation – will consist of 27-36 credits. What Minors could your department offer? Please specify the ideal structure of the minor (courses and their order). What interdisciplinary minors could you offer in association with other departments? What would be their structure?
2. What would be the structure of 2<sup>nd</sup> B-Tech/B.S. degree (Major) in your department for students from other departments? Specifically, what should be the minimum number of credits for award of the 2<sup>nd</sup> degree? What should be the course / credit mix (choice of electives and core courses) for 2<sup>nd</sup> degree?
3. Do you think there should be an option for a B.Tech (Honours) degree? If so, what should be the criteria for giving this special honours degree?
4. Should there be an exit option for students who consistently underperform during the core programme at IIT Kanpur? If so, what form should this exit option take?
5. In the proposed curriculum, a student may take a maximum of 35 credits (three full-semester courses) and a minimum of 10 credits (one full-semester course) under the ESO category. Which ESO courses would you make compulsory for your department?
6. In what ways can your department integrate communication skills as a necessary evaluative criteria in some of your department courses?
7. Should we switch from the pattern of two midterm and one end-term exam to one midterm and one end-term exam for all courses?

## Appendix I

### Proposed 4-year Bachelor Degree Program

Sem	Course			Sem	Course		
I	MTH101 (Calculus) CHM102/CHM103 (Choose one) PHY101/CHM101 (Lab) [TA101 (Engg. Graphics)+ LIF101 (Life Sciences)]/ ESC101 (Computing) ENG112/HSS-1 PE101  <i>TA101 &amp; LIF101 alternate with ESC101</i>	3-1-0 2-1-0 0-0-3 [2-0-2 + + 2-0-06]/ 0]/ 3-1-3 3-1-0 0-0-3	11 08 03 [08 + 06]/ 14 11 03 <b>50</b>	II	MTH102 (Lin Al, ODE,...) PHY102 (Mechanics) CHM101/PHY101 (Lab) [TA101 (Engg. Graphics)+ LIF101 (Life Sciences)]/ ESC101 (Computing) HSS-2 (Level 1) PE102  <i>TA101 &amp; LIF101 alternate with ESC101</i>	3-1-0 3-1-0 0-0-3 [2-0-2 + 2-0-0]/ 3-1-3 3-0-0 0-0-3	11 11 03 [08 + 06]/ 14 09 03 <b>51</b>
III	PHY201 [ESC102 (Electronics)/ ESO-1/SO-1] ESO-2/SO-2 DEPT TA201 (MME)/TA102(Mech) Composition (Web based)	2-1-0 [3-1-3/ 3-1-0] 3-1-0 3-0-0 1-0-3 0-0-2	08 [14/ 11] 11 09 06 02 <b>50/ 47</b>	IV	SO-3 [ESC102 (Electronics)/ ESO-1/SO-1] HSS-3 (Level 2)/ DEPT DEPT OE-1 / DEPT TA102 (Mech)/TA201 (MME)	3-1-0 [3-1-3/ 3-1-0] 3-0-0 3-0-0 3-0-0 1-0-3	11 [14/ 11] 09 09 09 06 <b>55/ 58</b>
V	ESO-3 DEPT DEPT HSS-4 (Level 2) / DEPT UGR1 (Optional) OE-2 / DEPT Comm Skills (Deptt)	3-1-0 3-0-0 3-0-0 3-0-0 0-0-4 3-0-0 0-0-2	11 09 09 09 04 09 02 <b>49/ 53</b>	VI	DEPT / OE-1 DEPT / HSS-3 (Level 2) DEPT DEPT [UGR2/ OE/DE] OE-3 / DEPT	3-0-0 3-0-0 3-0-0 3-0-0 [0-0-9/ 3-0-0] 3-0-0	09 09 09 09 [09/ 09] 09 <b>54</b>
VII	OE-4 / DE-1 DEPT / HSS-4 (Level 2) DEPT / OE-2 HSS-5 (Level 2) / DE-2 [UGR3/ OE/DE]	3-0-0 3-0-0 3-0-0 3-0-0 [0-0-9/ 3-0-0]	09 09 09 09 [09/ 09] <b>45</b>	VIII	DEPT / OE-3 DE-1 / OE-4 DE-2 / HSS-5 (Level 2) OE-5 OE-6 UGR4 (Extra credits)	3-0-0 3-0-0 3-0-0 3-0-0 3-0-0 0-0-9	09 09 09 09 09 09 <b>45/ 54</b>

- Total credits: minimum 399, maximum 412. Department core is denoted by DEPT.
- SO+Sc core: 76 credits (19%), Esc+ESO: 46 credits (11.5%). A total of four slots are kept for ESO and SO courses. A student can use these four slots in three different ways: 3ESO+1SO or 2ESO+2SO or 1ESO+3SO. The aforementioned percentages are computed assuming a balanced ESO/SO i.e. 2ESO+2SO.
- HSS: 51 credits (12.8%)
- TA: 14 credits (3.5%)
- OE: 54-72 credits (13.5-18%)



- DEPT core: 99 credits (24.8%). A department has complete freedom in designing the core course structure to use up to 100 credits. The template shows only an example of how to allocate 99 credits across eleven courses. A department is expected to have at least 20 laboratory credits in its core course structure. The eleven courses shown in this template *does not have any laboratory credits*. While the template does not show the “D0” course any more meaning that it is no longer required, a department is free to include one such course in its core structure. However, if a department does have a “D0” course, it must carry appropriate credits (there is no zero-credit course in the proposed program).
- DEPT elective: 18-36 credits (4.5-9%)
- UGR1 (research experience) is optional and graded (S/X). UGR2 and UGR3 can be taken in place of a DE or OE. However, at most one OE slot and at most one DE slot can be used for this purpose. UGR2 and UGR3 have letter grades. UGR4 is extra credits.

## Appendix II

### Communication Skills for Undergraduate Students

We strongly feel that there is indeed a need for IITK students to develop their communication skills. Feedback from placement, alumni, companies as well as the experiences of various instructors clearly shows that this is an area that requires significant improvement amongst our student body. It is therefore necessary that we include communications skills in our formal curriculum.

Broadly speaking, we define Communication Skills as the expression (oral and written) of thoughts and ideas in a logical and coherent manner. Given the global realities in the present world, we also stressed that such expression needed to be specially honed in the English language. Given this definition, Communication Skills may be divided into the following components:

- Basic English language proficiency (including writing, speaking and listening skills)
- Basic composition skills
- Technical writing and presentation
- Professional communication skills (including group discussions, interviews, résumé writing, etc.)

Given the scope of this field, as well as the necessity for practical application and continuous practice for the development of students' communication skills, one conventional lecture / tutorial based course for all students is not enough. Instead, we propose a modular format that is spread over the entire undergraduate programme. This will include the following elements:

- 1) **An English diagnostic test (EDT) for all incoming undergraduate students:** The focus of this test will be exclusively on evaluating students' English language skills (listening/comprehension, grammar and vocabulary). This may be an online test modeled on TOEFL. This test score would help to divide students into different groups based on their English language skills. Currently the EDT is administered manually by the English faculty to all incoming UG students who are then divided into two groups on the basis of their performance in this test – those requiring ENG112C and those exempted from it.
- 2) **Remedial English Language Course (modified version of the present ENG112C):** A completely tutorial based language-intensive course for the students identified by EDT. This course would retain its present format of teaching approximately 90 students in three sections of 30 each (unless a significant increase of English faculty in the HSS department occurs?).
- 3) **A web-based basic composition skills course:** All students, irrespective of their diagnostic test score, would be expected to complete this course before their third semester. This course will cover topics such as sentence composition (how to write clear concise sentences), converting sentences into logical coherent paragraphs, different organizational patterns in writing, etc. Students will not receive any formal grade for this course (not even pass/fail) in the grade-card, but a record of the performance will be kept in the UG office. The student will simply need to submit their

numerical score in this course to be admitted to the next course in the series. This score will be based on the student's performance in the various tests / exercises that are part of the web-based course. The student will clear the course provided he/she scores more than 50% in the examinations. The student may take this course up to three times to improve his/ her understanding of the course material and get the "clearing" score.

- 4) **Writing Laboratory and Composition Help Desk:** Students who are unable to clear the web-course will be required to report to the writing laboratory for about 20 hours of remedial sessions. After the sessions, the student can retake the examination of part (3). The score, along with the certification of the remedial sessions, is enough for the student to go to the next stage (i.e. the "clearing mark" is not mandatory).

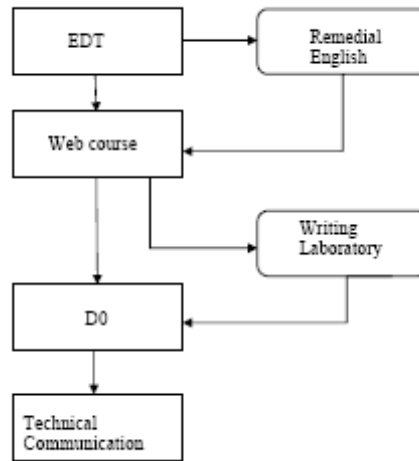
The writing laboratory will have a *communication help-desk*, manned by senior UG, dual degree, M.Tech or Ph.D students from various departments. The help-desk will have designated time slots and will be open to all students seeking help with respect to either the web-course or any other technical communication issues. The help desk students will be chosen based on criteria setup by the English department. It is recommended that this responsibility of the help-desk students be taken into consideration for their MHRD-scholarship.

- 5) **Basic introduction to technical writing and presentation:** This would be part of the current D0 course with the caveat that the D0 course be offered in the third semester instead of the second semester as done now. The communication skills part of this course would constitute 1/4<sup>th</sup> if not 1/3<sup>rd</sup> of the course content / grade. The student would here learn to gather material on a chosen technical topic and organize it into a coherent written as well as oral presentation. The instructional part of this course may be made web-based, with reports and presentations to take place on a flexible basis whenever individual students finish the web-based part of the course.
- 6) **A 2-credit department specific technical communication skills course:** This course will introduce students to their discipline-specific compositional requirements (report and summary / abstract writing, research articles, etc.) as well as the techniques of effective multi-media presentation (use of and coordination with audio-visual aids, body language, etc.).

In addition to the above REQUIRED courses, we recommend the following:

- Clearly defined evaluation of communication skills in other existing courses:
  - ✓ Lab courses: a portion of the lab report grade determined by its presentation
  - ✓ The addition of reports / presentations in various dept. and HSS courses, to be evaluated both for content and a specified percentage for communication skills.
- Workshops for professional communication skills (GDs, Interviews, Résume writing, etc.) that would be open to students on a payment basis to students after their fourth semester. The instructors for this workshop maybe from outside the Institute. These workshops may be organised in coordination with the SPO.

A flow chart in terms of the student's program is as follows:



NOTE: As part of teaching communication skills to undergraduate students, we also discussed the possibility of having another ‘intermediate level’ course in English language for those who are middle-scorers in the EDT. However, upon further discussion, we removed this suggestion from our recommendations primarily for two reasons:

- a) The course content for this course would largely duplicate material covered by the required web-based course and the proposed communications content of the DO course.
- b) Any such additional language-intensive course would require additional faculty since a language-intensive course can only be taught in small sections of 30 students each. Such a course, therefore, would require a substantial increase of the number of English faculty in the HSS department.

## Appendix II

### Report of the Math Subcommittee

1. 1<sup>st</sup> course – Basic Calculus (Finney is a reference): Single variable calculus and concepts of sequences, continuity, differentiation and integration have to be introduced in detail. Vector calculus also to be discussed in detail. Idea should also be to enable logical thinking. Concepts like divergence theorem, Stokes theorem and Green’s theorem may be left out of the syllabus (as these are developed in physics, fluid mechanics and other courses taken later). This is to lower the content of the course. Other concerns/ideas:
  - All proof should not be done. Some results given for formal application.
  - Introduce more of formal application problems.
  - About 30% proofs should be given in detail; for certain results only sketch of proof given accompanied by detailed notes for further reference or a set of web-based “Basic analysis lectures” – to augment the learning for the keen students (this is extra material over and above the normal course load – not to be examined).
  - Redo the problem set. Harder problems given as “starred” problems, uploaded on the course web-site. The emphasis should be on sound learning of the basic concepts and not too much emphasis on the tricks involved in specific problem solutions.
  - Solve more problems in the lectures.
2. 2<sup>nd</sup> course – the second course should be based on modules of basic linear algebra (20 lectures) and ordinary differential equations+ transform methods (20 lectures).

These two courses cover the material that all departments need. These will be compulsory for all departments. Additional mathematics is specialized to departments, and has been broken into modules (preferably of 20 hours each), as:

- a) Introduction to partial differential equations
- b) Basics of probability and statistics
- c) Numerical methods using MATLAB – this can be handled by engineering faculty.

Under the SO option, the departments may ask students to take two of the three modules. Other modules may be added later.

3. Advanced, or specifically designed courses, to give additional exposure to mathematics, may be devised and taught by departments internally.
4. The committee felt that experience with student tutors has not been very encouraging (barring exceptions). Hence, a new paradigm of a bigger class of 100-150 dedicated to problem solving should be done (1 hour a week). The class will be conducted by a faculty member. Further, the students can be used to evaluate

assignments, examination papers, with the instructor as the Head Examiner, and the faculty tutors as the examiners. Suitable monetary compensation to the student tutors is strongly recommended.