Curriculum Design for Engineering

In my previous column, we looked at issues related to curriculum design for university programmes. Some of the suggestions were hard to implement, considering the typical process by which the curriculum gets decided. This time, we will look at engineering disciplines and discuss the process that has been successfully used at the Laxmi Narayan Mittal Institute of Information Technology (LNMIIT) to redesign the curriculum.

The main problem in designing curriculum, is that it tends to get bloated. This overloads students and faculty, and brings down the quality of education. The strategy that was adopted at LNMIT, was to divide the task into steps, and to involve different sets of people in each step.

Decide the Goals

The curriculum will often depend on the mission of the university. The first step is to decide the goals of an undergraduate programme. Is the university preparing students for immediate absorption in core industry? Does it want its students to go for higher technical education, and eventually get into academics research, or at least very high-end technical careers? Or, does it expect them to also opt for careers which may not need a strong engineering background like management, finance, and administrative services? It may be possible to have several different programmes, for different goals.

At this juncture, one should also decide any special distinguishing feature of the university. For instance, some universities may want all its students to be ready for the Information Technology (IT) revolution, and even non-IT students will be exposed to more IT content than what is the norm. In such cases, they must not only have additional IT courses, but should also weave IT into courses of all disciplines. Similarly, if a university wants students to be aware of their surroundings and the society, it should make mini-projects involving problems faced by people in their neighbourhood compulsory in regular courses.

If the goal is to prepare students for immediate absorption in industry, then it might be a good idea to have industry exposure as a compulsory component of the curriculum— not just a short internship in the summer, which is largely a waste of time for both students and industry, but perhaps a one-semester project in the industry (like the Practice School of BITS Pilani). If the goal is to prepare them for academics or research career, the final year project must have substantial credits, and it must be directed towards gaining a research experience.

Determine Importance of Components

Once the overall goal is decided, the next step should be to divide the curriculum into various components and decide the percentage for each. For an engineering discipline, the components could be basic sciences (physics, mathematics, chemistry, and biology), humanities, social sciences, and soft skills (economics, sociology, psychology, literature, arts, communication, etc), engineering sciences and technical arts (computing, basic electronics, workshop, engineering drawing, thermodynamics, etc), discipline courses (courses in the specific discipline in which the degree is to be granted), and open electives. While each component would have compulsory and elective courses, it is good to have a few open elective credits so that students can do different elective credits of a particular component.

Select Number of Credits

Once the relative importance of each component has been decided, an independent group should look at the number of credits (or courses) a student should be doing. As we have discussed previously, in a semester system, five courses of 40-lecture duration (or equivalent credits through labs, short courses, etc) appear to be a fine balance.

If all these steps have been systematically followed then none of the departments should have any issues regarding the credits granted to their individual components. Now let us look at each component separately.

When it comes to basic sciences, the 20th century engineering was largely based on mathematics and physics. But 21st century engineering seems to be borrowing a lot from chemistry and biology, and is indeed blurring the distinction between natural sciences. While chemistry has been a compulsory part of the curriculum of most engineering colleges in India, people are still reluctant to embrace biology.

To overcome this reluctance, the concept of “flexible credits” could be of help. One could design a 20-lecture (half) course for biology to begin with, and review it after a couple of years. What is extremely important here is that the courses on biology should not be the same as what they teach a science student in a traditional university. It should be designed to show to an engineering student that a lot can be learnt about engineering design from biological systems, and biology related problems could be solved through an engineering approach.

In terms of engineering science and technical arts courses, the main challenge is to fit in the new (computer programming, digital electronics and IT workshop) and stay with the traditional (thermodynamics, material science, fluid mechanics, mechanical workshop, etc).

Aim for Long-Term Benefits

One has to realise that everything cannot be learnt and taught during the time the student spends in the university. Thus, a larger set of courses should be short listed and some of them should be chosen for each discipline.

Humanities (social sciences and soft skills) should include courses that help students in the long-term and not just to get their first job. It is also important for students to understand basics of sociology, economics and ethics.

When it comes to allowing students to choose a discipline, one should not look at what is useful, but what is critically important to that discipline. For instance in computer science, data structures and algorithms are absolutely critical, but heavens are not going to fall if some students graduate without a course in databases. In most disciplines, there are professional societies who have done a lot of work on curriculum, and their recommendations could be useful.

Once all the courses have been designed, one must carefully decide the pre-requisites for each course. A course should be a pre-requisite only if there is substantial part of the course that is assumed while teaching the second course.

Finally, the courses need to be placed in different semesters. It is recommended that except for the first year compulsory courses, the university allows students to complete courses in any order. A curriculum designed in this way can help the students plan and personalise programmes to suit their interests and needs. EDU

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