

**The UG Programme  
at IIT Kanpur**

**Recommendations of the  
Fifth Academic Programme  
Review Committee**

**October 2010**

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## Executive Summary

- **Credit system:** The Academic Programme Review Committee proposes a completely credit-based system with 395-430 credits required for graduation with a Bachelors' degree. In this system, the course credits will be computed based on the student-time required per week for the course using the following formula.

$C = L + T + P + SS$ , where C is the number of credits, L is the number of lecture hours, T is the number of tutorial hours, P is the number of laboratory hours, and SS is the number of self-study hours given by the following formula with A representing the additional number of hours needed for assignments and projects, as decided at the time of approval of the course.

$$SS = 2L + T + A$$

There is no discussion hour in any course. The overall credit formula then becomes  $C=3L+2T+P+A$ . An average student, registered for normal load, is expected to spend 50-55 hours per week on his/her academic programme. A student may register for 40-65 credits in each semester. The credit system is discussed in detail in Section 2.1.

- **Grading scales:** Add a new grade A\* with same equivalent points as A grade to recognize excellence on transcripts. Introduce E grade in UG curriculum worth two points and bring F down to zero. The grading scales are discussed in detail in Section 2.2.

- **Degree options/Graduation Requirements:** All UG students will enter into a four-year BTech/BS programme through JEE. The graduation requirement is that the student collects all the credits that are prescribed for that programme. Students who do well in the programme will be awarded a distinction. The minimum residence time for the BTech/BS programme is 7 semesters. BTech/BS with Distinction will be awarded to students with a minimum CPI of 8.0 and either an average CPI of 9.0 in department core or an average CPI of 8.0 in all UG project courses. This is further discussed in Section 2.3.

- **APEC rules:** The normal academic load, for the purpose of evaluating performance, is 50 credits per semester. A student goes on warning if s/he accumulates less than 75% of the cumulative credits, with normal academic load, up to that point. The programme of the student is terminated if s/he is on warning and fails to accumulate at least 50% of the cumulative normal load up to that point. The semesters that the student may be on leave are excluded from the computation. These are further discussed in Section 2.4.

- **BTech/UG project:** BTech projects in the present form are recommended to become optional. A department can still make BTech projects mandatory by appropriately allocating the department credits. Four UG project courses are introduced in the curriculum, two of which can earn extra credits. The other two can be taken in place of open electives or departmental electives. Departments that wish to continue with a mandatory project may do so by specifying either UGP2 or UGP2-and-UGP3 mandatory. Of course, the credit requirements for graduation of such students from these departments will increase. Further discussions on BTech projects and UG projects can be found in Section 2.5.2.

- **BTech in Engineering Science:** UG students can opt for a BTech in engineering science, an interdisciplinary degree not limited to one single department. This is further discussed in Section 2.5.6 and Appendix XI.

- **Minor:** UG students can claim a minor either from a department different from her/his parent department or from across multiple departments and IDPs. A minor is a sequence of 3-4 courses accounting for 24-36 credits. Further logistics of minors are presented in Section 2.5.3.
- **Double major:** UG students can decide to opt for a second major at the end of the fifth semester of the programme. A minimum CPI of 8.0 is required to exercise this option. Graduation with two majors will extend the programme by one year. Double majors are further discussed in Section 2.5.4.
- **Dual degree:** All students will enter into a four-year BTech/BS programme through JEE. A BTech/BS student can opt for MTech/MS/MBA. This will extend the programme by one year. Note that MS is the follow-up Masters' degree of BS. The dual degree option is further explored in Section 2.5.5 and Appendix XIII.
- **Examinations:** One mid-semester and one end-semester examination. Instructors must conduct two quizzes for all core courses, one on each side of the mid-semester examination. This is explained in greater detail in Section 2.5.7.
- **Modular courses:** A modular course can be offered for half a semester with only one examination at the end aligned with the mid-semester examination schedule. Modular courses open up the option of offering an elective course only during one half of a semester. This will bring enormous flexibility in the system. This is further discussed in Section 2.5.8.
- **Electives:** Increased flexibility for students through an increase in the elective component of the curriculum, with **12-12.4% as core electives (ESO / SO), 13-15.7% as open electives, and 4.3-6.7% as departmental electives**. The committee recommends that the category of Science Electives (SE) be discontinued. 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.
- **Core programme:** The committee proposes that in the compulsory core programme, students will be required to do only two Maths courses and one Chemistry course. TA201 has been split into two courses – TA102 (ME) and TA 201 (MME). A six-credit course on life sciences is included in the core curriculum. All courses with two-hour tutorials now have only one-hour tutorials. Due to reduction in contact hours in various core courses (such as Discussion Hour), the core load is reduced. Further discussions on the academic programme structure can be found in Section 2.5.1 and Appendices VI, VII, VIII, IX, X.
- **HSS courses:** HSS courses (except those offered at Level I) will not have tutorials. One HSS slot has been added, taking the total of HSS slots to **five (11.3-11.7% 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).
- **Introduction to profession:** D0 (Introduction to Profession) has been deleted from the curriculum. Departments may choose to use one of their departmental core courses for this purpose.
- **Communication skill:** The departments are encouraged to include communication skill components in their curricula. The recommendations are further discussed in Appendix V.

- **Class attendance:** The fifth academic programme review committee recommends that 80% class attendance be made mandatory for passing a course. The administrative issues are further discussed in Appendix XII.
- **Transfer of credits from outside IIT Kanpur:** Up to 25% of the credits required for graduation can be collected from outside IIT Kanpur. This avenue can also be exercised to collect UG research credits from outside IIT Kanpur. Necessary approval(s) from various bodies are required for such a transfer.

## 1. 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. Designing a relevant curriculum requires an understanding of the evolving needs of all stakeholders, namely students, teachers, industry, and R&D/academic establishments. We also need to review the shortcomings and the advantages of the current academic curriculum before embarking on designing a new academic programme. The following discussion focuses on each of these topics.

### Students

It is a commonly acknowledged fact that the IITs attract the cream of the country's students. Unfortunately, in a majority of cases, 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.

### Teachers

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.

## **What is an Ideal 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 whom we are going to share human resources with, 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 society. To increase the participation of 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) instil a sense of ownership and national pride among the students. The students should also have



an awareness and appreciation of art, literature, and culture. In summary, the ideal product of an IIT should be humane global Indians who are leaders in their fields.

The skills required to produce the ideal product or 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

### **Current Curriculum**

Considering the necessary 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.

## 2. Proposed Curriculum

In the following, we discuss, in detail, the recommendations of the fifth academic programme review committee for the UG curriculum.

### 2.1 Credit System

The fifth academic programme review committee proposes a fully credit-based UG curriculum. Every academic activity will be evaluated in terms of credits. To understand the necessity of a new credit system, we first review the existing credit system. The credit system is described in more detail in Appendix I.

#### Present Credit System

- Students are expected to study an average of 50 – 55 hours/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 is then converted to a weight according to the following non-linear mapping.

Academic Load (AL)	Weight
5 – 6	2
7 – 8	3
9 – 12	4
13 – 15	5

#### Proposed Credit System

- Academic load is directly converted to credits, as opposed to going through a non-linear mapping.
- Credits (C) explicitly reflect contact and self-study (SS) hours.
- Discussion hour is dropped or can be replaced with office hours manned by student tutors.
- The new formula for computing credit is given by  $C = L + T + P + SS$ .
  - $SS = 2L + T + A$ , 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 a course may have individual

projects (not in groups), etc. In such situations, to reflect the actual academic load of the course, A may be adequately chosen.

- As an example, consider a course with three lecture hours, one tutorial hour, and two hours of laboratory per week. With A=0, this course will be worth 13 credits ( $C=3*3+2*1+2$ ).
- Any laboratory related material is recommended to 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.

## 2.2 Grading Scales

The fifth academic programme review committee recommends the following two changes in the grading system:

- Introduction of an A\* grade carrying the same level of points as an A grade. However, the A\* grade is intended to recognize and encourage outstanding performance in a class. This grade should be used sparingly.
- To bring parity between the UG and the PG grading systems, the introduction of an E grade in the UG system is recommended. This grade is worth two points and an F grade will be equivalent to zero points. An E grade, however, is not a passing grade, but a student can use this grade to satisfy pre-requisites.
- The description of the various letter grades is:

Grade	Weight	Description
A*	10	Outstanding
A	10	Excellent
B	8	Good
C	6	Fair
D	4	Pass
E	2	Exposure/Repeat
F	0	Fail

## 2.3 Graduation Requirements and BT BS with Distinction

The fifth academic programme review committee recommends that all students enter the academic system through JEE by opting for either a four-year Bachelor of Technology (B. Tech.) degree or a Bachelor of Science (B. S.) degree. The graduation requirement is the collection of 395-430 credits worth of courses as specified by the respective Department/Programme. The student must pass all the courses to graduate (minimum of D grade in each course). To recognize those students who perform well in the programme, they will be awarded a BT/BS with distinction.

B. Tech. / B. S. with distinction: This recognition is introduced to recognize and encourage the best students of the graduating batch. There are two possible ways to earn a distinction.

- A CPI of at least 8.0 and an average CPI of at least 9.0 in department core.
- A CPI of at least 8.0 and an average CPI of 8.0 in four UG research courses (these courses are discussed in Section 2.5). Note that students in this category take more credits than others.

The committee recommends various other specialization options, further detailed in Section 2.5.

#### 2.4 Relevant APEC Rules

The fifth academic programme review committee recommends the following rules to facilitate and evaluate academic performance of students:

- Academically deficient students be allowed to continue with the academic load that they are comfortable with. The normal academic load is defined to be 50 credits per semester. A student may register for 40-65 credits every semester, roughly a 20% under/over-load. An average student may finish the program in 8 semesters while a good student may finish the programme in 7 semesters. The minimum residence time is 7 semesters. The maximum duration of the academic programme may be 1.5 times the duration under normal circumstances (=12 semesters).
- The student may drop a course up to one week prior to the last day of classes. Of course, this is permitted only if the student does not go below the minimum academic load.

The various categories under which a student may be placed based on their academic performance are:

**Warning:** A student will be placed on Warning if the number of credits cleared by the student is less than 75% of the cumulative normal load up to that point. This excludes the semesters that the student may have dropped. There was a discussion on whether there should be a restriction on the number of credits that a student on Warning can register for. It was pointed out that this will be inconsistent with our criterion of 75% of the cumulative load. The student on warning will do the following:

- He/She shall register for all CORE/compulsory courses (if available) in which the letter grade E/F is obtained.
- He/She shall not hold any office in the Hall of Residence, Students Gymkhana or any other organization/body while on Warning.
- Submit the required undertaking signed by the parents
- Any other term(s)/condition(s) laid down by SUGC/Senate

**Termination:** A student will be placed on Termination if the student is on Warning and if he/she fails to acquire at least 50% of the cumulative normal load up to that point. This excludes the semesters that the student may have dropped.

More details are given in Appendix II.

**APEC for second of the Double-Major:** To be a student in good standing in the second major, the student must complete the requirement of the first major. The computation of CPI and the format of the degree should be similar to the one for the Dual-Degree Programme.

## 2.5 Structure of the Academic Programme

Having discussed the credit system, grading scales, the base degree options, and the APEC rules, now we proceed to explore the structure of the proposed academic programme.

### 2.5.1 Overview

We start the discussion by presenting the credit allocation to various components of the UG curriculum in Table 1.

**Table 1 Guideline for Percentage credit allocation in academic programme**

Item	Broad Area	Proposed Percentage of total credits
1	HSS (excluding Management, Comm Skills etc. )	10%
2	Science (including electives)	20%
3	Engineering Science (E Sc, ESO)	10%
4	Technical Arts	5%
5	Management + PE + Comm Skills + Foreign Language	5%
6	Department Core (Mandatory)	25%
7	Department Elective	10%
8	Open Elective (Room for Minor)	15%

The proposed break-up is consistent with the need to provide a broad-based education at the undergraduate level to produce a global Indian. The relatively higher proportion of core/open elective credits has also been allocated to facilitate a smooth transition to a second degree discussed in the subsequent parts of this section. Since the past academic programmes were not credit-based, we only present a percentage break-down of course allocations proposed by the past four academic programme review committees in Appendix XVII. These are presented only for completeness, and not for comparison.

### The 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
- 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 is recommended; 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 can have (potentially) two two-hour slots in a week. A faculty member could be made instructor-in-charge with coaches assisting 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 Component**

The proposed features of the science curriculum are given below:

- Science courses 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

Further details on the course outlines can be found in Appendices VI, VII, VIII, IX and X.

### **Engineering Science Component**

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 and should not be treated as a first course for electrical engineers
  - Laboratory should be made exciting by introducing projects, for example fabricating an amplifier

Please refer to Appendix VIII for more details on these recommendations.

### **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 are to be retained with these 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 two lectures and one practical per week.
  - The present course format is heavy -- (two lectures + two practical classes)/week + two 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 (two lectures/week) taught in the first year with visual teaching aids. Both ME and MME laboratories combined together in the second year as a single laboratory course with a composite project. The course on manufacturing theory in the first year can be a good substitute for the electronics course.
  - Two independent courses with separate ME and MME contents, each course having (one lecture + one practical)/week.
  - Advanced manufacturing processes should be introduced either as experiments or demonstrations.

The technical art course structure is further discussed in Appendix XIV.

### **Humanities and Social Sciences**

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

- Courses on Indian, world history
- Political science

### **Professional Skills**

Apart from courses in Humanities and Social Sciences, the core programme should also include courses in the following areas:

- Communication skills (recommendations are discussed further in subsequent parts of this section)
- General management that introduces students to the basics of finance, marketing, and human resource management
- Foreign languages

### **Proposed Template for a Four-year Programme: An Example**

An example template for structuring the four-year programme is shown in Table 2.

**Table 2. Example template for a four-year programme**

Sem	Course			Sem	Course		
I	MTH101 (Calculus) CHM102 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+ 2-0-0]/ 3-1-3 3-1-0 0-0-3	11 08 03 [08 + 06]/ 14 11 03	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 3-1-3 0-0-3	11 11 03 [08 + 06]/ 14 14 03  <b>56</b>
III	PHY201 [ESC102 (Electronics)/ ESO-1/SO-1] ESO-2/SO-2 DEPT TA201 (MME)/TA102(Mech) ** Composition (Web based)	3-1-0 [3-1-3/ 3-1-0] 3-1-0 3-0-0 1-0-3 0-0-2	11 [14/ 11] 11 09 06 02	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 UGP1 (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	VI	DEPT / OE-1 DEPT / HSS-3 (Level 2) DEPT DEPT [UGP2/ 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 [UGP3/ 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]	VIII	DEPT / OE-3 DE-1 / OE-4 DE-2 / HSS-5 (Level 2) OE-5 OE-6 UGP4 (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>

\* The PE credits will not be included for computing CPI, since this course has only S/X grades.

\*\* See Appendix V for detail.

*The salient features of this template are as follows:*

- Department core is denoted by DEPT.
- The total number of credits for this example template are 402-415. The lower number does not include the credits for UGP1 and UGP4.
- **SO+Sc core: 86 credits (20.7-21.4%), Esc+ESO: 50 credits (12-12.4%).** 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: 47 credits (11.3-11.7%)**
- **TA: 20 credits (4.8-5%)**
- **OE: 54-63 credits (13-15.7%)**
- **DEPT core: 99 credits (23.9-24.6%).** A department has complete freedom in designing the core course structure so that the total credits required for graduation is between 395-430 credits (excluding UGP1 and UGP4 which are extra-credits). Note that this template is for 402-415 credits.



The Review Committee strongly advocates that the Department template be conducive for a student to attempt Dual-Major if the student so desires. Therefore, the department must also spell out the template for a dual major in its Department. With the compulsory department credits restricted to 100 credits, the Dual-Major is very much possible. The template shows only an example of how to allocate 99 credits across eleven courses. The eleven courses shown in this template *do not have any laboratory credits*. However, a department is expected to have at least 15 laboratory credits in its core course structure (as represented by 99 credits in this template). 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: 18-27 credits (4.3-6.7%)
- UGP1 (undergraduate research/project experience) is optional. UGP2 and UGP3 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. UGP2 and UGP3 have letter grades. If a Department so desires, it can specify either UGP2 or UGP2-and-UGP3 as a mandatory part of their programme. UGP4 is extra credits. If UGP2 is specified as a mandatory course, the student will lose the option of taking a DE. The UGP courses can be taken during the summer also. The undergraduate research options are further discussed in the next section.

### 2.5.2 Undergraduate Research/Projects

Lately there has been a lot of emphasis put on undergraduate research/projects. The fifth academic programme review committee takes a serious stand regarding undergraduate research/projects. It has been understood that not all students are interested in pursuing research/projects. While the traditional B. Tech. project forces everyone to undergo a research/project experience, such a curriculum often leads to unhealthy practices and dissatisfaction among both the students and the members of the faculty. The fifth academic programme review committee recommends that the traditional B. Tech. project and undergraduate research be made optional. In the template shown in Table 2, the undergraduate research/project options appear as UGP1 to UGP4. While UGP1 and UGP4 are optional and a student can earn extra credits by opting for these, UGP2 and UGP3 can be taken to satisfy the corresponding number of open elective or departmental elective credits. The committee has also recognized the need to continue with the traditional compulsory B. Tech. projects in some of the departments. These departments are recommended to allocate departmental credits for B. Tech. Projects. *Alternately, the departments can specify either UGP2 or UGP2-and-UGP3 as a mandatory part of their programme. UGP4 is extra credits. If UGP2 is specified as a mandatory course, the student will lose the option of taking a DE.*

**Evaluation:** Each student registers for a UGP with an Instructor. The Instructor assigns a grade. The evaluation of best UGP is for the projects carried out within that department. It is possible that a student from some other Department might get the best BTP award. It is advisable that the Departments hold an Open House where all the UGP's are presented/demonstrated. This will also benefit other UG students. A department which makes the UGP(s) mandatory may prescribe a central grading for their students.

### 2.5.3 Minor

Section 2.3 discussed the base degree options. The fifth academic programme review committee further recommends multiple specialized options on top of the base degrees. One integral component of this

proposal is the introduction of a minor. A minor would consist of three to four courses worth 24 to 36 credits. A minor can be taken either from a department other than the parent department or from across departments. The latter would be an inter-disciplinary minor. A cap of less than one-fifth the batch size (170, for a batch of 850 students) is not permissible in a course floated as part of a minor unless the course makes extensive use of laboratory equipments. The selection of students (if the registration exceeds the cap) would be based on CPI. A student need not declare a minor beforehand. Only on completion of all courses in a minor, a student can claim a minor. This offers enough flexibility to the students in completing a minor.

To further increase the flexibility, the departments should make a commitment to offering the electives towards a minor. It is recommended that initially, as a test case, each department/IDP offers a maximum of two minors. This limit does not apply to HSS, as this department consists of several streams. It is recommended that the areas be kept sufficiently broad, such that a student can choose from a basket of courses (4-8 courses), and not be constrained by a course offered by an individual. This will make it possible to sustain the minor. The departments should be discouraged from screening students who are eligible for a minor, provided the student meets all the desired academic norms. **SUGC will be entrusted with the approval of a minor. Minors will be specified on the Transcript and not on the Degree/Diploma. Specialization within a Department cannot be recognized as a minor. The idea of a Minor is to encourage diverse/wholesome education.**

Since minors require a combination of departmental core and elective courses, it is proposed that designated time table slots be created for minor courses. Some of the OE slots are made available for minors. The current time table has four OE slots shown below.

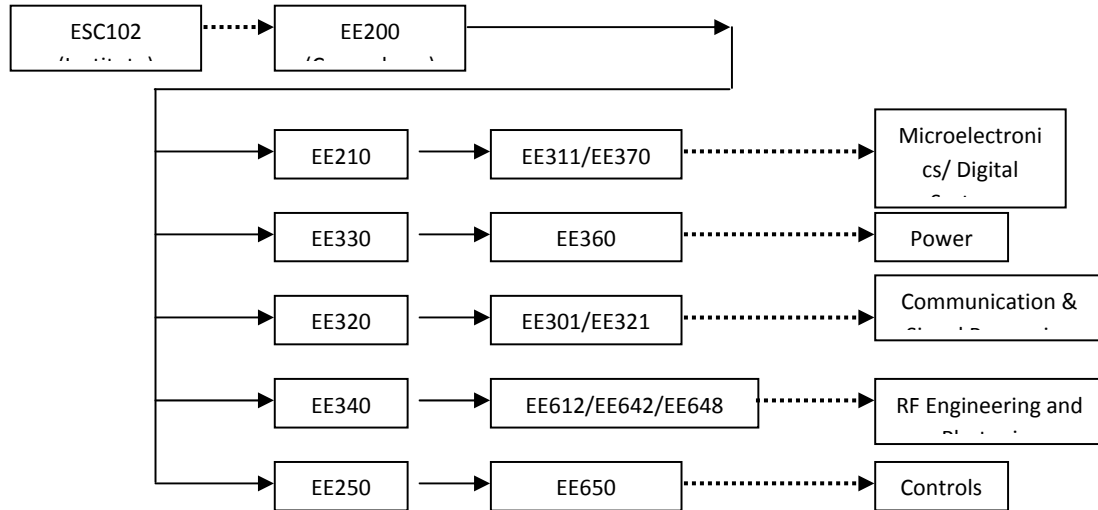
OE-Ia:	Lecture M W Th 9:00-9:55,	Tutorial T 9:00-9:55
OE-Ib:	Lecture T F: 9:00-9:55, Th: 12:00-12:55	
OE-IIa:	Lecture M W: 12:00-1:20,	Tutorial F 9:00-9:55
OE-IIb:	Lecture T F: 12:00-1:20,	Tutorial Th 12:00-12:55

The committee recommends the following related to scheduling of minors.

- Retain the four sets of slots for OE's as proposed by the Time-Table Committee.
- The OE's that are from the basket of compulsory core of the department and count towards a minor should be scheduled in OE-Ia and OE-Ib slots.
- If a department offers a compulsory course that does not count towards a minor (for students of other departments) it should be scheduled outside the slot for minors.
- All modular OE's should be scheduled in OE-IIa and OE-IIb slots so that they can take advantage of the 1hr 20 min slot. The concept of modular courses is discussed in the subsequent part of this section.
- Introduce an additional slot from 5:00-5:55PM for OE/Minor. This will also not interfere with PE for 1<sup>st</sup> year students as OE is for 2<sup>nd</sup> year onwards. Therefore, in all there are 5 slots for OE.
- HSS-I can overlap with OE-Ia
- HSS-II may be scheduled in 11:00-11:55AM

A few example minors are listed below:

**(A) Electrical Engineering**



\* ESO210 is a prerequisite for EE330

**(B) Physics**

Astrophysics

- 305 (Physics of the Universe)
- 407 (Special and General Relativity)
- CM/QM

Bio Physics

- 309 (Introductory Biophysics)/ 310 (Physics of Bio-materials)
- 617 (Physics of Natural Nanomachines)/ 619 (Statistical Physics of Biomolecules and Cells) / 641 (Element of Bio-Medical physics)
- Suitable elective (BSBE)

Chemical Physics

- QM
- 524 (Atomic and Nuclear Physics)
- Suitable elective (Chemistry)

Computational Physics

- 473/625 (Computational Methods in Physics)
- 627 (Computer Simulations in Physics)
- Suitable elective e.g. on Fluid Dynamics (ME/AE)

Condensed Matter Physics

- QM
- 412 (Statistical Mechanics)
- 543/622/634/642/642 etc.

#### Energy and Environment

301 (Energy)

Sociology (HSS)

Environment (covering sensors) (CE)

#### High Energy Physics

QM1

QM2

680 (Particle Physics)

#### Laser Technology

303 (Principles of Lasers and their Applications)

643 (Lasers and Laser Spectra)/ 644 (Quantum Electronics)

Elective (LTP)

#### Low Temperature Physics

QM

634 (Low Temperature Physics)

Experiments in different laboratories

#### Mathematical Physics

QM

Mathematics and Philosophy 407 (Special and General Relativity)

612 (Group Theory)

### **(C) Interdisciplinary**

#### Minor in “Meso/Nano scale Engineering”

ChE688: Colloids and Interface Science

ChE674: Introduction to Nano-science and Technology

ChE659: Process Engineering Principles in Microelectronic Fabrication

Basket of courses from other departments may include MS617 (Organic Electronics),

ME689 (Microscale thermal engineering), MME467 (Materials for Semiconductors industry) and

MME688 (Nanomaterials Processing and Properties).

#### Minor in “Polymers”

ChE672: Polymer Processing

ChE676: Engineering Application of Rheology

ChE677: Introduction to Polymer Physics and Rheology

#### Minor in computational mechanics

ESO 218, Advanced MOS

Advanced Fluid mech.

Basic Aerodynamics

Continuum mechanics.

FEM/CFD/FEM for fluids

### 2.5.4 Double Major

The fifth academic programme review committee also recommends the introduction of double majors in the UG curriculum. Under this scheme, an undergraduate student, at the end of the 5<sup>th</sup> semester, may decide to pursue a second major. Such a student must have a minimum CPI of 8.0 at the end of the 5<sup>th</sup> semester to exercise this option. A bachelors' degree with a double-major would usually require five years to complete. The student is required to complete all departmental core credits in her/his second major. It is suggested that at least 10% of the sanctioned strength of the Department be open for candidates for Double Major. As a possible template, Table 3 depicts a double-major programme in ME and AE.

**Table 3. Double major in ME and AE**

Course Type	ME		AE	
ESO	ESO210,ESO214	ESO202,ESO204		ESO202,ESO204
DEPT. CORE	ME251N, ME321N ME341N,ME352N, ME361,ME301, ME351,ME453, ME452	ME231N/ESO212 ME353/AE231*	AE232,AE211 AE321,AE341, AE312,AE322, AE332,AE342, AE461,AE462	AE231/ME353N ESO212/ME231N
DEPT. LAB.	ME371,ME471		AE331,AE411, AE422	AE361**
BTP*	ME461,ME472		AE471,AE472	
TOTAL	13+2* COURSES	4 COMMON	13+2* COURSES	4 COMMON +1**NOT MANDATORY

\* a course that is required for the regular undergraduate degree, but is not required to be done for a dual major, e.g. BTP in the second department.

\*\* AE361 (Aeromodeling design and fabrication) is mandatory for Aerospace students, but will not be required for a student seeking a dual major in Aerospace engineering.

A student in AE will have to do thirteen courses (provided ME mandates the ESO courses as necessary for a double major) towards a double major with the second major being ME. Similarly, a student in ME will have to do thirteen courses towards a double major with the second major being AE. B. Tech. projects must be waived in the second major. Out of the thirteen courses, registration for 3-4 may be allowed from the OE/DE pool towards fulfilling the requirement of the double major. The student opting for a double major should have a mentor/counselor from both the departments helping him chart the course schedules.

The proposed curriculum mandates about 100 credits of departmental core. As per this mandate, the student will have to do fewer courses (about 10) towards a double major in AE/ME. For example, AE may propose as mandatory: Aerothermomechanics I, II and III; Aerospace structural analysis I and II; Principles of Flight Mechanics; Aerospace Lab. I and II; Flight Lab.; Aircraft Design I and II. This will be mandatory for a double major. The rest will be specializations obtained from the DE pool.

### 2.5.5 Dual Degrees

An undergraduate student in B. Tech. / B. S. programme can opt for an M. S. / M. Tech. / MBA. Such an option would extend the programme by one year. The eligibility for opting for a Masters' degree can be

picked up from the existing rules laid out in the PG manual. However, various new possibilities exist. The most attractive of these is a cross-departmental programme. For example, a BSBE major can now opt for an M. S. degree in Chemistry. Further, a B. Tech.-MBA programme would have much relevance today. One can also do a B. Tech. / B. S. followed by M. S. in a suitable stream of HSS. Two example dual degree structures are discussed in Appendix XIII.

#### **2.5.6. Engineering Science: A Multi-Disciplinary Programme**

The fifth academic programme review committee recommends the introduction of a B. Tech. degree in Engineering Science. This is a multi-disciplinary degree programme cross-cutting several engineering and science disciplines. This option will not be made available at the time of JEE counseling, but the students can opt for this degree programme as a branch change. **The engineering science program is especially aimed at highly motivated students, who would feel constrained within the conventional compartmentalization of departments. The proposed program on Engineering Sciences will enable the student to excel in both engineering and applied sciences, and will offer the student a great degree of flexibility in choosing courses so as to obtain a specialization in a specific track of modern engineering. The progress of modern science greatly depends on innovations at the interface of traditional disciplines, and the proposed curriculum would give the student an opportunity to specialize precisely in such cross-disciplinary subjects.** The academic programme review committee recommends that there be a programme undergraduate committee (PUGC) for the engineering science programme. It must also have an administrative structure similar to other departments/IDPs, although a physical structure may not exist. The possible outline of this programme is further discussed in Appendix XI.

#### **2.5.7 Examinations**

The fifth academic programme review committee recommends one mid-semester and one end-semester examination. The reasons for its preference over the existing two mid-semester examination model are as follows:

- A very short examination is not necessarily a good/fair evaluation. A longer examination covers a wider portion of the course material and tests the students more thoroughly and perhaps, more fairly. Some students are slow and a one-hour examination is too stressful for them. Therefore, instead of two one-hour examinations, a single two-hour examination appears more attractive.
- In the present system, the end-semester examination period is spread over 10-11 days. However, the mid-semester examinations are held in a period of three days. Also, there is virtually no dead period between the classes and examinations. This leads to stress in the students. It is proposed that the mid-term examinations be also held in a period of one week (six days: Monday-Saturday). The week-end on each side be declared a dead-period for scheduling of classes/laboratories/presentations. The students may use the week-end preceding the examinations as preparation time. This, of course, cannot be done twice a semester. Therefore, a longer one mid-semester examination is the preferred model.
- Presently, in certain elective courses a single mid-term examination is held. The other examination is typically replaced by a project/term-paper. This promotes self learning and motivates the student to explore more details in the area she/he likes. The committee feels that this approach should be extended to as large a number of courses as possible.

- The possibility of having two mid-semester examinations for core courses and one for other courses was also discussed. This model has implementation problems as a student could possibly be taking both kinds of courses. This will lead to staggered examinations and defeat the very purpose of scheduling examinations in a given slot.
- To continue with the IITK tradition of continuous evaluation, it is proposed that for *core courses at least two quizzes* be held, one on each side of the mid-semester examination. If there are going to be only two quizzes, it is best that they not be scheduled in the week just before and after the mid-semester examination.

To enable smooth conduct of examinations, it is also recommended that the examination schedule be prepared centrally just as done for the end-semester examinations. It should be declared along with class schedule right at the beginning of each semester.

### **2.5.8 Modular Courses**

The concept of a modular course will work very well with one mid-semester examination. A modular course will run for exactly half a semester and will have only one examination at the end. A core course that is modular must have at least one quiz in addition to the this examination. The examination period of a modular course in the first half-semester will coincide with the mid-semester examination of a regular course. Several departments are already proposing such courses. The credits for such a course would be half that of a full course. For example, a course with 3L+1T+1P will constitute an academic load of 11 hours per week. It will, however, contribute only 6 credits. The registration for all modular courses will take place along with the regular courses. To provide more flexibility, it is proposed that the instructors can propose an already existing course as a modular course. This is illustrated with an example: EE624 (Information and Coding Theory). Suppose the course is designed to teach 'Information Theory' in pre-mid-semester part and 'Coding Theory' in the second half. It could be offered as (a) EE624: "Information and Coding Theory" for the entire semester worth 11 credits (b) EE624A: Information Theory (worth 6 credits) and (c) EE624B: Coding Theory (worth 6 credits). The student may request for a conversion from EE624 to EE624A or EE624A to E624 during the semester. Of course, a student may also register for EE624B only, which is taught in the second half.

## Appendix I: Credit Based System

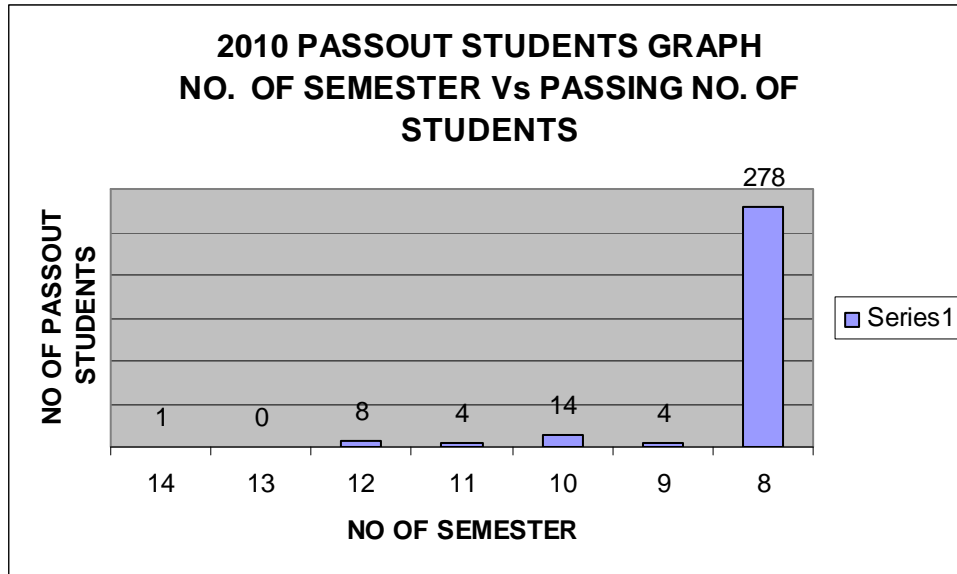
1. Credit reflects the time a student is expected to spend per week on learning a course through lectures, tutorials, laboratories and self-study, averaged over the entire semester.
2. Graduation requirements will be in terms of number of credits and not in terms of number of courses. Even the current eight semester residence requirement for a "good" student can be dispensed with.
3. There will be flexibility in terms of the number courses that can be offered. For example, even with the same total credits, two departments can customize their compulsory curriculum by offering different number of courses. The same principle holds for students, in terms of the number of courses they can register for in the science elective, department elective, or open elective slots.
5. Offers flexibility to students' to position their choice of courses. For example, a student may wish to do TA201 in the first semester and Phy101 in the second semester. This obviously requires that the time table for compulsory core and department courses is frozen, for say 10 years, or till the recommendations of the new ARC is accepted. Another pre-requisite in administering this flexibility is that the pre-requisites have to be accounted for in positioning courses.
6. A student's progress through different modules such as HSS, science, Esc, department compulsory, open electives can be effectively and conveniently monitored.
7. A credit based system allows for ease and efficiency in book keeping.
8. It is also useful in mobility of students and collecting credits from various universities.



## Appendix II: APEC (Academic Performance Evaluation Committee) rules

### Maximum number of semesters allowed to a student to graduate:

The data for BT students who graduated in 2010 is shown below:



The data above shows that very few students take more than 10 semesters to graduate. Therefore, twelve semesters to complete the programme seems adequate.

### APEC rules

The rules should be simple to implement and be consistent with a credit-based system. The APEC rules should not be linked to SPI/CPI. Two models were short-listed by the committee:

#### Model 1:

**Warning:** If the number of credits cleared by the students is less than 75% of the cumulative normal load up to that point.

**Termination:** If the student is on Warning and if he/she fails to acquire at least 50% of the cumulative normal load up to that point. This excludes the semesters that the student may have dropped.

#### Model 2:

**Warning:** If the number of credits cleared by the students is less than 80% of the cumulative normal load up to that point.

**Termination:** If the student is on Warning and if he/she fails to acquire at least 60% of the cumulative normal load up to that point. This excludes the semesters that the student may have dropped.

**Waiver Clause:** If the student acquires at least 80% of the credits for which s/he is registered for in that semester, the termination is waived. However, warning stands.

The table below shows the summary of the simulation of the new (proposed) APEC rules to the Y6 batch of students. Both models are tested. The normal academic load is assumed to be 19 credits. Note that a typical course is 4 credits at present and it is 11 credits as per the new definition.

**Simulations results for Model 1 (War < 75%; Ter < 50%)**

<b>Year/Sem</b>	<b>Warning+AP (Old APEC)</b>	<b>Termination (Old APEC)</b>	<b>WARNING (New APEC) Model 1</b>	<b>Termination (New APEC) Model 1</b>
2006-07/1	18+17 = 35	2	16	0
2006-07/2	12+8 = 20	7	13	6
2007-08/1	52+17 = 69	13	16	3
2007-08/2	22+06 = 28	9	10	1
2008-09/1	30+1 = 31	12	8	1
2008-09/2	28+05 = 33	15	9	0
2009-10/1	26+2 = 28	16	4	0
2009-10/2	32+1 = 33	11	2	0
	<b>277</b>	<b>85</b>	<b>78</b>	<b>11</b>

**Simulations results for Model 2 (War < 80%; Ter < 60%; Waiver >80%)**

<b>Year/Sem</b>	<b>Warning+AP (Old APEC)</b>	<b>Termination (Old APEC)</b>	<b>WARNING (New APEC) Model 2</b>	<b>Termination (New APEC) Model 2</b>	<b>Waiver (New APEC) Model 2</b>
2006-07/1	18+17 = 35	2	16	0	0
2006-07/2	12+8 = 20	7	25	9	3
2007-08/1	52+17 = 69	13	17	7	0
2007-08/2	22+06 = 28	9	16	3	1
2008-09/1	30+1 = 31	12	8	3	1
2008-09/2	28+05 = 33	15	12	1	1
2009-10/1	26+2 = 28	16	4	1	0
2009-10/2	32+1 = 33	11	7	0	0
	<b>277</b>	<b>85</b>	<b>105</b>	<b>23</b>	<b>06</b>

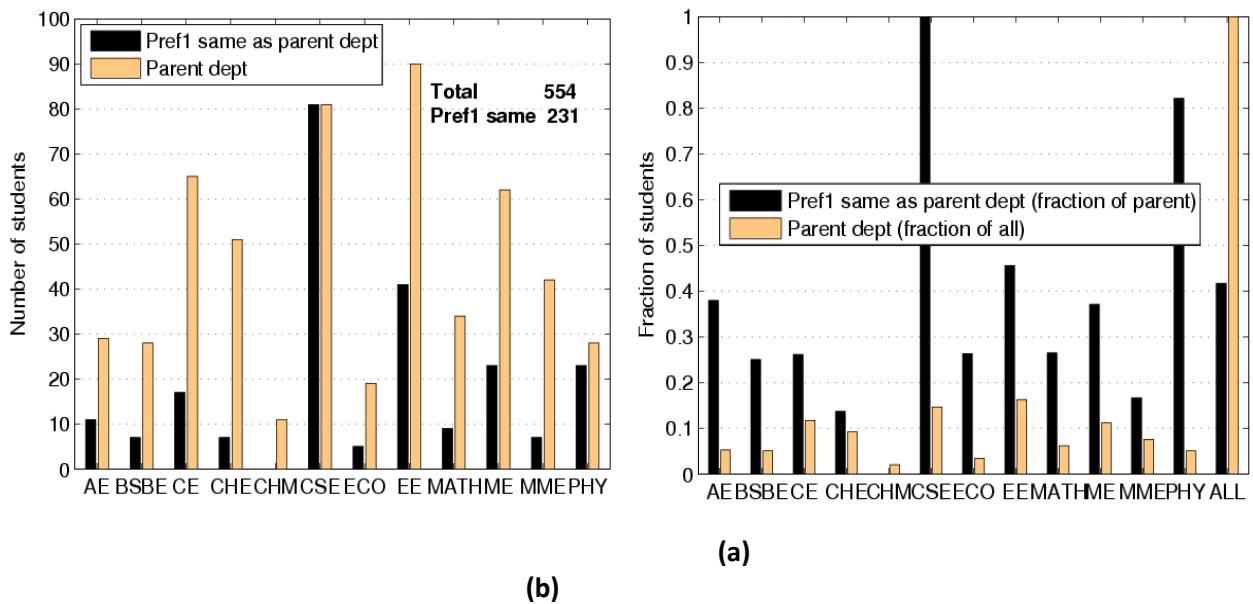
It is seen that the proposed APEC rules lead to the patterns that are expected. Also, Model 1 appears to be more liberal. **Therefore, the committee decided to go ahead with Model 1.**

### Appendix III: Student Survey-I

In this appendix, we analyze the data gathered from a survey conducted by the fifth academic programme review committee among the undergraduates of IIT, Kanpur. The survey was taken by 554 students from Y3 to Y8 spread across twelve departments. In the following, we present each question from the survey and analyze the corresponding response.

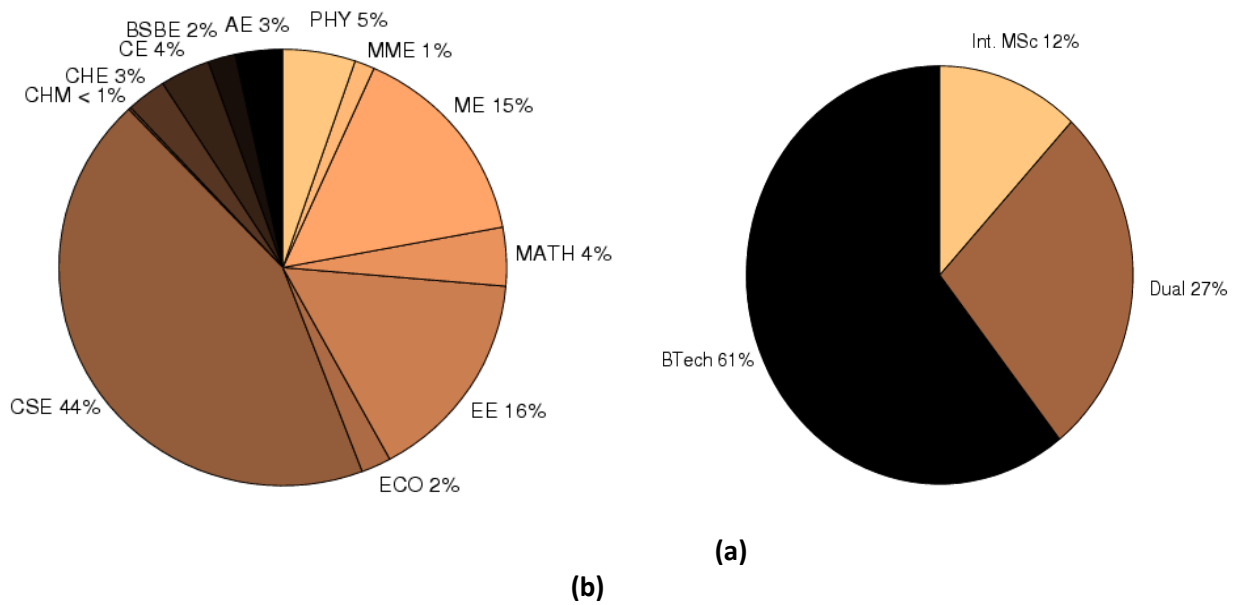
The first question was on the preference about the department and the programme. The purpose of this question was to gain insight into the popularity of departments and programmes among the students. The question is presented below.

*If you had full freedom to select any programme you wanted, which programme would you select today? Please give two preferences. If you had full freedom to select any programme you wanted, which programme would you select today? Please give two preferences. The department choices are AE, BSBE, CE, CHE, CHM, CSE, ECO, EE, MATH, ME, MME, and PHY. The programme choices are BTech, Dual (BTech/MTech), Int. MSc.*



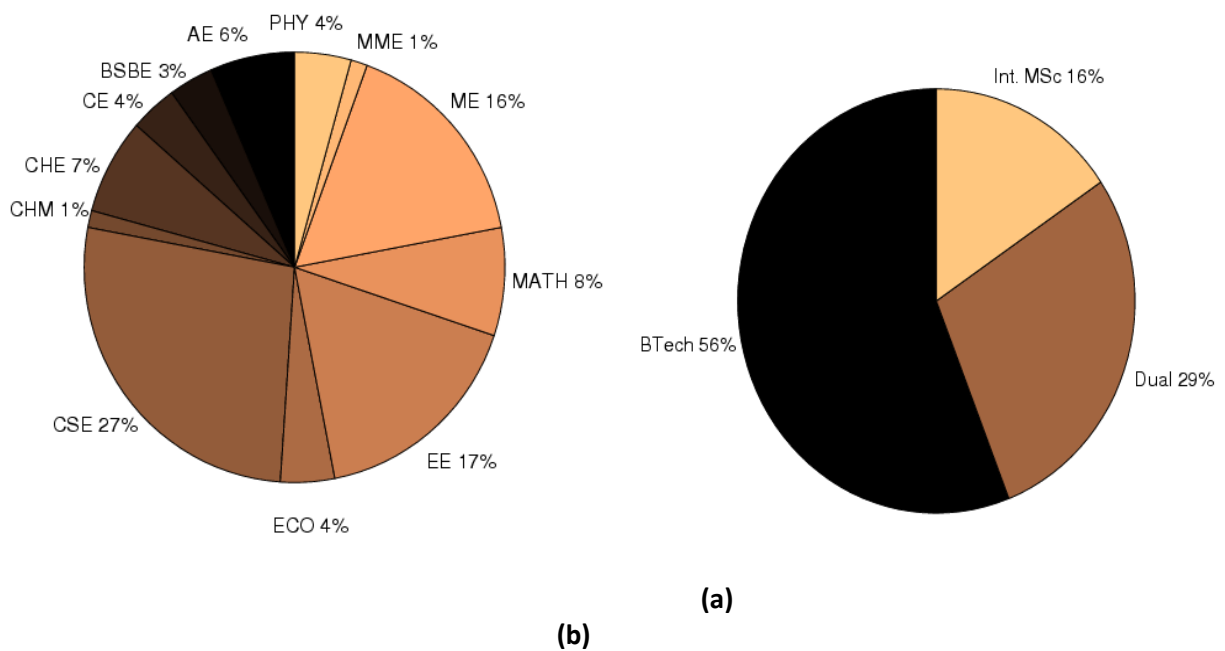
**Figure 1. (a) Number of students choosing their parent departments as the most preferred departments. (b) Same data as percentage.**

Figure 1(a) shows two pieces of information. For each department, the right bar presents the number of students participated in the survey from a particular department and the left bar shows how many of them chose their department as the most preferred department. Figure 1(b) shows the same data as percentages, e.g., the right bar is presented as the percentage of all students taking the survey and the left bar is the percentage of students taking the survey within a particular department. While all students of CSE chose their department as the most preferred department, over 80% of PHY students did so. EE, ME, and AE were the others among top five with more or less 40% of their students choosing them as the first preference. Overall, slightly over 40% of students chose their parent department as the most preferred department.



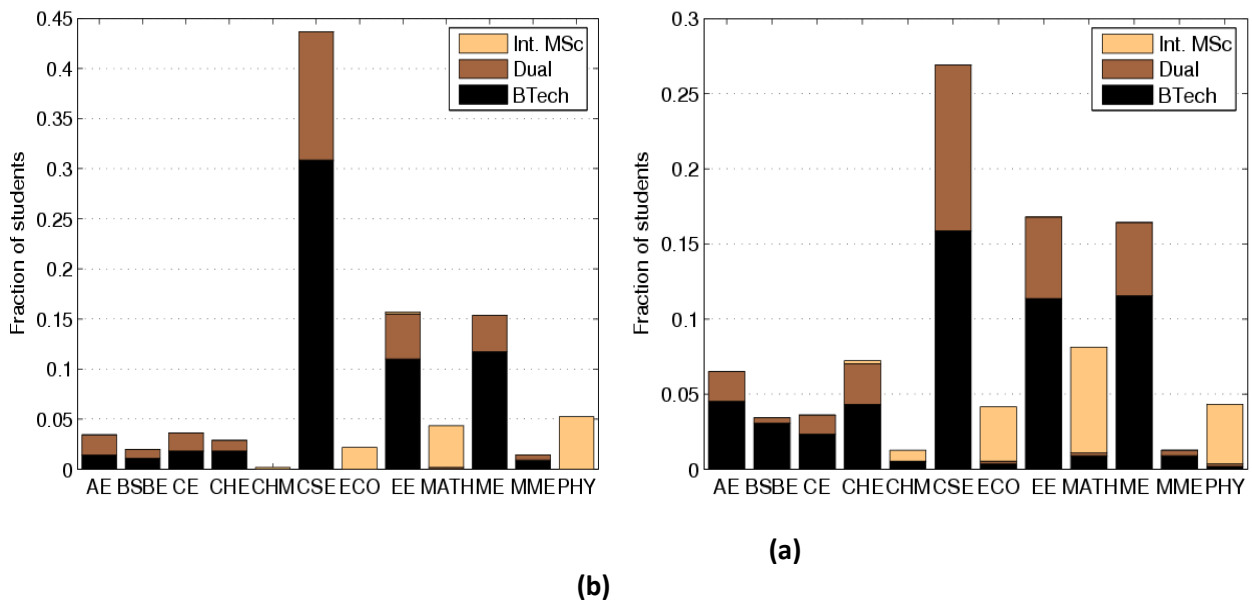
**Figure 2. Percent vote for (a) each department and (b) each programme as the first preference.**

Figure 2(a) shows the percentage of students choosing various departments as their first preferences. Similar data related to various programmes is shown in Figure 2(b). The top three departments by first preference are CSE, EE, and ME, while B. Tech., by far, turns to be the most preferred degree programme.



**Figure 3. Percent vote for (a) each department and (b) each programme as the second preference.**

Figure 3(a) shows the percentage of students choosing various departments as their second preferences. Similar data related to various programmes is shown in Figure 3(b). The data looks very similar in nature to the previous one, though less skewed. Some students chose B. Tech. as their first as well as second preferences leading to a total of more than 100% of students choosing B. Tech. as top two preferences. Taken together, 71% of the respondents chose CSE as their first or second preference.



**Figure 4. Combined department-programme data: (a) first preference, (b) second preference.**

Figure 4(a) shows the combined department-programme data for first preference. For example, 44% students chose CSE as the most preferred department, while 31% chose a B. Tech. in CSE as the most preferred degree option and another 13% chose a B. Tech.-M. Tech. in CSE as the degree of choice. Similar data for the second preference is presented in Figure 4(b).

Next, we turn to the second survey question. In this question, we gave six different degree options to the students and asked them to rank these options. The question is presented below.

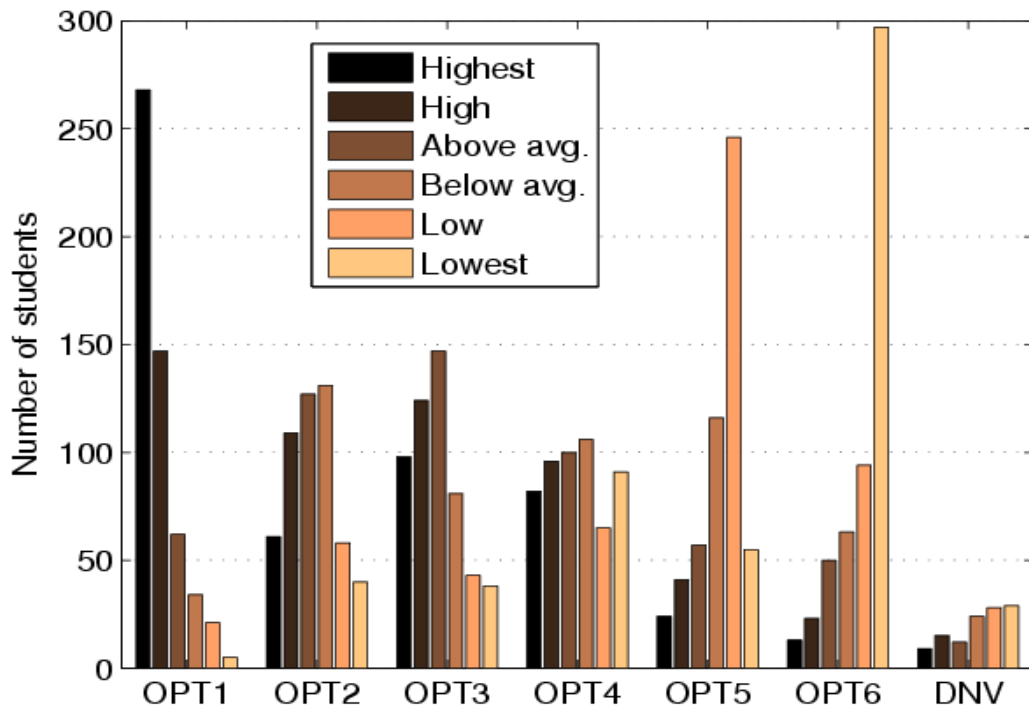
*If IIT Kanpur introduces the following new programmes or degrees, how would you rank them in order of preference from the most (1) to the least favourite (6) option?*

*NOTE: All terms marked with an asterisk (\*) are explained below.*

1. B.Tech. in one department with a minor\* in another subject
2. B.Tech. in Engineering Sciences\*\*
3. B.Tech. Dual degree in two departments (Courses in the second dept. would require about two to three semesters of work beyond the courses done in the first dept.)
4. B. Tech.-MBA Dual degree
5. B. S. (upgradeable to M. S. Integrated: similar to B. Tech.-M. Tech. Dual)
6. B. S. programme in HSS such as Psychology, Economics, etc. (upgradeable to M. S.)

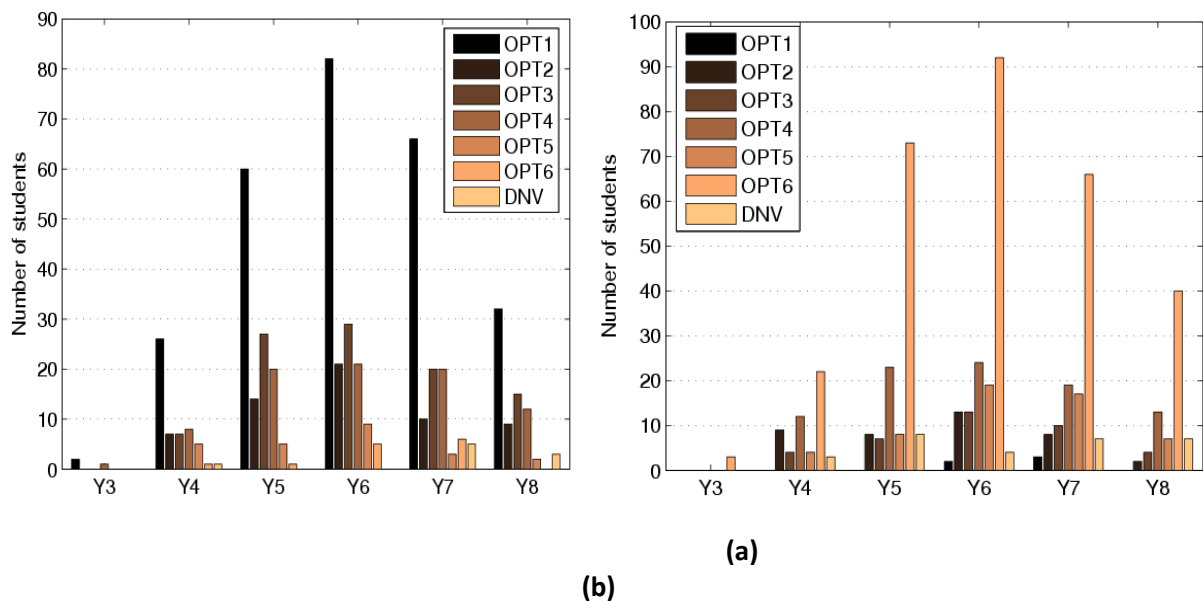
*\*Minor means sub-specialization which would require taking 4-5 courses in one Dept. / one HSS subject (which is NOT your own department).*

*\*\*Engineering Sciences is a multidisciplinary programme designed to integrate the sciences with areas of traditional engineering such as research, design, and analysis. It includes a core of basic courses in mathematics, physics, and chemistry, and electives from areas such as fluid dynamics, solid mechanics, operations research, information technology engineering, dynamical systems, bioengineering, solid-state devices, materials science, electromagnetics, nanoscience, nanotechnology, energy, and optics.*



**Figure 5. Degree option ranks. DNV stands for category of students that chose not to specify at least one rank.**

Figure 5 shows, for each degree option, the number of students voting it as highest, high, above average, below average, low, or lowest. A few observations can be made without pain. Option 1, namely, B. Tech. in one department with a minor in another subject is voted as the highest ranked option by almost 270 students (out of 554), while option 6, namely, B. S. in HSS (Psychology, Economics, etc.) is voted as the lowest ranked option by almost 300 students. Nearly 250 students ranked a B. S. degree option as “low”. Interestingly, a B. Tech. in Engineering Science (option 2) does not turn out to be a highly preferred option. More astonishingly, a B. Tech.-MBA degree (option 4) does not fare well either.

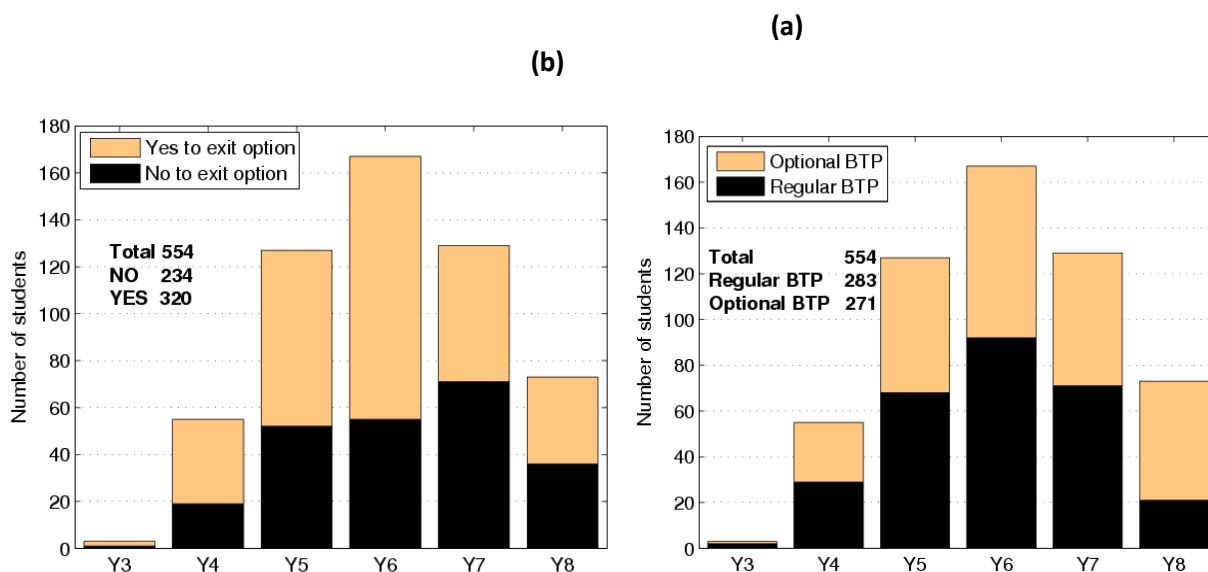


**Figure 6. Year-wise distribution of (a) highest and (b) lowest ranked degree options.**

To further understand any year-wise bias of the degree option ranks, Figure 6(a) and Figure 6(b) respectively present the highest and the lowest ranked degree options for respondents from each year. Most of the students from each year ranked option 1 as the most preferred one, while option 6 is the lowest ranked option for most students.

Next, we present the third question. This question was related to exit options. The question is presented below.

*Suppose there were an exit option (a degree) called B.Tech. Pass for those students who have spent at least four years in IIT, but are not doing academically well and have only completed 70% of the credits required to graduate with a regular B.Tech. degree. Do you think this is a good option?*



**Figure 7. Year-wise distribution of (a) exit option polls, (b) BTP polls.**

Figure 7a presents the year-wise number of students agreeing and disagreeing to the aforementioned exit option. Overall, 320 students out of 554 respondents voted for the exit option.

The fourth question is presented below. This question relates to the final year B. Tech. projects (referred to as BTP).

*Given a choice, which of the following two options would you prefer?*

1. A programme with a BTP.
2. A programme in which BTP is an elective. You can have do additional course work in place of the BTP.

Figure 7b presents the year-wise number of students choosing an optional BTP or a regular BTP (in the current form). Interestingly, the overall data is slightly skewed toward the current practice of regular BTP.

## Appendix IV: Student Survey-II

An open house among students was conducted on ARC Interim Report on undergraduate programme on August 21, 2009 to take student feedback on various recommendations made by the committee in their report. An online survey was conducted by the Student Gymkhana on some questions based on the report. Based on over 700 responses received in total, here are some salient points which the student body reinforced upon.

### a) Survey questionnaire

**Table 4. Response summary**

S. No.	Question	Yes	No
1	All students shall enter in 4 year B Tech/BS program through JEE and later on they can go to M.Sc. integrated/dual degree/double major as per their interest	591	133
2	There should be an option of B Tech in Engineering Sciences (i.e. inter-disciplinary degree not limited to one single department)	580	144
3	There shall be 3 degree options depending on CPI – B Tech/BS (CPI $\geq$ 4.0 and at least average C grade in dep. Courses), B Tech/BS Pass (CPI $\geq$ 4.0) or B Tech/BS Ho0urs (CPI $\geq$ 8.0 and an avg. CPI of 9.0 in dep. Courses OR an avg. CPI of 8.0 in all UG research courses)	344	380
4	There should be a minor option.	639	85
5	There should be a double major option. Students with CPI $\geq$ 8.0 shall be eligible to apply at the end of fifth semester, and both degrees shall together take 5 years.	598	126
6	There should be a possibility of MBA as a dual degree after B Tech/BS.	542	182
7	80% attendance should be made compulsory.	221	503
8	BTP should be made optional.	303	421
9	There should be one mid semester examination and one end semester examination.	490	234
10	No. of HSS courses to be done by UG students shall be increased to 5.	244	480
11	DO (Introduction to Profession) courses shall be done away with.	380	344
12*	Industrial training/internship shall be made compulsory for departments.	520	204
13	There shall be only 2 mathematics (MTH) courses in the core programme.	395	329
14	Modular courses (courses offered for half a semester with only one examination at the end) shall be offered.	557	167
15	4 UG research courses shall be introduced in the curriculum (2 of which are extra credits).	599	125
16	E grade with the weightage of two shall be introduced and F be reduced to zero. (E grade is not a passing grade, but can be used as a grade to satisfy pre requisites)	506	218
17	Academic deficiency warnings shall be done away with. Only AP (Academic Probation) and terminations to take place.	275	449
18	There should be a core course from IME department/on entrepreneurship.	475	249
19	Foreign language teaching shall be included as an HSS course.	620	104
20	Departments should take initiative of including communication skills as a part of curriculum. There should be more weightage in courses on technical presentation.	608	116

\* This is not a recommendation of the ARC

### b) Individual feedback related to recommendations of the report:

#### ***Entry of students through JEE and later branch change***

- When students are ready to get into IIT system after clearing JEE, they have practically no knowledge about different options/departments available in different IITs, and hence they fill in their priority of



branches during counselling mostly based on their JEE ranks. The student body felt following things can help:

- Senior UG students are also involved as a part of counselling process, rather than only professors there, so that the entrants can talk more freely to the students present there and get a realistic view of the department and hence different options.
- Students may be accepted without allotting any branch to them and then at the end of first year, branch allotment be done based on either their CPI and/or their JEE ranks. This will hopefully result in a more informed decision, and a better and more interested set of students would be promoted, thus leading to an increase in the Standard of education as a whole.

Students were also concerned about the issue of reservation while branch change option.

### ***Course evaluation and content***

- Continuous evaluation of courses shall be continued in spirit. If we are reducing to one mid semester and one end semester examinations, there should be enough quizzes/assignments in the course, rather than these examinations sharing the lion's share of weightage for two reasons:
- Such evaluation keeps regular check whether students are at par what is being taught in the class, and keeps them on their toes with the regular updates in it.
- This also gives students more chances to recover in a course if one of their examinations did not go well.

Innovative thinking shall be promoted through projects, and technical communication be paid attention by means of presentations/term paper discussions etc.

More inter-departmental courses (for example, BSBE and CHE both offer 2 separate courses on Biochemical Engineering, instead there may be a common course) should be encouraged, and faculty members should accept students from outside the department, if students are really interested to opt for the course. Sometimes many courses have unnecessary pre-requisites. That should be looked into.

### ***Core courses***

One course each on life sciences and economics should be considered to be included as core courses.

For students in Science departments, the no. of science courses they need to do become more because every student as per the new proposed model shall do 20% of science/SO courses. To redress the situation, each student may be given a choice to do 30% of his credits in ESO/Esc/Science/SO courses. This takes care that each student, be of engineering or science department, get chance to be exposed to other engineering/science courses.

### ***Regarding UG research courses and summer internships***

There shall be an option of considering summer industrial/university internships as a UGR (UG research) course. A student shall not be bound to take UGR courses in same department he is majoring in. Option of a semester long internship and consequent allocation of credits may also be considered.

### ***Miscellaneous***

Lecture duration shall be decreased from 55 minutes to 50 minutes.

More emphasis should be given on 'applied engineering' in the spirit of the courses, specially advanced ones.

Time tabling has always been a major issue at IIT K. Kindly develop a more robust time table so that not many students are deprived of taking courses of their interest due to clash in time table.

## Appendix V: Communication Skills Sub-committee Report

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 the 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 modelled 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.

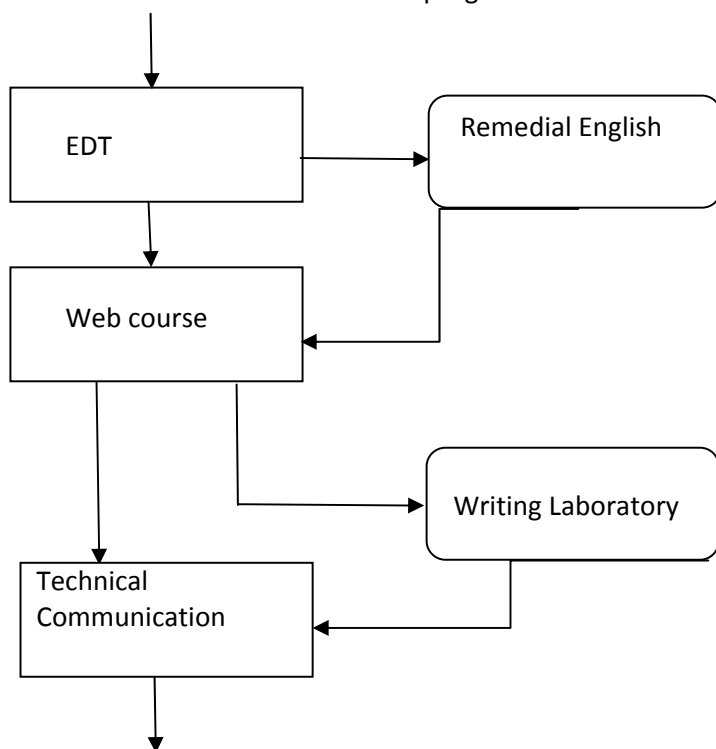
4) **Writing Laboratory and Composition Help Desk:** Students who are unable to clear the web-course will be required to report to the writing laboratory for about 20 hours of remedial sessions. After the

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 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) **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.). Considering the ARC committee’s strong views it is suggested that this technical communication skills course is strongly recommended.

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



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, Résumé 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.

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:

1. 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.
2. 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. (If a significant increase in the number of English faculty in the HSS department occurs then this may be considered)

**Recommendations on the logistics of the web module:**

1. The communication skills programme should be offered as part of the Life Skills Centre, proposed to be set up under the Golden Jubilee celebrations. It would have a faculty coordinator, who may be from any department.
2. The detailed curriculum would be worked out by an academic committee appointed by the Communication Skills Programme. Among possible members of the committee would be experts from Central Institute of English & Foreign Languages (CIEFL, Hyderabad), Walchand Dale Carnegie Finishing School, the department of Humanities and Social Sciences, IITK and other institutions. The detailed curriculum would specify the components to be taught through (1) a web module, (2) a writing lab and (3) hands-on tutorials. The curriculum committee would periodically review the functioning of each component.
3. The Web Module and the Writing Lab would be run directly by the Communication Skills Programme. They would rely for personnel on the UG, PG students of the institute. Both the components would closely follow the curriculum spelt out by the academic committee.
4. The hands-on sessions in communication skills would be conducted by the parent departments of the students. These, too, would be given detailed guidance by the curriculum worked out by the academic committee. Departmental support would be expected here. In terms of departmental effort it would be no more than if tutors had been sent for a central communication skills course. A simple and productive process would be emphasized, with the help of clear guidelines from Communication Skills Programme.

## Appendix VI: Core Mathematics Sub-committee Report

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 website. 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, i.e. have problem solving sessions instead of tutorials.
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 common 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 theory\*
- (c) Numerical methods using MATLAB – this can also be handled by engineering faculty
- (d) Complex analysis

*Note that (b) is part of the current ESO209. ESO209 may be taught in a modular form, with students taking the first module, the second module, or the full-course as desired. This allows for more flexibility. The student can take a module or a combination of modules, based on departmental requirement. E.g. (a)+(d) or (a)+(c) or (b)+(d) or (c)+(d), etc.*

*Some of the modules may be offered by engineering faculty also – e.g. module (c) and module (d).*

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 graduate students can be used to evaluate assignments, examination papers, with the instructor as the Head Examiner, and

the faculty tutors as the examiners. However, the graduate students used for the courses should be suitably compensated.

## **Appendix VII: Core Physics Sub-committee Report**

1. The contents of course Phy102 should be retained and the course should run with 3 lectures a week and one tutorial. The course is important for (a) help in developing a scientific temper, (b) serving as a prerequisite for more advanced courses. A question was discussed whether the topic of relativity be covered in the course. It was felt that students really like it and it is good for the general education of a student.

2. The course Phy201 has two components: Electromagnetic theory which is covered in about 30 lectures and an introduction to Quantum Mechanics that is about 10 lectures. As a result both the parts are covered in a rather hectic pace and the course tends to be a bit heavy on the students. It is therefore suggested that the course should cover only Electromagnetic theory but in 40 lectures.

The committee also felt the need for a short introductory course on quantum mechanics. For interested engineering students, an optional twenty lecture modular course would be ideal for this purpose.

## **Appendix VIII: ESC 102 Sub-committee Report**

The following recommendations are made regarding the core Introduction to Electronics course (ESC102).

1. Shift the course to the second year so that students have a better background in relevant math concepts.
2. Reduce the number of topics covered and use the resulting additional time to illustrate important electrical and engineering design techniques with examples taken from different disciplines. Some of these lectures can also be used to introduce some of advanced concepts such as fast Fourier transforms, microprocessors, sensors, etc. at a very high level.
3. Modernize the ESC102 lab through incorporation of suitable hardware and software so that students are exposed to current practice in the field. Introduce experiments which use interesting applications to illustrate concepts. The possibility of using LabView in some of the experiments was also discussed. It was felt that the students should have a first-hand experience on soldering.
4. Remove the lab lecture.
5. Try to design experiments such that synchronization issues between the lecture material and the experiments, if any, are easy to handle. Thus, the pace of the lectures should not be dictated by the immediate requirements of the lab.
6. Explore possibilities of designing at least one long experiment (mini-project), which may need 2-3 turns. Given the size of the class, this may be difficult to implement.



## Appendix IX: Outline of Core Chemistry Courses

There should be only one General Chemistry Lecture course (2L + 1T) offered. The details of the course are given below:

Title: Introduction to Chemical Sciences

Topics:

1. Atomic Structure and Bonding: Schrodinger Equation, atomic wavefunctions, orbitals
2. Chemical bonding, molecular wavefunctions, molecular orbitals
3. Molecular Spectroscopy: Principles of Rotational, vibrational and electronic spectroscopy
4. Shape conformation and stereochemistry of organic and inorganic molecules
5. Metal Ligand systems
6. Reactions and reaction mechanisms in organic/organometallic systems
7. Catalysis in chemical, industrial and biological systems

## Appendix X: Outline of Core Life Science Course

### A. Molecules

1. Effects of water's polarity: importance of cohesion of water molecules for life; moderation of Earth's temperature; Suitability of water as a solvent for life.
2. Carbon and the molecular diversity of life.
3. Polymer principles: most macromolecules of life are polymers; variety from a small set of monomers.
4. Carbohydrates – structure and function
5. Proteins – structure and function
6. Lipids – structure and function
7. Nucleic acids – structure and function
8. Introduction to metabolism: pathways; energy transformation in organisms follow the laws of thermodynamics; life at the expense of free energy; enzymes as biocatalysts; regulation of metabolism

### B. Cell

1. Structure: how we study cells; bird's eye view of cell structure; subcellular structures; organelles; cytoskeleton; cell surface and junctions
2. Membrane structure and function; traffic across membranes
3. Cellular respiration; photosynthesis; cell communication; cell cycle

### C. Genetics

1. Introduction to heredity: inheritance of chromosomes; comparison of asexual and sexual reproduction; meiosis and sexual life cycles; origins of genetic variation
2. Mendel's discoveries; extending Mendelian genetics; Mendelian inheritance in human
3. Chromosomal basis of inheritance: Relating Mendel's principles to chromosomes; Sex chromosomes and sex-linked inheritance; errors and exceptions in chromosomal inheritance

### D. Molecular biology

1. DNA as the genetic material; DNA replication and repair
2. Gene to protein: connection between genes and proteins; synthesis and processing of RNA; synthesis of protein
3. Organization and control of prokaryotic genomes
4. Organization and control of eukaryotic genomes: chromatin structure; control of gene expression; molecular biology of cancer
5. DNA technology and genomics: DNA cloning; DNA analysis and genomics; practical applications of DNA technology
6. Genetic basis of development: single cell to multicellular organism; differential gene expression; genetic and cellular mechanisms of pattern formation

## Appendix XI: Sub-committee Report on Engineering Science

Engineering science program is envisaged as a multi-disciplinary degree program cross-cutting several engineering and science disciplines. The engineering science program is especially aimed at highly motivated students, who would feel constrained within the conventional compartmentalization of departments. The proposed program on Engineering Sciences will enable the student to excel in both engineering and applied sciences, and will offer the student a great degree of flexibility in choosing courses so as to obtain a specialization in a specific track of modern engineering. The progress of modern science greatly depends on innovations at the interface of traditional disciplines, and the proposed curriculum would give the student an opportunity to specialize precisely in such cross-disciplinary subjects.

1. *Philosophy of engineering science program:* Most contemporary scientific and technological challenges such as alternative energy sources, weather prediction, climate modelling, bioinformatics etc., cannot be readily classified into traditional engineering or scientific disciplines. Advances in these fields inherently require expertise in cross-disciplinary areas. The proposed B.Tech in “Engineering Sciences” program is a step that will train and equip students in specified “tracks” with a particular focus on a well-defined and naturally emerging theme. Thus, this program, while being cross-disciplinary, at the same time ensures depth in the chosen track. Once the student has acquired the “big-picture” of the track, he/she may choose to go deeper into the subject through a post-graduate program. Further, many state-of-the-art industrial organizations also require students with multi-faceted exposure and interest. From the students’ perspective, the B.Tech in Engineering Sciences will allow them greater flexibility to choose a discipline of his/her interest. For instance, an engineering student may wish to gain expertise in a track with fundamental scientific content. Or, vice versa, a science student may want to specialize in an applied technological area. Finally, this program will also bring faculty members in cross-disciplinary areas together and foster collaborations. It is hoped that if this foray is successful at the UG level, this will nucleate a similar “Engineering Sciences” program at Master's and PhD levels as well.
2. *Administration:* The program will be administered through a *Program Coordinator*, who will also be a member of the *Program Undergraduate committee (PUGC)*. The PUGC will execute all the academic responsibilities that the DUGC does, for a regular department. The PUGC will be chosen from faculty members from participating departments (four to five members).
3. *Department size:* The committee felt that in keeping with the sizes of normal departments, the size of this department should be about 50.
4. *Tracks on offer:* The committee discussed various possible tracks (as proposed in the ARC report). It was felt that the tracks should use mostly existing courses across departments; the tracks should have a balance between feasibility and logic of offering such a track, and should have at least 3 participating existing departments (in terms of course required/offered). The committee therefore decided to identify naturally emerging tracks from the existing curriculum and specialization. To begin with, few tracks should be offered. Based on the experience gained from this exercise, more tracks could be envisaged.
5. *Curriculum design philosophy:* The committee felt that the students should not be constrained to only follow narrow tracks, but should be given a basket of courses to choose from within a given track, in keeping with the basic philosophy of this program.

6. *First and second year core program:* The committee felt that it should first look at the "department core" program and then discuss the 1st two years, if need be.
7. *Proposed tracks:*

(1) Various options for tracks are possible. Specifically, the tracks on "*Engineering Mechanics*", "*Energy, Environment and climate (EEC)*", "*Sensors and Automation Technology*" and "*Information, computation, communication and control (ICCC)*" were considered in more detail to create specific implementable examples.

(2) Several other possible tracks were also proposed. E.g. modelling and simulation, mathematics and computations, molecular engineering, cognitive science and engineering, mechatronics, instrumentation, etc.

The committee decided to create detailed outlines for a few tracks. Details of two such tracks are given below. These tracks are:

- (a) Energy, environment and climate
- (b) Mechanics

The details are given below.

### **Energy, Environment and Climate (EEC)**

#### ***Course Outline***

Objective of the track is to prepare the students to work in the industries related to any of the three primary areas, i.e. Energy, Environment and Climate, as well as in the organizations working in the interfaces of these areas. After completion of a set of courses comprising the core curriculum of the program, the students will have enough courses available as program electives and open electives so that they can pursue in depth studies in any of the areas according to their interest.

The core curriculum of the program will have the following components:

- Power Generation: fossil fuel/hydrocarbon, hydro-power, alternative sources such as, wind, solar, biofuel and fuel cells.
- Storage and Transmission of Power
- Environmental systems: water, soil and air pollution due to anthropogenic activities, measurement of pollution (laboratory), pollution mitigation, treatment of wastewater, air pollution control, solid waste management, environmental impact assessment.
- Introduction to Climate and Climate Change
- Laboratory: hands on experiments on environmental monitoring techniques, power generation, storage and transmission.

The core curriculum consists of 9 courses. The students will be free to choose elective courses from a basket of a large number of courses existing in the institute. The sequence of courses is shown in the ARC template. This is followed by a list of suggested courses in the elective basket and suggested course contents for the new courses.

### Schedule of Courses for the Track EEC

Sem	Course	Sem	Course
I	MTH101 (Calculus) CHM102 PHY101/CHM101(Lab) [TA101 (Engg. Graphics)+LIF 101]/ESC101 (Computing) ENG112/HSS-1 *PE101 TA101 & LIF101 alternate with ESC 101	II	MTH102 (Lin Al, ODE....) PHY 102 (Mechanics) PHY101/CHM101(Lab) [TA101 (Engg. Graphics)+LIF 101]/ESC101 (Computing) HSS-2 (Level 1) *PE102 TA101 & LIF101 alternate with ESC 101
III	PHY 201 [ESC102(Electronics)/ESO-1/SO-1]: ESO202 ESO-2/SO-2: ESO 212 DEPT: CE 361 <sup>4</sup> TA201 (MME)/TA102 (mech) **Composition (Web Based)	IV	SO-3: ESO218 [ESC102(Electronics)/ <del>ESO-1/SO-1</del> ] HSS-3 (Level 2)/ <del>DEPT</del> DEPT: ME301 <del>OE-1</del> /DEPT: CHE312 TA201 (MME)/TA102 (mech)
V	ESO-3: ESO209 DEPT: AE753 or ME744 (availability) <sup>1</sup> DEPT: ME401 HSS-4(Level 2)/ <del>DEPT</del> UGR1 (Optional) <del>OE-2</del> /DEPT: EE330 **Comm Skills (Deptt)	VI	<del>DEPT/OE-1</del> DEPT/ <del>HSS-3 (Level 2)</del> : EEM606 DEPT: NC1 <sup>2</sup> DEPT: NC2 <sup>2</sup> [UGR2/OE/DE] <del>OE-3</del> /DEPT: NLab <sup>3</sup>
VII	<del>OE-4/DE-1</del> DEPT/ <del>HSS-4 (Level 2)</del> : CE362 <del>DEPT/OE-2</del> HSS-5 (Level 2)/ <del>DE-2</del> [UGR3/OE/DE]	VIII	<del>DEPT/OE-3</del> <del>DE-1/OE-4</del> DE-2/ <del>HSS-5 (Level 2)</del> OE-5 OE-6 UGR4 (Extra Credits)

<sup>1</sup>AE753 and ME744 are both PG courses at present. They have to be given either dual numbering for undergraduate courses or create a new undergraduate course with similar course content.

<sup>2</sup>New compulsory courses for the track (to be created). Suggested course content is given.

<sup>3</sup>New Laboratory course to be created which will have sessions in 3 existing departmental laboratory courses in AE, ME and EE departments. Suggested content is given.

<sup>4</sup>This course has a large laboratory component (~40-50% of the course) on environmental monitoring techniques.

**General Comments:** All DEs have to be chosen from the elective basket (given). Students may also choose some OEs from this basket if they so wish but it will not be binding on them.

#### Elective Basket

PH 304: Introduction to Atmospheric Science

EEM 603: Ecological and Biological Principles and Processes in Environment

NT 602: Nuclear and Reactor Physics

CE 463: Environmental Impact and Risk Assessment

EE 360: Power Electronics

CE 414: River Engineering

ME 401N: Energy Systems II  
ME 402: Power Systems  
EEM 613: Atmospheric Physics and Chemistry  
CE 442: Physical and Environmental Geology  
CE 462: Environmental Management in Industries  
CE 717: Groundwater Hydrology and Pollutant Transport  
EEM 609: Fate and Transport of Contaminants in Natural Systems  
ME 690: Alternative Fuels and Advances in IC Engines  
NT 611: Nuclear Power Engineering I  
AE 650: Applied Combustion  
AE 653: Thermal Turbo-machines  
ECO 341: Environmental Economics and Policy  
ART 405: Architecture and Environmental Design  
ART 406: Environmental Design & Ethics  
ECO 442: Energy Economics

### **Suggested Course Contents for the New Courses**

#### **NC1: Alternative Energy Course**

Origin of energy sources: Energy, progress and economics; Origin of renewable sources: Energy cycles of earth

Solar radiation: Direct and scattered radiation, energy content, Variability

Wind energy: Kinetic energy and power, variability

Ocean waves: Wave spectra, power density, tides, rivers and hydropower and sustainability

Geothermal energy: Region specific resources, power densities

Biological potential and other sources: Photosynthesis, salinity differences

Energy conversion: Thermodynamics and irreversible thermodynamics in energy conversion, Photovoltaic conversion, Turbines, Thermoelectric/thermionic conversion, Electrochemical conversion; Conversion of solar radiation via solar thermal methods; Conversion of wind and wave energy; Chemical, electrochemical, photochemical and electrochemical conversion strategies

Renewable energy storage: Using latent heat, phase change, flywheels, pumped hydro, compressed gas, batteries

Energy distribution: Heat pipes, power electronics simulations, load structure, life cycle analysis, break even analysis

#### **NC2: Climate Course**

Introduction: Climate in the Spotlight; The Spectrum of Scientific Opinions, introduction to physics and chemistry of atmosphere.

The Earth's Natural Greenhouse Effect, Radiative Balance, importance of water, Greenhouse Gases: Role of carbon dioxide and methane, major uncertainties; anthropogenic CO<sub>2</sub> Emissions, concerns of developed and developing countries.

The Earth's carbon reservoirs: biogeochemistry, atmospheric carbon reservoir, breathing of Gaia, missing CO<sub>2</sub> sink, carbon cycling. Some examples: physical carbon pump, biological carbon pump, marine carbon cycle, terrestrial carbon cycle.

Climate and Weather: The Earth's climate machine, global wind systems, trade winds and the Hadley cell, westerlies, importance of monsoon rains, occurrence of seasons.

Clouds, Storms and Climate: Cloud Formation and Climate, Introduction to Global Ocean Circulation; El Niño and the Southern Oscillation, and its Effects.

Outlook for the Future: Introduction to Climate Change, Advances in Computer Modeling

#### NLab: Laboratory Course (Inter-departmental Laboratory Course)

*This is an outline of the laboratory course on energy generation and transmission. The components are taken from the existing courses. Therefore, the setup to run the courses exists. Once the track is enabled, a detailed session-wise plan can be formulated.*

- Experiments in dynamics of machines related to energy generation (Components of existing ME 371)
- Experiments in Energy Conversion (Components of existing ME 471N)
- Experiments in circuits, control systems and power systems (Components of existing EE 380 and EE381)4
- Unit Operations in Heat and Mass Transfer (Components of existing CHE 391)
- Chemical Reactors, Process Dynamics and Control (Components of existing CHE 492)
- Characterization of a two-stage axial fan (AE propulsion Lab.)
- Cascade analysis of a turbine stage (AE propulsion Lab.)
- Cascade analysis of a compressor stage (AE propulsion Lab.)
- Performance analysis and emission estimates in a continuous combustion unit (AE propulsion Lab.)
- Performance analysis of a 2 shaft gas turbine unit (AE propulsion Lab.)

### Mechanics

Mechanics is central to science and engineering, encompassing from very abstract and fundamental mathematical ideas to very practical mechanical gadgets. This track will expose the students to the fundamentals of mechanics through basic theoretical and experimental courses on solid mechanics, fluid mechanics, and thermodynamics. After these courses, the students will be encouraged to explore more advanced topics in mechanics through higher level courses and projects.

We hope this program will excite students from both engineering and science to take the interdisciplinary program. It also envisaged that similar Masters and Ph. D. level program will be offered in future.

Sem	Course			Sem	Course		
I	MTH101 (Calculus) CHM102 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- 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) <b>MTH203 (Diff eqns)</b> <b>ESO 204 (Mechanics of solids)</b> TA201 (MME)/TA102(Mech) ** Composition (Web based)	3-1-0 [3-1-3/ 3-1-0] 3-1-0 3-0-0 1-0-3 0-0-2	11 [14/ 11] 11 09 06 02 <b>53/ 50</b>	IV	<b>ESO202 (Thermo)</b> <b>ME353 (Dynamics)/CE620</b> HSS-3 (Level 2)/ DEPT <b>ESO212 (Fluid Mech &amp; Heat transfers)</b> <b>ESO218 (Computational methods)</b> 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 <b>ME321 (Adv mech of solids)</b> <b>CHE312/ME341 (Heat &amp; Mass transfer)</b> HSS-4 (Level 2) / DEPT UGR1 (Optional) <b>AE331 (Expts in structures)/New lab</b> ** 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	<b>PHY306/SE312 (Order &amp; Chaos)</b> DEPT / HSS-3 (Level 2) <b>ME371 (ME Lab 1)</b> 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) <b>AE411/ME471 Laboratory (ME or AE)</b> 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>



Note that:

(1) Out of the three labs, one of them could be developed into a hands-on laboratory. This could be a project based lab.

(2) Few departmental and DE slots are vacant. These will be filled by the student by taking advanced courses in any of the preferred direction of specialization, as discussed below.

### **Suggestions for elective courses for this track**

The students should do several compulsory courses for the track (like department core), and then they can follow one of the five streams:

1. Solid Mechanics
2. Fluid Mechanics
3. Bio Mechanics
4. Earth and Atmospheric Science
5. Theoretical Mechanics and Astrophysics

In addition to the core courses, the students in this track will be required to do the following courses preferably early in their program (within 5 semesters):

### **BASIC COMMON COMPULSORY COURSES**

1. ESC 202: Thermodynamics
2. ESO 218: Computational Methods in Engineering (Basic numerical algorithms, Computing in C/Fortran/Matlab)
3. ME 353: Dynamics and Vibrations of machinery
4. ESO 212: Basic Fluid Mechanics and Heat processes
5. MTH203: Ordinary differential equations and partial differential equations
6. ESO 204: Mechanics of Solids

Basic Labs on: Solid mechanics/ fluids/ machines/ dynamics/Design/Computation

### **ADVANCED ELECTIVES USEFUL FOR ALL (Electives)**

PHY401/ME652: Classical Mechanics  
Numerical Methods for PDEs (Finite difference/Finite Volume/Finite elements/spectral)  
MTH 650: Partial differential equations and their applications  
MTH 650: Applied numerical methods  
Advanced Computing Methods  
Parallel Computing Methods  
Nonlinear Dynamics I  
Nonlinear Dynamics II

\*\* Electives from other streams (Modeling & Simulation)

**Solid Mechanics (Electives/Departmental electives/courses to fill additional departmental slots)**

SE 394/MTH423: Continuum Mechanics  
ESO 208: Earth Science  
SE312: Nonlinear Dynamics (Order and Chaos)  
AE231: Elements of vibration  
ME 628: Nonlinear Vibrations  
MTH 791: Finite Element Method  
AE601/602: Aerospace engineering (Mechanics of Flights)  
ME622: Mathematical theory of elasticity  
ME 629: Stability of Engineering Systems

**Fluid Mechanics (Electives/Departmental electives/courses to fill additional departmental slots)**

AE622: Computational Fluid Dynamics (Basics)  
AE615/ME 634: Computational Fluid Dynamics (Advanced- Project based).  
PHY672: Physics of Turbulence  
AE625: Transition and Turbulence  
AE 621/ME 647: Introduction to turbulent fluid mechanics  
AE 617: Boundary layer instability and transition  
MTH 791: Finite Element Method  
AE 619: Intro to Environmental fluid mechanics  
ME 355: Introduction to tribology  
ME 631: Viscous flow theory  
ME 635: Introduction to fluid mechanics  
ME 637: Elements of kinetic theory and rarified gas dynamics  
Hydrodynamics Instabilities

**Bio Mechanics (Electives/Departmental electives/courses to fill additional departmental slots)**

BSE 314: Biomechanics  
BSE 441: Evolution of biological machines  
PHY309: Introductory Biophysics  
PHY314: Natural Nano-machines  
SE 304: Physics of Bio-materials: structure and Dynamics  
SE 334: Biosystems  
SE 395: Molecular fluid dynamics and microfluidics  
Biological fluid dynamics

**Earth and Atmospheric Science (/Departmental electives/courses to fill additional departmental slots)**

SE 397/ESO 208: Earth Systems  
SE 389: Atmosphere and Environment  
CE 640: Earth System Processes  
CE 642: Geological Hazards  
CE 423: Introduction to Earthquake Engineering  
AE 619: Intro to Environmental fluid mechanics  
PHY 304: Introduction to Atmospheric Physics  
PHY 670: Atmospheric Physics

ME 725: Granular Materials

\*\*Courses of Fluid Mechanics stream

**Theoretical Mechanics and Astrophysics (/Departmental electives/courses to fill additional departmental slots)**

PHY306: Physics of the Universe

SE 312/PHY306: Order and Chaos

PHY401/ME652: Classical Mechanics

PHY 407: Special and General Relativity

SE 306: Nonlinear Systems

PHY 412: Statistical Mechanics

EE 444: Radio Astronomy

SE 396: Conceptual foundations of mechanics

AE 487: Space systems engineering

ME 650: Solar system mechanics

ME 660: Space mechanics

ME 725: Granular Materials

ME 624: Variational Calculus

AE 641: Space dynamics I

AE 642: Space dynamics II

ME 726: Hamiltonian Mechanics and Symplectic Algorithms

**RECOMMENDATIONS**

1. Strong interface with mathematics department in applied mathematics side.
2. Strong computational laboratory and courses
3. There are repetitive courses at advanced levels (600). It is possible that we need different mathematical or computation courses at 300/400 level that are departmental specific, but we should try to merge them at 600 level, where the students have the maturity to see the link. For IDP interactions, it may be advisable to give some of these courses universal numbers like SEs for UG courses.

## Appendix XII: Administrative/Miscellaneous Issues

This appendix presents the view of the ARC on three pressing issues, namely, attendance, class sizes, and tutorials.

**Attendance:** It is felt that if Senate approves the mandatory attendance then proper measure needs to be taken for maintaining the attendance. One existing method is to assign seats for each student at the beginning of the semester and then count the vacant seats in each class. It has its own limitations. More technologically sophisticated method needs to be developed, and for that matter, help from competent person(s) needs to be taken.

**Class sizes:** If proper infrastructure is available then whether the class size is 100 or 500, should not make any difference. Based on the viewpoint from faculty time, the committee members feel that 500 (maximum) seems to be an optimal choice. Infrastructure does not exist at present, and will need to be thought of. To encourage more students to benefit from a Minor, there should be no cap on the maximum number of students in a class that constitutes a Minor. If at all, the cap should not be less than one-fifth the batch size (For a batch of 850 students, the cap should not be less than 170). Similarly, the cap on an ESO cannot be less than one-fourth of the batch size. This is to make sure that the students have enough options available to exercise their choice of courses.

**Tutorial:** ARC has already proposed only one tutorial per week. In the current academic semester a new model is in practice, where one tutorial has been converted to problem solving session. If the feed back is positive the same model should be continued.

**Student lounge:** Each department should have a student lounge with reading/library facility. This will help students to utilize their time in between classes, and otherwise, efficiently. One such student lounge should be there close to the LHC as well.

**Duration of each lecture:** The classrooms are now quite spread out. Typically students take about 10 minutes to change-over. The effective duration of most classes as of today appears to be 50 minutes. ARC proposes that this be now regularized. Each lecture hour be 50 minutes to allow a 10 minute change-over time.

**Supplementary examinations:** Students who do not do well in the end-semester examination may be offered an option to appear in a supplementary examination. This was discussed in great detail. Following points came out: (a) It should have the same weightage as the end-semester examination. The concept of continuous evaluation has to be kept in mind. (b) Should it be clubbed with Make-up examinations? (c) Some preparation time is required. The December Semester does not appear to allow that. (d) Too much work for Instructors (e) Perhaps, the Supplementary Examination need not be administered to all students; only to some who have put in a certain minimum effort in the course. This may be determined by the Instructor. (f) There must be an upper limit on the grade that such a student can receive. Even if a student does extremely well in Supplementary Examination, does s/he deserve an A? *The committee decided against holding Supplementary Examinations.*

**Slow paced programme:** The committee noted the following: a) The slow-paced programme at this point is only in Math and Physics. b) Several students are already undergoing the preparatory course. c) The Physics preparatory programme at this point leads to a problems for students who take PHY103 in the first semester and then opt for PHY102S after the mid-term examinations. Since PHY103 is not offered in Summers, they must take it in third semester of their programme. However, this clashes with their Department courses/OE/HSS and leads to build-up of back-logs. This causes major discontentment in the students. d) In the present system, several students are advised to go for slow-paced based on their performance up to the first mid-semester examination, but many do not opt for it. e) The ARC recommendation is to hold only one mid-semester examination. This will cut-short the period for the slow

paced course. f) In the new ARC proposal, a student can drop a course up to a week before the end-semester examination.g) In a credit based system, the student may choose the pace of their program by registering for +/- 20% credits compared to normal load. In view of these observations, the committee recommends that there is no need to continue with a slow-paced programme.

### Appendix XIII: Example Dual-degree Course Structure

In the following, two dual-degree examples are shown: a BTech from any department followed by an MBA; BTech from any department followed by an MTech in Nuclear Engineering and Technology (NET)

#### A. Structure of B. Tech.-MBA Dual Degree

1. In the existing/proposed UG structure, for BT-MBA dual degree, a UG student can take (i) one MBA core course in seventh semester, (ii) two MBA core courses in eighth semester, and (iii) 12 MBA courses (core and electives) in the fifth year. It would be possible for a student to get a BT-MBA dual degree with this course structure. IME department will decide later on the combination of core courses and electives, and the sequence of the courses to be offered.
2. It is proposed to explore the possibility of student taking the core IME course on Economics as a substitute to the HSS elective Economics course as these courses are essentially similar and this will allow a student to take one more MBA course. Likewise, there may be overlap with any other HSS course and this should be considered while designing the program.
3. If ARC's proposal of modular courses is accepted and implemented, this will further increase the flexibility of taking more elective MBA courses. The details of this structure would be decided later based on the number of modular courses that are offered.
4. MBA program has an important and compulsory component of summer internship. This is done during the summer period after first year of MBA program as majority of the core courses (about 12 core courses) are offered in first year. This is also important from student's perspective as summer training provides an opportunity to get a pre-placement offer (PPO). In the present structure as listed in item (1) above, a UG student can only possibly take 3 core courses before summer internship. This may not be sufficient for summer internship. In this context, items (2) and (3) are significant and would contribute to an appropriate design of the program.

#### B. Structure of BTech followed by MTech in NET

**Table 5. Dual Degree B. Tech – M. Tech (Nuclear Engineering and Technology)**

Department	Structure of B.Tech - M. Tech or M.Sc	Proposed structure of B. Tech -M. Tech (NET)
CE	7 PG electives in CE (7 <sup>th</sup> , 8 <sup>th</sup> , 9 <sup>th</sup> sem) + M.Tech Thesis in CE.	5 PG courses in NET ( 4 compulsory + 1 NET elective) and 2 open electives + M. Tech Thesis in NET.
EE	6 PG electives ( 5 open + 1 Dept) in 7 <sup>th</sup> , 8 <sup>th</sup> , and summer semester and + M. tech Thesis in EE.	Same as above.
ME	6 PG electives ( 5 Dept + 1 open) + M.Tech Thesis in ME.	Same as above.
PHY	7 open electives + Project.	Same as above.
	Proposed B. Tech/BS Program 6 open electives.	Same as above.

## **Appendix XIV: Sub-committee Report on TA201**

The committee visited the two laboratories associated with the above mentioned course and evaluated the experiments that students perform during the course. Discussions were held about the theory and experimental components of the course. The committee also discussed the administrative aspects of the course.

### **Observations of the committee:**

1. The course is a must for all undergraduates. Further, based on the feedback, the students also enjoy hands-on exposure to manufacturing processes.
2. Laboratories for the course run all five days a week with each section performing two sets of experiments each week.
3. Project is an essential part of the course and students should get more time to devote to the projects that they undertake in this course. However, it is seen that designing a project that uses facilities in both the laboratories is quite difficult.
4. It is difficult to get tutors for this course, particularly because it deals with both the mechanical as well as the metallurgical manufacturing processes.
5. There is lack of sufficient number of trained technical staff required to run the laboratories properly. Further, better coordination between technicians from the mechanical and metallurgical laboratories is needed for smooth running of the course.
6. Because of a large number of students who take this course, first two weeks of laboratory work are essentially wasted because the students are not settled either in their sections or it is not clear which group do they belong to.

### **Points that the committee considered:**

1. Is theory component necessary in this course? If yes, what is the proper number of lectures required for each component (mechanical and metallurgical) of the course?
2. Is it good to have one course that combines the mechanical and metallurgical components or will it be better if we instead run two courses, each focusing on the individual aspects of manufacturing processes.
3. Could one design courses that put more emphasis on one component (mechanical or metallurgical) of the course and then give students a choice of choosing one of these depending on their taste?
4. Is the training good if students do a project that combines both the mechanical and metallurgical processes or would the training be as effective even if the two are not linked?

### **Conclusions and recommendations of the committee:**

1. Theory and experiments: The committee is of the view that theory forms an important part of the course. To impart proper theoretical knowledge, about 20 lectures are required for the mechanical component of the course and about 28 lectures for the metallurgical component. Further one 3 hour laboratory is needed for each component.
2. Projects form an important part of the course and more time should be devoted to them. In fact after the initial run of the practice experiments, real learning in this kind of course is done through project work.
3. It is required – but practically not possible - that the course have tutors who are equally interested in both the aspects of the course.

4. The committee therefore recommends that instead of having one combined course on manufacturing processes, we should have two courses. The course covering the mechanical part will have one 1.5 hour lecture per week and one laboratory of three hours. The course on introduction to metallurgical processes will have two 1-hour lecture per week and one three hour laboratory. In each semester, half the batch will be doing one course while the other half the other course.
5. The courses proposed take care of many difficulties being faced by instructors running the course in its present form. It takes care of the main problem of finding tutors who are interested. More importantly it gives students more time for their project work which very important in learning the material covered in these courses.



## Appendix XV: Open House Feedback

The open house held on 21<sup>st</sup> February, 2009 was very well attended with active participation of about 80-100 faculty colleagues. The meeting began with opening remarks by Sanjay Mittal followed by a presentation of the report by Rajiv Shekhar. The floor was then thrown open to remarks/suggestions from all. In addition to the comments during the Open House, suggestions also came via e-mails/discussions from colleagues. The comments have been classified in one of the following seven categories:

A: Degree options

B: Attendance/graduation requirement/evaluation

C: Communication skill

D: Core structure

E: Implementation

F: UG research

G: Miscellaneous

### A: Degree options

- Five-year MSc should be retained (through JEE as an entry option).
- Can the duration of the dual-major program be made flexible e.g., may go beyond five years? This may reduce the pressure on the faculty members.
- Consider the employment angle of the four-year BS program.
- The structure of minor and the sequence of courses for each minor should be clearly specified.
- Consider the option of "better" degrees for better students e.g., honors.
- Consider the time tabling issues that come with minors and half-semester courses.
- The dual-major program should not be time-bound.
- To facilitate implementation, groups must be defined for the second major. For example, ME & AE; EE & AE/ME; CHE & CHM, CHM & BSBE, MTH & CSE. How will these appear in transcripts?
- BT/MT dual degree through JEE should be retained.
- The structure of the Engineering Science program should be clearly prescribed. Also, one needs to consider the employment opportunities after going through such a program.
- Consider the implementation issues for minor.
- Every minor must have an adequate lab component.
- Consider a "fast track" different program for students interested in doing research.
- Dual major appears to be a better option compared to minor as far as time tabling goes.
- Reward students in some way who opt for research. Reward good students.
- Consider multiple exit options.
- Integrated programs should stay e.g., integrated PhD.
- Consider multiple entry points independent of JEE.
- Consider extra project-oriented courses for good students and introduce an A\* grade.

### B: Attendance/Graduation requirement/Evaluation

- Graduating CPI: instead of 4.0, it should be 4.5. Retaining 5.0 was also suggested by some.
- Report class attendance (as a percentage or a fraction) in the transcript; something like attendance index (0-1).
- Instead of having a lower graduation CPI requirement for weak students, is it possible to reduce the credit requirement (e.g., thirty two courses instead of forty courses) for them? This may better cater

to the greatly increased spread in the preparedness among the students.

- Attendance in class cannot be a criterion for admission to examinations.
- No student should be terminated, but the institute commits the resources toward a student for only four years.
- The graduation requirement must include obtaining passing grades in all core courses.
- Associate attendance with grades e.g., 90% attendance is required for getting A.
- Attendance requirement is a good way to grow the sense of ethics among the students.
- One mid term/One end semester exam is good. Can be supplemented by more projects and oral exam type evaluations.
- Finer grading (A+, A, B+, B, B- etc.)

### **C: Communication skill**

- Emphasis should be placed on technical writing when preparing the lab reports.
- Need appropriate guidelines for the departmental component of the communication skill course.
- Let the JEE team handle the English diagnostic test.
- Teach English as a foreign language. Allocate extra semester for students weak in communication and teach them English in this extra semester (possibly the first semester).
- Mention of DO in the communication skills report should be removed.
- Hire professionals for teaching communication skill courses.
- Make the technical communication skill course optional.

### **D: Core structure**

- Seek department feedback for core structure e.g., some departments may want more than two math courses in the core program.
- A "research lab" component can be associated with the UG labs where new experiments can be tried out. This can be made department-specific.
- Take department opinion in deciding a minimal core program.
- Participation of members of the different faculties may not be a pragmatic option for running the core program.
- There should not be any time limit for completing the core courses (e.g., a two-year time bound is too restrictive).
- Make core, level-1, level-2 HSS course placement more flexible.
- Students need more exposure to computing. There is a need for a second computing course.
- Make the core more flexible i.e., different departments may want different cores.
- Can the core science courses be moved to second and third semester. Have no science courses in first semester to break the monotony for the student.
- Need another course related to Computers as a follow up of ESC101

### **E: Implementation**

- Opine on increased student population in tutorials.
- Modular course structure may be good for manufacturing science courses.
- Have only two lecture hours per week instead of three. Allow students to take a large number of courses. This may reduce the complication of time tabling.
- Instead of half-semester courses, have two-lecture semester-long courses.

- Have supplemental instructors (SIs) for conducting the tutorials. These positions are filled by students who got high grades in the past offerings of the course. Leave the tutorial scheduling to the SIs (e.g., can be held in the residence halls). The SIs get paid by the institute.
- Take into account the widely varying competence of students in the class.
- Off-load some portions of management-related activities in teaching to scientific officers and good students.
- Consider the entire proposal in the light of implementation issues. Specifically, attendance, electives, time-tabling.
- Not enough OE's at present to choose from. Each department must offer two OEs and these must be placed in the OE slots.
- Fix the types and time table slots of the modular courses.
- Trimester system may bring more flexibility.
- Tinkering requires more resources such as labs etc.

#### **F: UG research**

- Consider the possibility of introducing industrial training.
- Making BTP and industrial training optional is contradictory to the fact that ARC wants to emphasize exposure to experimental science.
- Consider 4-6 weeks of internship at the end of the 3rd year.
- Tour of Indian industry during the 3rd year.
- Consider two weeks of community service at the end of the 2nd and 3rd year. Expose students to the lives of "ordinary" citizens. Identify ways to improve their lives by better and more efficient technology. Students should prepare a business case (economic viability) for such technology and may take up BTPs on these topics.
- Relate industrial work with senior-level course contents. Relate research with national needs.

#### **G: Miscellaneous**

- So many new Institutes have come up. What is the objective of IITK's education? What is our brand value? How are we different than others. This is to be sorted out at all levels. For example, all courses must have a description of the objectives of that course.
- The issue of Washington Accord and international credit compliance.
- Value education: emphasize on value creation among the students through NSS, NCC, and yoga.
- Consider the grading scales.
- There should be another open house at a later date.
- Consider a course on ethics, civic duties, and responsibilities.
- Consider a monitoring committee for overseeing teaching.
- Do not only look at student point of view. Also look at ways to make the curriculum and its implementation faculty friendly so that they have more time for research.
- Mentor young faculty members.
- Have a week long course on "living life" for first year students. This might be useful in teaching them to learn to take decisions.
- Need to review electives. Presently they are proposed and never reviewed.
- Electives must be offered only if there are a minimum number (decided a priori) of students.
- We need about 4 TA courses to allow for Design, Synthesis, Tinkering and Industrial Interactions.

**Table 6. Summary of the data from the feedback forms (43 respondents)**

Questions	Responses		
	Yes	No	Total
Graduating CPI being 4.0	15	27	42
B.Tech. in Engg. Science	29	08	37
Minor	37	04	41
How much should be compulsory Math/Physics/Chemistry/Life-Science Content	* Please see the comments below		
BTP becomes optional	26	04	30
80% Mandatory attendance	30	11	41
Modular courses	30	02	32
Semester v/s Quarter	36 (S)	04(Q)	40
One v/s Two mid sem exams	23(O)	15(T)	38
BT-MT dual degree is not offered at time of JEE but can be opted later by interested candidates can opt for it later	36	06	42
M.Sc. Integrated is not offered at the time of JEE (instead, 4 yr BS is offered). Interested candidates can opt for it later	29	09	38
PE/CPA has slots in the time table	23	05	28
Possibility of dual major/degree	31	04	35
Possibility of MBA after BTech/BS	26	11	37

**\* Some of the comments made by respondents for Q4 are:**

- 1/4<sup>th</sup> of the total course
- 8 courses in total
- 2 in each subject (8 in total)
- 6-8 courses
- 2 courses in MTH and rest should be department specific
- Science course should not be diluted. There should be basic emphasis on the basic contents of the course.
- 30% each in Math, Physics, and Chemistry
- Do not change MTH to 2 from existing 3
- 1 course in PHY, CHM and BIO is OK. 2 courses in MTH is OK.
- 25% interdisciplinary, 25% HSS or Open Elective
- 2 MTH, 1 PHY, 1 CHM, 1 LIFE Sc + Labs
- 100-150 credits
- Let it be decided by the Dept
- 30-35%

- The proposed break up is OK
- 3, 2, 1,1 each in MTH, PHY, CHM, & Life Sc
- Equal distribution
- Keep ~20% for each one
- More emphasis on applied MTH
- 60%, 25%, 15% in Profession, Sciences and HSS respectively

## Appendix XVI: Department Feedback on Interim Report

### 1. Salient features from the interim report and questions asked to the departments

#### A. Salient features:

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:
2.  $C \text{ (credit)} = L \text{ (lecture hours)} + T \text{ (tutorial hours)} + \text{Practical (lab hours)} + SS \text{ (self-study)}$
3. Where  $SS = 2L + T + a$  (assignments), where  $0 \leq a \leq 2$ .
4. Graduating CPI to be 4.0 (in line with passing grade being D)
5. JEE entrants may also opt for a B.Tech. in Engineering Sciences, an interdisciplinary degree not limited to any one department.
6. All JEE entrants may opt for a Minor – a sub-specialisation in their own department, in any other department (including HSS), or a proposed interdisciplinary minor.
7. 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.
8. In the compulsory core programme, students will be required to do only TWO Maths courses.
9. In the compulsory core programme, students will have the choice of doing EITHER CHM102 OR CHM103.
10. TA201 has been split into two courses – TA102 (ME) and TA 201 (MME)
11. 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. 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).
12. 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.
13. DO (Introduction to Profession) has been deleted from the curriculum. Departments may choose to use one of their departmental core courses for this purpose.
14. 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.
15. 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.
16. Discussion Hour has been deleted from ALL courses.
17. 80% attendance is made mandatory in a course for a student to appear in its end-term examination.
18. 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.
19. 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.

## B. List of 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 evaluation 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?

**Table 7. Summary of departmental responses to the salient features and the questions**

Legends: Y=YES, N=NO, D=DIVIDED, NR=NO RESPONSE

	AE	BSBE	CE	CSE	CHE	CHM	EE	HSS	MTH	ME	MME	PHY	IME
<b>Credit-based</b>	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
<b>Grad. CPI 4.0</b>	NR	NR	NR	N	NR	Y	N	NR	N	N	D	N	NR
<b>Minor</b>	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	Y
<b>2<sup>nd</sup> Major</b>	Y	Y	Y	N	Y	Y	N	NR	Y	Y	Y	Y	NR
<b>Mod. courses</b>	NR	NR	NR	NR	NR	Y	NR	NR	Y	NR	Y	NR	NR
<b>Optional BTP</b>	NR	NR	NR	NR	NR	NR	NR	NR	Y	N	NR	N	NR
<b>Comm. skill</b>	Y	N	N	N	Y	Y	N	NR	N	Y	N	Y	NR
<b>Attendance</b>	NR	NR	NR	N	NR	D	N	NR	Y	N	NR	NR	NR
<b>Abolish AP</b>	NR	NR	NR	Y	NR	NR	NR	NR	N	NR	NR	N	NR
<b>BS through JEE</b>	NR	NR	NR	N	NR	NR	NR	NR	NR	NR	NR	N	NR
<b>Honours</b>	N	Y	Y	NR	Y	NR	N	NR	N	N	Y	NR	Y
<b>Exit options</b>	Y	Y	NR	NR	Y	Y	N	NR	N	N	N	NR	Y
<b>One mid-term</b>	Y	N	Y	D	Y	D	N	NR	NR	N	N	Y	Y

## 2. Detailed responses from the departments:

### AEROSPACE ENGINEERING

1. With the understanding that the faculty of the department accepts the proposal of the current ARC, in principle, the committee has restarted the process of framing the department's undergraduate curriculum – as per the guidelines of the ARC. The group discussed the questions posed by ARC to the department. The answers are:
2. Minors are a good proposition and 3-4 courses per minor is satisfactory.
  - a. The group looked at possible options, and came up with some possibilities: (a) Turbomachinery (can be offered together with mechanical): propulsion 1, thermal turbo-machinery, design of turbo-machinery; (b) Combustion: Propulsion 1, applied combustion, theory of combustion, rocket combustion design; (c) Turbulence; (d) Viscous flows; (e) Computational mechanics (with solids or fluid specialization): Numerical analysis, CFD or Intro. To FEM, Advanced CFD or FEM for fluids or Nonlinear FEM; (f) Stability and control; (g) Structural dynamics: (MOS and dynamics prereq.) mechanical vibration (discrete systems), vibration of continuous systems, aeroelasticity/random vibrations/nonlinear vibrations/advanced structural dynamics, acoustics/dynamics and controls.
  - b. More options can be created in future.
3. For a 2<sup>nd</sup> major in Aerospace (for students from outside the department), the course structure will be given after the department freezes its basic core structure – all mandatory professional courses have to be taken
4. No special degree is required for good students. Acknowledgement of performance could be done by giving certificates/ keys type recognition, grade of A\* in a course, etc.
5. For weak students exit option is OK. However, the group feels that student should have atleast cleared the 3<sup>rd</sup> year level courses (another alternative is all the mandatory departmental core, i.e. what is required for a second major) and spent atleast 4 years at IITK. The group could not converge on the appropriate name for such a degree – diploma in Aerospace Engg. could be one.
6. The ESO courses that the departmental students should take are: ESO204, ESO212, ESO202. Optional ESO's are: ESO216, ESO214, ESO218.
7. The department likes the idea of stressing upon communication skills in the courses. This will be done through presentations and seminars. Lab. Courses will have a mandatory (1/2 hr. ) part on report presentation; a seminar course in the 6<sup>th</sup> semester is also mooted (in a 20 hr. module). The student will prepare and present on a topic, based on literature review.
  - a. More rigour in design report preparation and presentation + mandatory presentation in aeromodelling.
8. The group would like 1 mid-term examination and 1 end-semester examination. It also strongly recommends conducting only one examination per day (centrally organized exam. Schedule)



- a. The group also discussed the preliminaries of the curriculum structure: 2 aero. Lab. Classes, one 20 hr. lab. Theory module; one 20 hr. flight lab. Module.
9. It also discussed having 3 courses in aerodynamics+propulsion combined; the first course in FM can be made into a 20 hr. module with aeromodelling added to it (to make a full course) to be offered in the 4<sup>th</sup> or 5<sup>th</sup> semester; a course on control theory should be introduced; a course on space mechanics should also be added; one compulsory structures course will be offered – rest in specialized DE courses.

## **BIOLOGICAL SCIENCES AND BIOENGINEERING**

The Interim Report was discussed at the Faculty Meeting held on March 10, 2009. The outcome of this discussion on specific topics is listed below:

- Minors
  - The department favors minors at sub-topic level, rather than at department level.
  - A minimum CPI – members agreed on 8.0 – should be essential to choose minors.
  - It will be great to have interdisciplinary minors – a group of 6-7 courses from multiple departments from which 3 are chosen to qualify for a given minor.
  - One potential minor is Computational Biology. The department will soon come up with a few more titles.
- Second Major
  - Credits required should be 40.
  - All department core courses will be essential.
  - A minimum of 9.0 CPI will also be essential.
  - Only a certain number of seats will be made available.
- Honors
  - Honors is a good idea.
  - Should be based on performance (CPI) + Honors project.
  - Honors project will have a pass / fail grade.
  - This project will not be required for the basic B.Tech. degree.
- Exit option: A certificate – not a diploma – may be provided.
- Compulsory ESO: Fluid mechanics
- Communications skills: Department can not handle this.
- Number of Midterm exams: Two.

## **CHEMICAL ENGINEERING**

1. A minor- an area of sub-specialization- 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?

### **CHE MINOR**

ChE minor to consist of four courses with the first three courses being D3, D6 and D7 and the fourth course being a choice between D9 or D10.

D3: Chemical Engineering Thermodynamics

D6: Mass Transfer

D7: Reaction Engineering

And

D9: Process Control or D10: Process Design

## **INTERDISCIPLINARY MINORS (ChE participates)**

### *Minor in "Meso/Nano scale Engineering"*

ChE 688: Colloids and Interface Science

ChE XX: Introduction to Nano-Science and Technology

ChE659: Process Engineering Principles in Microelectronic Fabrication

Basket of courses from other departments may include MS617 (Organic Electronics), ME689 (Microscale thermal engineering), MME467 (Materials for Semiconductors industry) and MME688 (Nanomaterials Processing and Properties)

### *Minor in "Polymers"*

ChE672: Polymer Processing

ChE676: Engineering Applications of Rheology

ChE677: Introduction to Polymer Physics and Rheology

Basket of courses from other department may include courses from ME in polymers related area (?).

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?

## **SECOND B TECH DEGREE IN CHE**

Second B Tech in ChE requires completion of all the 103 department specific core credits.

3. Do you think there should be an option for a B.Tech (Honors) degree? If so, what should be the criteria for giving this special honors degree?

## **PROVISION FOR B TECH (HONORS)**

B Tech (Honors) to be awarded to UG students accomplishing significant research (through UGR credits). Honors awarded only to students with Min. overall CPI of 7.5 and at least 9.0 grade average in the UGR credits. A research minor may be awarded to students not satisfying the Honors criteria but successfully completing all 31UGR credits.

B Tech with distinction may be awarded to meritorious students satisfying a min CPI criterion.

4. Should there be an exit option for students who consistently underperform during the core programme at IIT Kanpur: If so, what from should this exit option take?

## **EXIT OPTION FOR STUDENTS UNDERPERFORMING IN THE CORE PROGRAMME**

An underperforming student may be allowed to exit from the program after completing ~ 200 credits. The credits should not be restricted to "Core Courses" only. Appropriate Certificate to be given to the students making an exit. Exit option to be exercised only after minimum of three years residence. Both the students and the Institution can exercise the option. Consultation with parents/ guardians in the exercise of the option is recommended.

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?

1. ESO202- Thermodynamics
2. ESO214- Nature and Properties of Materials

6. In what ways can your department integrate communication skills as a necessary evaluative criteria in some of your department courses?

Given the emphasis on the need to improve students' communication skills, it is desirable to have group projects/term-papers with presentations towards the end of the semester in all courses (including lab courses). Developed course contents may explicitly highlighted the same. Department sub-committee may suggest a few sample term-papers/group projects.

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?

#### TWO MID TERM EXAMINATIONS VS ONE MID-TERM EXAMINATION

To ensure continuous evaluation, the one mid-term examination may be supplemented with two quizzes (duration 20-30 mins each).

### **CHEMISTRY**

#### Credits

Chemistry Department supports the proposed 'CREDIT' based credit system. The graduation requirement of 400-420 credits appears reasonable.

#### Graduation Requirements

The CPI 4.0 was felt to be sufficient to graduate by most department colleagues. However, concerns were raised that lowering CPI requirement could erode academic values of IITK system.

#### Degrees

Chemistry department strongly supports the recommendation that B.Tech. (Engg.) and B.S. (Sciences/Economics) will be of 4 years duration.

Although the concept of 'MINOR' in a second branch was received well, it was felt that modalities should be chalked out carefully. It should be prudent to start with a fixed set of minors having clearly defined requirements and preset time table.

Along the same line, the department, in principle, supports the option for a second degree at the end of III year. As noted before, the details must be worked out very carefully so that it fits well with the course structure and the time table. Students should be able to exercise these choices offered without much difficulties. A well-meaning initiative must not get blocked because of flawed implementation procedures.

Regarding the Chemistry 'MINOR', discussions indicated that there should be at least 5 courses of about 40-45 credits. A departmental committee has been constituted to discuss the Chemistry minor. It was felt that the minor, if offered, will be a General Chemistry minor without any specializations. For a second BS degree in Chemistry, the department felt that at least 100 department credits should be credited by a student.

#### Academic Programme

The proposed break-up (HSS/Science/ESC/TA/Electives etc) of the academic program seems appropriate and chemistry department supports it.

The chemistry department, in general, agrees with essential features of the proposed core program.

With respect to the choices of certain courses particularly about ESO/TA the Department needs more time to deliberate which ESO courses are needed and whether both TA courses are needed for a Chemistry graduate.

With respect to the Chemistry core course, the department felt that offering two courses is fine. Students will have the choice to decide which course to opt for. The other course may be taken by the students as an elective if they so decide. It was noted that the course content of these courses have not been defined, and the department would like to actively participate in that process.

#### Modular courses

Chemistry department felt that the 'Modular Course' is an excellent idea and reflect the flexibility and originality introduce in the core program

#### Exit Option

Chemistry department felt that an EXIT option should be offered for a student who consistently underperforms. (Can be a diploma).

#### Communication Skills

It was felt that communication skills can be imparted by having a written/oral presentation of some of the lab experiments. Secondly by insisting original lab reports written communication skills can be improved.

#### Examination Pattern

The Department had a divided opinion on having one mid-sem vs two mid-sem exams.

##### Tutorials

The Department supported one tutorial per week for the core course and scrapping of the discussion hour.

##### Attendance

No clear opinion emerged on this issue.

### **CIVIL ENGINEERING**

1. A Minor – an area of sub-specialization – 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. Principally the department agreed with the idea of a minor - an area of sub-specialization. However, it was suggested that instead of intra departmental faculty members, the faculty members from different departments should come forward and offer the minors. Few major thrust areas have been identified to be offered as minors such as Mechanics, Climate Science, Atmospheric Science and Earthquake Engineering. The structure can be formulated later after discussions with faculty members of other departments.

3. What would be the structure of 2nd 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 2nd degree? What should be the course / credit mix (choice of electives and core courses) for 2nd degree?
4. The department agreed to this point also provided one must declare at the end of 3rd year that he/she wants to go for a major. In that case, the graduating criteria should be exactly in line with that required by the department in which he/she wants to pursue his/her major. The credit requirement was proposed to be 25-30% extra over the normal requirement.
5. 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?
6. The department expressed that there is a need to reward the better students in the class by evolving some mechanism, particularly with the large number of students in the class at present. The mechanism could be B.Tech (Honours) or something else but in no case it must be coupled with CPI.
7. 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?
8. It was decided that there is no need to discuss upon the matter related to the exit option at this stage.
9. 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?
10. It was suggested to continue with the existing ESO courses without any further change.
11. In what ways can your department integrate communication skills as necessary evaluative criteria in some of your department courses?
12. It was pointed out that a lot of avenues are already available to improve the communication skills and therefore, there is no need to open any new channel. However, there was a suggestion where the students can take the initiative to structure a communication course and take the whole responsibility to run the same in which any faculty member should only monitor.
13. 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?
14. The department agreed to the pattern of one midterm and one end-term examination for all courses. However, it was suggested to keep the system flexible to decide the exam pattern for case to case basis.

#### **COMPUTER SCIENCE AND ENGINEERING**

1. ARC proposes that admission be made for BTech and students may be able to decide about changing to dual degree later.
2. There was not much support for this proposal. The following was suggested.
  - a. Students are admitted to 5 yr programme, and may leave after 4 years.
  - b. It was noted that DD students exiting with BTech is made logistically difficult due to 498/499. This perhaps may be alleviated with BTP not being made compulsory.
3. On a more general note, SB observed that the current ARC does not address the PG program. The interim report cannot be addressed in isolation, when the total resources are fixed.

4. On the issue of Core courses. There was considerable diversity of opinion. There could be department specific core. There is no need for a common intersection of courses across the departments. Departments give guidelines for core. The core could be viewed as general education--in this view, specify the minimum number of credits in Physics, Math, Chemistry or BioChemistry that must be taken by students.
5. ARC suggests that every student may do a minor. It was felt that this may be allowed, provided department load does not increase. Also it was felt that from a scheduling standpoint, it may be very difficult to keep department load constant. Again it was reminded, that the proposals for the PG and the UG programs should be discussed in tandem.
6. Further discussion on Minor: A collection of a sequence of courses will be offered, if the students can manage to complete them, then they can get a minor.
7. Second BTech degree: Dept not in favour of second BTech degree as it will increase the load on faculty.
8. "B.Tech light" degree as an exit option had strong agreement. For example: 20% less of CS core and professional courses. Also have a BTech Honours degree that requires students to do a BTP. Eligibility for different degrees: CPI as a basic criteria--other criteria to be discussed.
9. Communication Skills- Dept may not take lead role. Recommend to JEE for testing language skills.
10. 2 midsem versus 1 midsem: Opinion was divided with no agreement.
11. Credits formula: for CSE--no formula for labs, since labs are unsupervised. Hence CSE courses will get smaller credits than they deserve. To handle this, the additional component for the credit calculation (the parameter A) should be allowed to have a value up to 4.
12. Recommendations for Esc101-- ESc 101 committee report may be considered when tabled.
13. Graduating CPI: 4.0 ARC proposes to make it 5.0. Separate minimum CPI for Btech light. Agreed in principle.
14. Engineering Sciences Degree: Dept felt that it cannot comment without due details.
15. ARC: 1/3 courses should be electives. Generally agreed.
16. ARC: Science Elective abolished, 10-35 credits as Science option (1-3 courses). Generally agreed.
17. Compulsory 2 math courses: agreed.
18. Choice between Chm 102 and Chm 103: agreed.
19. TA 201 split between TA Mechanical and TA Materials: agreed.
20. HSS: 5 courses= 2 first level + 3 second level: agreed.
21. 2 credit courses--agreed.
22. D0 deleted- agreed.
23. BTP made optional. BTP research: 4 research slots as OE/DE may be used for BTP.

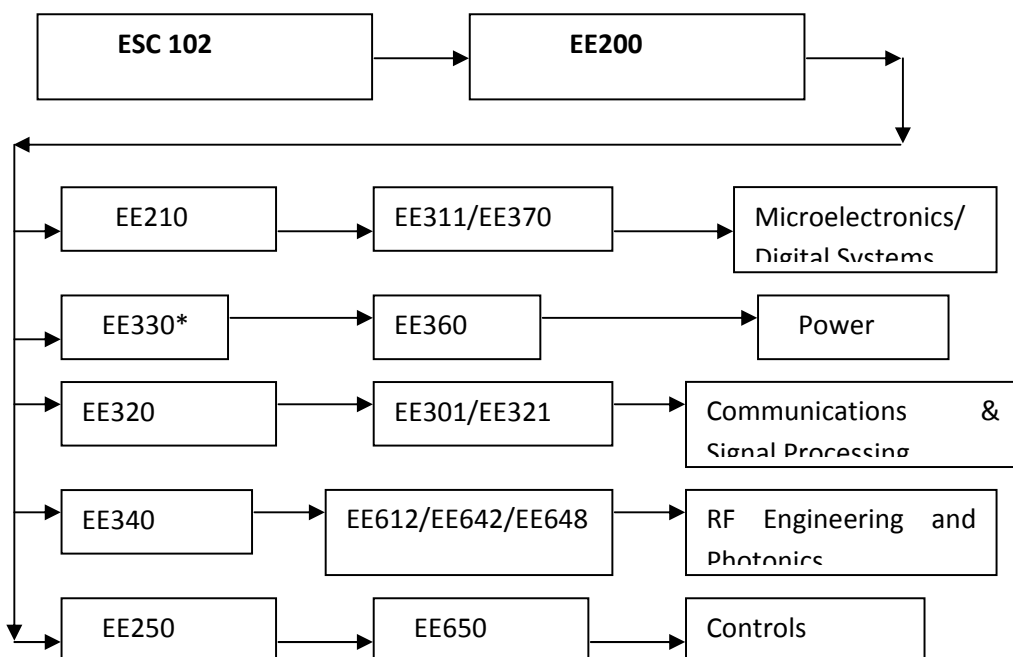
24. Dept strongly opposes dept specific technical writing skills- Dept does not intend to design such a course.
25. 80% attendance compulsory--rejected.
26. Only AP, no WR -- agreed.

## ELECTRICAL ENGINEERING

### 1. Departmental Minors

Minor is a sub-specialization within Electrical Engineering department and will consist of 27-36 credits (three courses). It should be encouraged in principle. However, minors will increase faculty load. Hence some limit on the number of students has to be imposed. The student opting for minor in Electrical Engineering will have to take **EE200** as a **compulsory course**. He can take **any other two** EE courses subjected to prerequisite fulfillment out of which at least one course should be at **300 or higher level**. Some *suggested* minor courses are give as follows. The figure given here is only for a guideline. The student is free to choose two remaining courses from EE courses (other than EE200).

#### Course Structure for Minor in Electrical Engineering



\* ESO210 is a prerequisite for EE330

The Minor system cannot be implemented unless the **Timetable** permits the student to take these courses. Timetable is the responsibility of DOAA. It is advisable to have centralized timetable for all courses and the timetable should be fixed for the next five years. Repercussion of fixing the timetable in advance is that the timetable decides the faculty courses. This may be unpleasant at times. However, flexibility should be allowed in the timetable of PG (600 level) courses.

### 2. Interdisciplinary Minors

Offering interdisciplinary minors is not very straightforward. The background (prerequisite) for such minors should be fulfilled. There is a need of blending the existing courses of two departments or structuring new courses in two different departments to offer these minors.

### **3. Second B.Tech. Degree in Electrical Engineering**

Considering that EE Dept. will be offering minor courses, the second degree in Electrical Engineering will increase the faculty load. The possibility of second B.Tech. program was extensively discussed in the faculty meeting. It was felt that the minor courses should be offered and tried successfully before undertaking the second B.Tech. degree. Hence the second B.Tech. degree in Electrical Engineering will not be offered by EE Dept.

### **4. Suggested ESO courses for Electrical Engineering**

(max.: 35 credits or 3 courses; min.: 10 credits or one course)

#### Compulsory:

ESO210 (Introduction to Electrical Engineering)

ESO209 (Probability and Statistics)

#### One out of three:

ESO202 (Thermodynamics)

ESO211 (Data Structures and Algorithms-I)

ESO214 (Nature and Properties of Materials)

### **5. Should there be an option for B.Tech. (Honours) degree?**

The criteria of awarding a B.Tech. (Honors) degree is not very clear. One option is to make the B.Tech. (Honors) degree based on good performance in BTP. However, in the proposed ARC report, BTP is optional, and hence performance in BTP cannot be a criterion for awarding B.Tech. (Honors) degree. B.Tech. (Honors) degree based on CPI does not have much merit. Hence EE Dept. is not in favor of a separate B.Tech. (Honors) degree.

### **6. Passing CPI of 4.0**

Passing CPI of 4.0 will degrade the standard. In major universities, the total passing percentage is more than the passing percentage in individual courses.

It is suggested to retain the passing CPI as 5.0. The structure of WR and AP should be maintained.

### **7. Should there be an exit option for students who consistently under-perform during core programme at IIT Kanpur? If so, what form should this exit option take?**

It is suggested to retain the passing CPI as 5.0. The structure of WR and AP should be maintained.

A student enrolled for a B.Tech. / M.Tech. (dual)/ M.Sc. programme will not be happy with a degree less than what he/she has enrolled for. Awarding a Diploma of IIT after three years is one of the options discussed as this will ensure some employability to the student. However, awarding a Diploma after 3 years will create confusion as IITs are known for awarding B.Tech./ M.Tech.(dual)/ M.Sc. degrees to JEE entrants. Any certificate from IITK without having some employability will not serve any purpose.

Thus there should be no exit option.



**8. In what ways can your department integrate communication skills as necessary evaluative criteria in some of your departmental course?**

Many EE faculty members offering 600 level courses for final year B.Tech. Students introduce presentation as a part of the course evaluation. Students opting for BTP will have to present their work and submit a technical report of the BTP. Thus, the communication skill test is implicitly implemented in many final year courses. Students opting for UGR courses will have to present their work before the faculty advisor. Hence, no separate communication skill course is required for the students.

**9. Switch from two midterms and one end-term to one midterm and one end-term exam.**

The two mid-semesters and one end-semester system is better as the students study and are evaluated uniformly throughout the semester. The student has better chance to recover. In view of increased number of students, more student tutors can be inducted. This will help in reducing the load of grading the answer scripts.

**10. 80% compulsory attendance**

Making 80% attendance is difficult to implement. Issues regarding the students who fall marginally below 80% of attendance need to be addressed. It is often difficult to take attendance for very large classes.

**Humanities and Social Sciences**

1. It was reiterated that all HSS Level 1 and Level 2 should have 4 contact hours, including one tutorial/lab hour.
2. There should be a 10-minute gap between classes.
3. Minors would be offered by each discipline. A student who has passed four courses in any discipline, without any particular order, would be eligible to receive a minor in that discipline.
4. English discipline's recommendation on course modification (vide Minutes of the DUGC held on 26 March 2009, Item 2) was approved.

**Industrial Management and Engineering**

1. The department is willing to offer a minor in Management. The course mix of the proposed minor can be structured later.
2. Exit option is very much needed. Perhaps all such students at some point, say after 3rd or 4th semester can be put through a separate channel for two more semesters and then given a BSc or such like degree.
3. Honours Degree- This can be introduced. All students can be initially admitted to the Honours degree, and if a student performs below a certain level (CPI) in the core courses, the student must be transferred to the General programme. Alternatively, all students can be initially admitted to the General Programme. In this case, students performing above a certain level can be transferred to the Honours programmes of the respective departments. However, the graduating requirements for the honours students should be more stringent than for the general programme students.

4. Only one mid sem exam should be there.

## **MATHEMATICS AND STATISTICS**

The following issues emerged during the discussions, on the interim report of the ARC, at the faculty meeting held on 6<sup>th</sup>, 9<sup>th</sup> and 19<sup>th</sup> March 2009.

1. In principle the idea of second degree is fine. However, the implementation guidelines must be spelt out.
2. Duration of the 2<sup>nd</sup> degree: The normal duration of the 2<sup>nd</sup> degree must be spelt out.
3. A common nomenclature for all 4 year academic program was suggested. For example: BS(discipline) such as BS ( ME) or BS (Physics).
4. The existing minimum CPI and W/AP rules should be retained. However the pass credit option (PCO) should be revived.
5. In keeping with the objectives of producing global humane Indians, a few courses on Value Education (say through NCC, NSS) are desirable.
6. The credits assigned to the professional courses in the given templates are based on the assumption that there will be no tutorials. However, some departments may wish to continue with tutorials, amounting to a requirement of greater number of credits to complete the academic program. The minimum number of credits required to complete the academic program of a department should be left to the department.
7. UGR1-UGR4: A mechanism should be evolved so that only serious students are able to exercise this option.
8. There should be a requirement for minimum attendance. However, the students may get exemption, in very special cases, from the concerned instructor.
9. The time table for all courses, including department courses, should be centralized. This is particularly necessary with the introduction of minors and the second degree.
10. Non-intrusive course monitoring is not clearly spelt out.
11. The Department of Mathematics and Statistics will be able to offer only 2 modular courses.
12. It is not possible to cover the basics of Probability and Statistics in one modular course.
13. Tutorial sessions by senior undergraduate students based on payment should be encouraged.

The following are the responses to the questions posed for the department:

1. Possible minors by the department - this will be decided by the various groups.
2. All compulsory department courses should be done in order to obtain the second degree.
3. No B.Tech(honors) degree.

4. No exit option. The present system is working well.
5. ESO 211 - Data Structures and Algorithms- should be the only compulsory ESO course for the Mathematics students.
6. It is not possible to introduce communication skills in a formal way. However, informally this could be achieved by ensuring that the students do take part in discussions in every course.

### Proposed Minors in Mathematics and Statistics

#### I. Minor in Scientific Computing (Linear Algebra)

1. Linear Algebra
2. Principles of Numerical Computation
3. Numerical Linear Algebra
4. Applied matrix theory

#### II. Minor in Scientific Computing (ODE)

1. ODE
2. Principles of Numerical Computation
3. Numerical Solutions of ODE
4. Parallel Numerical Algorithms

#### III. Minor in Scientific Computing (PDE)

1. PDE
2. Principles of Numerical Computation
3. Numerical Solutions of PDE
4. Introduction to Computational MRI, MRS, and NMR / Parallel Numerical Algorithms

#### IV. Minors in Differential Equations (DE), Fluid Dynamics (FD), Mathematical Biology (MB):

1. MINOR-I (DE-1) : MTH407, MTH421, MTH424, MTH625.
2. MINOR-II (FD-1) : MTH423, MTH523, MTH662, MTH694.
3. MINOR-III (MB-1) : MTH603, MTH606, MTH661, MTH658.
4. Minor-IV (MB-2): MTH 606, MTH601, MTH762, MTH694
5. Minor-V (DE-2): MTH 421, MTH 424, MTH405, MTH656
6. Minor-VI (FD-2): MTH 662, MTH656, MTH630, MTH-693

#### V. Minors in Analysis:

1. Analysis I  
Analysis II  
Distribution Theory and Fourier Analysis/ Fourier Analysis/ Functional Analysis
2. Analysis I  
Complex Analysis  
Fractal Interpolation and Applications/ Functional Analysis
3. Analysis I  
Topology

Differential Geometry/ Algebraic Topology/ Functional Analysis

4. Analysis I  
ODE  
PDE
5. Minor in Discrete Mathematics:  
MTH 202 - Discrete Math,  
MTH 302 - Logic,  
MTH 204 - Algebra and  
MTH 401 - Theory of Computation.

**NOTE:** At least one minor in Probability and Statistics will also be possible. However, the structure of that minor is related to academic review of two-year M.Sc. (Statistics) program and will be finalized after the review of two-year M.Sc. (Statistics) program is over.

## **MECHANICAL ENGINEERING**

The philosophy behind the development of an ideal UG curriculum proposed by the academic review committee (ARC) is well appreciated by the Department. The Department during the discussion felt that there is no explicit mention about how the proposed new curriculum will be successful in alleviating the weaknesses of the present curriculum identified by the ARC. The proposed curriculum should be correlated with the weaknesses of the present curriculum. Further, the success of any curriculum depends on the feasibility of its administrative implementation. In the proposed curriculum, some of the implementation issues are not clear. They should also be carefully looked into.

Some of the issues related to above comments are presented below in a point wise manner.

1. It has been proposed in the new curriculum that the student tutors should man the discussion hour. In view of this, the department proposes that all the tutors (students and faculty both) should attend the lecture classes of the course instructor-in charge, The student tutors should have offices in the department, and the department should make sure that the student tutors do not register for the courses whose classes clash with the lectures & discussion hours of the courses in which s/he is a tutor.
2. The department feels that the present credit based system is well understood worldwide and it conforms to the international standard/practice. Hence, the proposed credit system should be re looked into from the point of view of its merits and demerits.
3. In the proposed graduation requirements, the graduating CPI has been lowered down to 4.0 from 5.0. The department does not feel it appropriate because the graduating percentage of 40% is followed in the universities where absolute marks grading scheme is in place. In such systems, normally the best student gets about 80% marks. In the letter based grading scheme of IIT Kanpur, the highest score of best student is 100%. Therefore, dropping the graduation requirement to 4.0 CPI becomes lower than the universities following absolute marking system. It is also felt that students with lower CPI may not be welcomed by the outside world and would have difficulties in getting the right kind of job opportunities.
4. The proposal on second B.Tech. Degree requires some additional considerations. The students are likely to face difficulties in selecting their courses due to the prerequisite requirements (both core and departmental) and timetable constraints. In all likelihood, their graduation date is going to be stretched beyond the stipulated time.
5. The department had many queries and apprehensions about the new proposed separate degree program in engineering science. For example, will there be a separate department for the general administration (i.e. head, DUGC, industrial training for the B.Tech. in engineering science)? The

students in engineering science stream will take courses in other departments, and their course work will depend on the regular course structure proposed by the parent department. Timetable clash and prerequisite requirements will add to the constraints of the students in engineering science stream in selecting the appropriate courses.

6. The new curriculum proposes inter-departmental participation in teaching/tutorship of core courses (i.e. science departments participating in engineering department courses and vice versa). It is proposed that the participation in tutorship between engineering and science departments can be encouraged but certain apprehensions were expressed about the interdepartmental teaching lecture classes the inter-departmental participation between science and engineering stream for core course teaching may also lead to additional preparation workload on the faculty.
7. The PE (Physical education) courses are offered in first year only in both the existing and proposed curriculum. However, it is felt that the introduction to physical education should be gradual with soft option like yoga, jogging, swimming etc. in the beginning. The PE courses should be redistributed to later semesters. The physical education is relevant to students throughout their stay in the UG program not for the first year students only, and should be introduced in a gradual manner. The new proposal for tutorship of the PE courses by faculty members from different departments can be difficult as enough number of competent faculty members may not be available.
8. The department agrees with the modification suggested by ARC related to the TA 101 i.e. Engineering Drawing course. However, the department does not agree with the observation in the ARC report about the existing TA course in manufacturing to be heavy and therefore does not favor splitting the TA201 course to TA102 (ME) & TA201 (MME). However, the department suggests the TA201 course to be offered as an optional core course. The departments should be given an option to opt out of the TA201 course if they feel so.
9. The proposed new curriculum supports the systems engineering oriented courses similar to the existing BTP course being run in the Department of Mechanical Engineering. The department recommends the BTP to remain in overall curriculum of the institute.
10. The departmental specific communication course (Semester V) should not be made compulsory on all departments. The department should be allowed to introduce project based communication course content in their regular laboratory course structures.
11. The policy on attendance should be left to the instructors instead of the institute policy of minimum 80% attendance to appear in the final examination. As a first step, the institute has to formulate the policy of taking attendance in large core classes. This can be an unnecessary administrative load on the institute.

#### Response to Questions posed to the departments

1. The department is not in favor of offering any minor sub specialization.
2. The students should take all compulsory departmental courses including the prerequisites to get the 2nd B.Tech. Degree.
3. The department doesn't favor introducing B.Tech. (Honours) degree.
4. **4.** The department does not favor any exit option for the under performing students in core courses.
5. The department would like to retain the status-quo of the ESO courses as in the present curriculum: (1) ESO 202 (Thermodynamics), (2) ESO 204 (Mechanics of Solids), (3) ESO 210 (Introduction to Electrical Engineering), (4) ESO 214 (Nature and properties of Materials)
6. The department will integrate project based communication course contents with the laboratory courses.

7. The department does not encourage switching from two mid-term pattern to one midterm pattern.

## **MATERIALS AND METALLURGICAL ENGINEERING**

1. Point on Self Study "SS": Previous implicit formula is fine. How to quantify SS rationally appears to be an important issue. Some of us did not agree to include SS explicitly in the formula.
2. Point on credit based system: General opinion was in favour of a credit based system.
3. Point on AL formula: General opinion is in favour of Earlier formula
4. Point on attendance: The faculty was divided though a majority was in favour of imposing mandatory attendance criterion
5. Point on all four year degree: Vast majority of the members opined in favour of all 4 year UG program at IIT Kanpur
6. Graduating CPI: The house was divided evenly on this issue -6 (Yes) and 4 (N) on lowering of passing CPI to 4.
7. Majority was in favour of B. Tech, in Engineering Sciences, but successful implementation would require
  - i. Proper program guidance of student possibly through a virtual or real DUGC
  - ii. Having many within departments/ inter-department minor options with fixed timetables
  - iii. Question about placements of graduating students are also to be considered
8. Majority in favour of Minors, but implementation difficulties in terms of timetable, etc. are summarized in DARC report.
9. MME is also in favour of second major in another department.
10. MME suggests that TA should not be split into two courses rather it should continue as only workshop course without lectures. Class room teaching can be substituted by well developed videos to be seen before/after the workshop. We also recommend single project incorporating MME/ME related processes.
11. HSS: In favour of expanding HSS elective, but Management should not be a part of HSS. It can be an open elective offered by IME.
12. Modular courses: MME in favour of modular courses with one exam.
13. Teaching of communication skills should be part of both UG and PG program.
14. Comments on proposed 4-year Bachelor degree program
15. If student's have the option to choose one chemistry course, then Physical Chemistry should be part of both courses.
16. PHY102 and PHY201 should have same credit or PHY102 should have less. We think that most of PHY102 is covered in JEE.
17. 4<sup>th</sup> Semester is overloaded. Our suggestion is to move OE-1/DEPT from this semester.

Response from the dept. of MME on various specific questions.

1. A minor- an area of sub-specialization- 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 with other departments? What would be their structure?

We are for minor- an area of sub-specialization. It is however noted that if all departments offer more than the required number of compulsory courses ( also detach lab component from courses, introduce fixed time table), then minors will have evolve automatically out of the compulsory

departmental UG teaching program. It will be very difficult to sustain the concept of minor unless the above ideas (large number of courses and fixed timetable) are implemented.

2. What would be the structure of 2nd B.Tech/B.S. degree (Major) in your department for students from other departments? Specially, what should be minimum number of credits for award of 2nd degree? What should be the course/credit mix (choice of electives and core courses) for 2nd degree?

The department is also in favour of Major. All designated compulsory courses together with two other elective courses will constitute the major in the department of MME.

3. DO you think there should be an option for a B.Tech.(Honors) degree? If so, what should the criteria for giving this special honors degree?

Yes, there should be provision for B.Tech. (Honors) degree. The following criteria are proposed;

- The student should not have F grade in any course
- UGR2 and UGR3 must have B grade
- Graduating CPI should be above 8.5

OR

The student secures CPI above 9.0, if he/she does not take UGR in his/her academic program.

4. Should there be an exit option for students who consistently underperform during the core program at IIT Kanpur? If so, what form should this exit option take?

We are not in favour of an exit option

5. ARC: 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?

ESO courses

- Nature and properties of Materials
- Mechanics of solids
- Rate phenomena

6. In what ways can your department integrate communication skills as a necessary evaluative criterion in some of your department?

It is a highly subjective issue and would tend to vary from one person to another. The institute may consider to address the communication skills at the entry level of the student at IIT Kanpur.

7. Should we switch from the pattern of two mid-term and one end-term exam to one mid term and one end-term exam for all courses?

Existing pattern of two midterm examination suffices

8. Opinion on Credit system

Credit system as proposed by IARC is OK.

9. Graduating requirement

The graduating CPI should be 5, not 4 as proposed by IARC. The grading system should be re-looked at. With overall “poor” grade a student should not graduate from IITK.

## **PHYSICS**

These suggestions and views are based on the Minutes of the Special Faculty Meeting held on March 01, 2009, and subsequent discussion of ARC Special Group in physics to articulate the views of the Department.

### **1. General Comments**

- The effort of ARC was appreciated. The suggested reforms were generally considered to be in the right direction.
- The analysis in the first part is good, but it is unclear how those issues are addressed in particular in the later recommendations! The changes required in the content are major and mere incremental changes may not be effective. The tuning of the structure alone is not enough to get the desired results.
- The ‘Science based Engg. Education’ may need a clearer articulation keeping the present context in mind, though there can be no going back on this.
- Flexibilities provided will work only if a) the exact target audience is identified; b) the fraction of students likely to benefit is estimated; c) conditions of access are laid down and d) responsibility for making the
- Particular flexibility work is fixed.
- The flexibility of minors and second degree has the potential of changing the academic ambience by making disciplinary barriers porous and movements easier.
- Flexibility in duration may be desirable to account for large variation in speed and style of internalizing concepts. To reduce stress ceremonial aspects of awarding degree may be done away with.

### **2. B.S. Degree Entrance Criteria**

- The B.S. degree will be a non-standard degree to start with and prospective candidates at JEE counseling will not have clear ideas about its future and hence genuinely good students interested in Science degree may shy away. The degree may then be filled up with lower ranking students, especially in the face of competition in the environment from new Institutions and other Programmes.

### **3. Graduation Criteria of CPI being 4.0 and above**

- The sharp numerical criteria of CPI less than 4.0 for termination will not work since in our system we are used to look at individual cases. In effect the AP cases will move to the CPI band 3-4. This may be invitation to many to habitually neglect studies only doing the minimum required to be in AP or just avoid AP.

### **4. CORE Programme**

- The advantages of allowing a student in the core programme to choose sequencing of core courses at her own will were debatable. May be this option can be given to the Departments rather than individual students. Logistics of offering each of the courses to number of students and half the batch doing at any time does not make it organizationally feasible either.
- Taking half courses at the core stage was not favored by many. This may be tied out in later into eh programme or in the PG part. The courses anyway give a dismembered view of a subject – half courses would accentuate this undesirable feature. Half courses can be of use to experienced people



with maturity when the academic goals are sharpened so that they know what exactly they want and what for.

## 5. PROFESSIONAL Programme

- Most people were not in favour of making Projects optional. An undergraduate programme should be capped by an integrating project. Our failure to regulate and administer projects should not lead us to abandon it. Instead more majors should be taken to streamline the project. In fact it should become one's best part of the UG programme.
- There is a difference between UG Research and UG Project. UG Research should be only for the highly motivated. Only a small fraction of the UG Projects would normally qualify as UG Research.
- Projects must carry letter grades and be compulsory. Project work should not be de-emphasized as suggested in the interim proposals.

## 6. Answers to Some Questions for the Department

- A Minor – an area of sub-specialization – 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?

***See Below***

- What would be the structure of 2nd 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 2nd degree? What should be the course / credit mix (choice of electives and core courses) for 2nd degree?

***See Below***

- In what ways can your department integrate communication skills as a necessary evaluative criteria in some of your department courses?
- *Through Presentations in Project Courses and Introduction to Department.*
- 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?
- *Most people seem to favour single Midsem Exam, though there are some who think tow midesems benefit students.*
- Suggested Course Structure for Second BS Degree (Physics Major)

### **Semester I**

Phy 401 (Classical Mechanics)

Phy 461 (Experimental Physics I)

Phy 552 (Classical Electrodynamics)

\*\*\* / OE

DE1 (Department Elective)

### **Semester II**

Phy 412 (Statistical Mechanics)

Phy 432 (Quantum Mechanics II)

Phy 462 (Experimental Physics I)

OE / \*\*\*

DE2 (Department Elective)

### **Note:**

1) Most students going for a Physics Major will have probably taken Phy 431 (QM) earlier; if they have not, Phy 431 (Quantum Mechanics I) must be taken in the OE slot.

2) \*\*\* is one of Phy 407 / 524 / 543

## Suggested Physics Minors

### **Astrophysics**

305 (Physics of the Universe)

407 (Special and General Relativity)

CM/QM

### **Atomic Physics**

QM

524 (Atomic and Nuclear Physics)

### **Bio Physics**

309 (Introductory Biophysics) / 310( Physics of Bio-materials)

617 (Physics of Natural Nanomachines) / 619 (Statistical Physics of Biomolecules and Cells) / 641 (Elements of Bio Medical Physics/ suitable elective (BSBE)

### **Chemical Physics**

QM

524 (Atomic and Nuclear Physics)

Suitable elective (Chemistry)

### **Computational Physics**

473 / 625 (Computational Methods in Physics)

627 (Computer Simulations in Physics)

Suitable elective e.g. on Fluid Dynamics (ME/AE)

### **Condensed Matter Physics**

QM

412 (Statistical Mechanics)

543/622/634/642/624 etc. (any

Condensed Matter Physics course)

### **Energy and Environment**

301 (Energy)

Sociology (HSS)

Environment (covering sensors) (CE)

### **High Energy Physics**

QM1

QM2

680 (Particle Physics)

**Laser Technology**

303 (Principles of Lasers and their Applications)

643 (Lasers and Laser Spectra) / 644 (Quantum Electronics)

Elective (LTP)

**Low Temperature Physics**

QM

634 (Low Temperature Physics)

Experiments in different laboratories

**Mathematical Physics I**

(Algebraic Topology Differential Geometry)

Elective (MTH)

**Mathematical Physics II**

QM

Mathematics and Philosophy

407 (Special and General Relativity)

612 (Group Theory)

**Materials Physics**

QM

308 (Modern Theories of Material Design)

suitable elective (MSP) / 621 (Electronic Structure of Materials)

**Nano Physics**

QM

629 (Physics and Technology of Thin Films) / 631 (Physics of Semiconductor Nanostructures) /617

(Physics of Natural Nanomachines) / suitable elective project (FIB/other lab)

**Non-Linear Dynamics**

306 (Order and Chaos)

322 (Nonlinear Systems)

elective on computations (e.g. ME)

**Nuclear Techniques**

QM

543 (Condensed Matter Physics)

638 (Nuclear Techniques in Solid State Studies)

**Physics and Philosophy**

305 (Physics of the Universe)

QM

Philosophy (HSS)

**Plasma Physics**

303 (Principles of Lasers and Applications)

552 (Classical Electrodynamics I)

690R (???)

### **Quantum Information Theory**

QM

elective (CSE)

### **Quantum Optics**

QM

307 (Modern Optics)

646 (Coherence Optics) / ???

### **Semiconductor Physics**

QM

312 (Quantum Processes in Low-dimensional Semiconductors)

628 (Topics in Semiconductor Physics) / 629 (Physics and Technology of Thin Films) / 631 (Semiconductor Nanostructures) / MSP

### **Spectroscopy**

QM

NMR/EPR

elective (Chemistry)

### **Statistical Physics**

412 (Statistical Mechanics)

613 (Advanced Statistical Mechanics) / 615

(Non-equilibrium Statistical Mechanics)

Elective

**Appendix XVII: Course Allocation in the Past Academic Programmes**

**Table 8. Percentage course allocation in the past academic programmes**

	HSS	Science/Sc. Electives	Esc + ES	TA	Dept.	Open/Core Electives
Original 1963	18.7%	22.6%	13.2%	11.3%	34%	
I UGRC 1970	16%	20%	10%	10%	32%	12%
II UGRC 1981	10.9%	12.9%	15.2%	6.5%	41.3%	12.9%
III UGRC 1992	10%	15%	15%	5%	42.5%	12.5%
IV UGRC 2001	9.6%	19.2%	9.6%	2.4%	50.0%	2.4%

## Appendix XVIII: List of Sub-committees

### **Credit Subcommittee**

Dr. A.K. Chaturvedi  
Dr. V. Chandrasekhar  
Dr. Debasis Kundu

### **Communication Skills**

Dr. Goutam Deo  
Dr. Amman Madan  
Dr. Suchitra Mathur  
Dr. Peeyush Mehta  
Dr. C.S. Upadhyay

### **Interim Report (for Open House)**

Dr. Rajiv Shekhar  
Dr. M. Harbola  
Dr. CS Upadhyay

### **Template Subcommittee for Interim Report**

Dr. S. Mittal  
Dr. Partha Chakraborty  
Dr. V. Chandrasekhar  
Dr. Debasis Kundu  
Dr. Suchitra Mathur  
Dr. C. S. Upadhyay

### **Questions to be sent to Departments for feedback in Interim Report**

Dr. Suchitra Mathur  
Dr. Peeyush Mehta  
Dr. Subramaniam

### **Caltech. Curriculum**

Dr. V. Chandrasekhar

### **Student Survey**

Dr. Suchitra Mathur  
Dr. Mainak Chaudhuri  
Mr. Mohit Jolly  
Dr. Sanjay Mittal  
Mr. Anurag Sujania

### **Administrative issues**

Dr. Debasis Kundu  
Dr. Goutam Deo  
Dr. M.S. Kalra

### **Mathematics**

Dr. CS Upadhyay  
Dr. V. Eswaran  
Dr. S. Ghorai  
Dr. V. Shankar  
Dr. P. Shunmugaraj  
Dr. S. Umesh

**Physics**

Dr. M S Kalra  
Dr. M. Harbola  
Dr. Rajendra Prasad

**Chemistry**

Dr. V. Chandrasekhar  
Dr. Amalendu Chandra  
Dr. Madhav Ranganathan

**Life science**

Dr. V. Chandrasekhar  
Dr. Debashis Chowdhury  
Dr. Anmangsu Ghatak  
Dr. Dhierndra Katti  
Dr. B V Rathish Kumar  
Dr. Balaji Prakash  
Dr. Sankar Ramakrishnan  
Dr. P. Sinha  
Dr. Subramaniam  
Dr. Sandeep Verma

**E Sc 102**

Dr. Mainak Chaudhuri  
Dr. Shantanu Bhattacharya  
Dr. Ajit Chaturvedi  
Dr. Anjan K Gupta  
Dr. A. R. Harish  
Dr. Joesph John  
Dr. A. Kushari  
Dr. Baquer Mazhari

**TA101**

Dr. Manoj Harbola  
Dr. Vinay Gupta  
Dr. Sudhir Kamle

**TA201**

Dr. Manoj Harbola  
Dr. N V K Reddy  
Dr. Anish Upadhyay

**E Sc 101**

Dr. Ajit Chaturvedi  
Dr. Sanjeev K Agrawal  
Dr. Mainak Chaudhuri  
Dr. V. Eswaran  
Dr. Nitin Kaistha  
Dr. Harish Karnick

**Minors**

Dr. C. S. Upadhyay  
Dr. Ajit K. Chaturvedi  
Dr. Manoj Harbola

Dr. Rajiv Shekhar

**Dual Major/Degree templates**

*Chemistry/Chemical/BSBE*

Dr. V. Chandrasekhar

Dr. Amitabha Bandyopadhyay

Dr. Goutam Deo

*AE/ME*

Dr. MS Kalra

Dr. CS Upadhyay

*Math/Economics*

Dr. Debasis Kundu

Dr. Surajit Sinha

*BT/BS leading t o MBA*

Dr. Peeyush Mehta

Dr. Rajiv Shekhar

*BT followed by MT in NET*

Dr. M S Kalra

**Engineering Science**

Dr. C. S. Upadhyay

Dr. S. Guha

Dr. Harish Karnick

Dr. Neeraj Misra

Dr. V. Shankar

Dr. Mahesh Sivasambu

Dr. S. C. Srivastava

**Interim Report-II (to Senate)**

Dr. Mainak Chaudhuri

Dr. Ajit K. Chaturvedi

Dr. Debasis Kundu

Dr. Sanjay Mittal

Dr. C. S. Upadhyay

**APEC**

Dr. Ajit K. Chaturvedi

Dr. Debasis Kundu



## **Appendix XIX: The committee members**

Dr. Sanjay Mittal, AE, Chairperson  
Dr. Peeyush Mehta, IME  
Dr. CS Upadhyay, AE  
Dr. K. Subramaniam, BSBE  
Dr. V. Chandrasekhar, CHM  
Dr. Goutam Deo, CHE  
Dr. M.S. Kalra, ME  
Dr. Rajiv Shekhar, MME  
Dr. Partha Chakraborty, CE  
Dr. A.K. Chaturvedi, EE  
Dr. Mainak Chaudhuri, CSE  
Dr. Debasis Kundu, MTH  
Dr. Manoj Harbola, PHY  
Dr. Suchitra Mathur\*, HSS

\*Dr. Suchitra Mathur nominated Dr. Amman Madan during the period she was on leave.

Mr. MK Diwakar, AR(AA), Secretary