Charter for

Centre for Education Research and Teaching Excellence (CERTEX)

Executive Summary

We, at the Indian Institute of Technology Kanpur (IITK), propose the establishment of the Centre for Education Research and Teaching Excellence (CERTEX) with an aim to enhance our educational approaches and adapt them to changing times. Building on IITK's legacy of educational excellence, CERTEX will provide a structured framework to address evolving challenges in teaching and learning. These challenges include an increasingly diverse student body, higher expectations for research and teaching innovation, and the need for advanced pedagogical methodologies.

CERTEX's initiatives will focus on the following four key areas:

1. **Education Research**: CERTEX aims to usher in and evolve a culture of education research and research-driven pedagogical methods to improve learning, investigate diverse student needs, and perform qualitative and quantitative analysis of the impact of new learning technologies.
2. **Infrastructure Development**: The centre will create and maintain advanced facilities and technical support for faculty, including lab simulations, AI/ML tools integration, and audio-visual content for effective teaching, while maintaining a repository of the same.
3. **Support Staff Training**: Recognizing the need for knowledgeable technical staff and TA's/Tutors, CERTEX will conduct periodic training and skill upgrades, ensuring labs and workshops meet IITK's high standards.
4. **Outreach**: CERTEX will share insights and best practices both within IITK and with other institutions globally, promoting IITK as a leader in education. Activities will include conferences, seminars, publications, and an online repository of exemplary teaching resources.

Through these initiatives, CERTEX aims to support IITK's mission of fostering a research-backed, and technologically advanced educational environment that equips students and faculty to set the highest academic standards.

I. Introduction

Indian Institute of Technology, Kanpur (IITK) has been a pioneer in setting up excellent standards of science, technology, engineering, mathematics (STEM) and Humanities and Social Sciences (HSS) education in India both at the undergraduate and postgraduate level. This became possible because of the environment prevailing at the institute since its inception that led to innovative teaching by the faculty members. Results of such novel teaching initiatives are evident from the impact that alumni of IITK have made in diverse fields. To be able to continue this path of excellence in teaching requires: (i) a detailed examination of the factors that made teaching at IITK so effective, (ii) analysis of these factors and how they have been changing over time, and (iii) research on adaptation and evolution of teaching practices to accommodate such changes in order to retain excellence in teaching at IITK. This proposal to establish a Centre for Education Research and Teaching Excellence (CERTEX) endeavours to address the aforementioned goals. In the following we begin by listing different elements that we feel made teaching at IITK effective. We subsequently describe the changes in these as seen by us as faculty members at IITK. This naturally leads to the objectives and requirements of the centre being proposed to provide pertinent services to the IITK teaching community, which are presented next.

II. What has made teaching effective at IITK since its establishment? [1]

Four pillars of great education at any institute are its faculty, technical staff, academic infrastructure and students, leading to an environment, which forms the fifth pillar. IIT Kanpur excelled in all five right from the beginning, as elaborated in the following.

(i) Faculty:

When the institute started, there were not many institutes of higher learning in India that imparted quality PhD training in current areas of interest. Therefore, a large majority of early faculty members were drawn from top universities across the world, particularly the United States of America. Since the main focus was to teach young Indians, faculty members took teaching very seriously, were highly motivated to teach and consequently, taught passionately and with high degree of excitement. Simultaneously, since a majority of teachers were also

researchers, the latest discovery or breakthroughs anywhere in the world discovery or breakthroughs anywhere in the world were rapidly introduced in the classrooms, thereby creating an adaptive teaching-learning system.

Another aspect of teachers at IITK was that the exercise of teaching for them was also a learning process. They were eager to learn from tutors and students both. Therefore, they encouraged students to ask questions, even if the questions made them uncomfortable, and worked hard to provide answers to these questions; it also helped students in overcoming teacher-student communication barriers and made them better learners. This passionate involvement from faculty members aided in intellectual development of students. An important aspect of many core courses was that they had tutors from across the departments and that gave multidimensional perspective both for the instructors and students in these courses.

While teaching a course, a faculty member usually did it for a couple of years and tried to bring out a textbook or a set of informal notes with contemporary course material.

In core courses and courses with laboratory components, faculty members were assisted by Teaching Assistants (TAs) who were PhD students. The passion of teaching by faculty members also spread to TAs who participated in running of a course with diligence and sincerity. One reason for that probably was that they looked upon themselves as becoming teachers after earning their doctorate.

In addition to aspects of teaching mentioned above, design of curriculum also helped in preparing students for the future.

These trends of teaching have continued and the new generation of teachers at IITK have followed them. However, as described later in this charter, expectations from faculty members at an institute of higher learning have changed over the years and that has been affecting their teaching. To keep it at the desired level requires more institutional support that this charter is proposing.

(ii) <u>Students:</u>

All students and faculty members from the past recall with pride the quality of students coming to IITK. Majority of them were independent thinkers, had a hunger to learn and were

quick learners. While they competed with each other in the relative grading system, there was a lot of peer learning too, which led to a great learning experience and personal development.

An aspect of student-body at IITK for a long time — distinct from today's students — was that a majority of them came from similar socio-economic backgrounds of upper middle class and urban areas. They therefore formed a homogeneous group in terms of their upbringing and educational background — most of them had educated parents and themselves attended well-known schools where the medium of instruction was English. Addressing a classroom made up of students from such a homogeneous group was relatively easy.

The student body has also changed with time and while it is heartening to see a large fraction of population from all sections of society wanting to get educated, it comes with its own set of challenges for educators, and we must rise up to it. This is elaborated upon further in the next section. While the merit of incoming students is ensured by the rigour of the entrance examination, their varied background and exposure makes it necessary to evolve new pedagogical methods. These are discussed later in this proposal.

(iii) <u>Support Staff: Technical Staff, Teaching Assistants (TA's) and Tutors:</u>

An institute imparting STEM education requires excellent laboratory facilities and workshops which run smoothly. This requires competent and well-trained technical staff at all levels — starting from laboratory and workshop assistants to supervisors — who are knowledgeable and experienced in running and maintaining instruments/machines, and who can be a guiding light for students in laboratories and workshops. IITK has been fortunate to have such staff right from its inception.

Additionally, the teaching system of IITK has been blessed to have very able and enthusiastic set of students who participate as teaching assistants (TA) and tutors. Furthermore, they would interact with the students outside the classroom to render academic help.

(iv) <u>Academic infrastructure:</u>

IITK has always possessed world class academic facilities. It started with a library with one of the best collections of textbooks, reference books and journals found in any top university. Similarly, the equipment in laboratories and workshops were latest and best possible even by

global benchmarks. For instance, IITK had its own aeroplanes and gliders to impart practical training to aeronautical engineers. To add to all this, IITK also had a television centre where academic films were produced. All this was facilitated by the Kanpur-Indo-American-Programme (KIAP).

Having touched upon four components of education at IITK, we now sum it up in terms of the environment that got created at the institute.

(v) <u>Environment:</u>

Different aspects of pedagogy mentioned above created an environment in IITK that was highly conducive to teaching, learning and personal growth of students. Some key points about this are mentioned below:

a) A strong foundation through five semesters of core courses (B.Tech. and M.Sc. integrated programmes were of 5-years duration till the incoming batch of 1982). This introduced students to all-round real-world knowledge, largely missing in their studies till then.

b) Humanities and Social Sciences education being important for becoming a well-rounded individual, it was also given due emphasis in the curriculum.

c) Openness in the classroom. Teachers did not hesitate to say: I do not know, I will find out and come back to you. The pursuit of knowledge has always been paramount and without hierarchy.

d) Cadence of teaching schedule, and structure of classes as lectures and tutorials with instructors and tutors being in sync. This was mainly a result of tutors attending the lectures.

e) Small class sizes that led to a direct and informal relationship between teachers and students.

f) Very high-quality facilities for games and sports and other extracurricular activities were developed to help in all-round growth of students.

g) Open campus with nothing being off limits for students.

h) High level of trust and mutual respect between students and teachers, and among teachers themselves, which encouraged open dialogues between all parties, leading to very high degree of engagement at every level.

i) Teaching was a significant component of the institute's commitment to academic excellence. Leadership played an important role in it.

III. What has changed over the years?

Over the years, as the Indian society started progressing and began coming out of the shadows of the past, aspirations and expectations of its citizens have also started evolving. As a consequence, the way faculty members and students look at the process of teaching and learning has also changed. Major changes affecting teaching and learning are as follows.

(i) Faculty related changes

Quantity of research expected from faculty members has increased manyfold leaving little time for any other activity. This results in faculty members having less time to invest on teaching and innovation in pedagogy, continuous upgradation of teaching material and laboratories, and in making evaluation more meaningful. On the other hand, given the observations about a large number of students, more time needs to be spent in preparing for the delivery of course content.

(ii) Students related changes

a) **Number of students:** The number of undergraduate students per batch has been steadily increasing over the years and has tripled, compared to twenty years ago. This has made direct in-person interaction between a faculty member/instructor/tutor/technical staff and students extremely difficult.

b) **Schooling background:** A large fraction of students now goes to coaching classes for two to three years before they appear for JEE. Furthermore, both JEE (Main) and JEE (Advanced) are multiple choice questions (MCQ) based examinations. Not going to regular

school, coupled with being coached to solve MCQ papers, makes them come to IIT with little training in independent, rigorous and logical thinking. Thus, a large number of students, although meritorious and talented, are not well prepared for demands of higher education.

c) **Language and communication skills:** The emphasis in coaching classes is on only three subjects, viz., physics, chemistry and mathematics. A majority of students are therefore not well conversant in English. In addition, their communication skills are also not at a level expected from a student of IITK in their age group.

d) **Socio-economic background of students:** As noted earlier, while it is heartening to see that now-a-days the student body consists of young persons from all sections of the society, including a large number from Social and Economic Disadvantaged Group (SEDG), this tends to make their transition to IITK and adjusting to life here a somewhat difficult and distressful process. From a teacher's perspective, it also makes the classroom a mixture of persons with different levels of exposure to schooling and other aspects of life, resulting in the teacher not being able to decide on the level of rigour of a course to cater to such varied background and ability of the class.

e) **Soft skills and peer learning:** A large number of students lack soft skills that are usually imparted during their school education. That makes it difficult for them to interact with their teachers and fellow students and affects their learning both in a classroom and from their peers.

f) **Expectations of students:** All students now have access to the internet and social media. Consequently, they have an enormous amount of information available to them and naturally, they compare what is done in a classroom with what they see on the internet. This sometimes creates an illusionary feeling about the education they should get at IITK, making their expectations unrealistic and consequently, affects their learning.

(iii) <u>Support Staff related changes</u>

a) **Quality of TAs:** With increase in the number of postgraduate (PG) students at the institute from a diverse set of colleges and universities, academic quality of a large number of TAs

is not on par with IITK standards. Furthermore, majority of them too do not possess required soft skills to be an effective mentor for students in classes and laboratories where they are teaching. Finally, because of the pressure to produce a large quantity of research papers, they too cannot pay as much attention to their TA duties as the institute would like them to do.

b) **Technical staff:** With rapid changes taking place in technology, laboratory equipment and machines become outdated in relatively much shorter times. This requires the technical staff to be well trained to adapt to these changes quickly.

(iv) <u>Academic infrastructure related changes</u>

With time, large classrooms have been built and sharing of laboratory equipment has become the norm. In addition, the use of audio-visual equipment is becoming more prevalent. Use of such new technologies can significantly enhance classroom experience of the students.

(v) <u>Environment related changes</u>

a) The environment has changed and students now have several distractions, which renders focus on academics challenging. The need of the hour is to capture their attention by conveying a concept via effective use of electronic platforms in making diagrams, animations, video clips and live demonstrations wherever possible, which have all become important components for delivery of the course content. Finally, we add here that story telling is a powerful vehicle to convey complex ideas yet this tool is not used often in education. Making analogies across disciplines is also another way to reducing “siloing” or “compartmentalization of knowledge phenomenon. Research is required to examine effectiveness of all these strategies in conjunction with traditional means of classroom teaching.

b) Access to newer modalities and avenues of learning, such as those available online from leading universities around the work, which demands that faculty members develop ways for them to be in tune with these continuously evolving developments. The centre will keep abreast with such developments and facilitate their adaptation by faculty members.

c) Evaluation of students, especially for large courses must include modern diverse modes of assessment and these needs to be upgraded continuously.

d) The number of PG students at all level (MTech/MS/PhD) has increased significantly in the past few years, and their academic backgrounds tend to be highly non-uniform. Many such students arrive at IIT with the aim of enhancing their academic capabilities and also to better prepare for possible future roles as faculty members. Hence, special attention has to be paid to their academic training at IIT Kanpur.

As is evident from the description of changes in all aspects of teaching and learning, effective teaching, and excellence in it, has become abundantly challenging and requires dynamic understanding of various factors affecting it. With that understanding one can then address various concerns so that teaching remains robust to the changes in society in addition to changes on the scientific and the technological front.

Given its track-record of excellence in teaching, IITK has a highly motivated set of faculty members, staff and students, along with the relevant technical expertise to address all the challenges described above. This requires channelling individual passion toward teaching to enrich pedagogy at IITK that can also become exemplary for other institutes to address the ever-evolving demands of teaching and learning.

It is with this in mind that IITK proposes to establish a Centre for Education Research and Teaching Excellence (CERTEX). We now present its goals and requirements.

IV. Centre for Education Research and Teaching Excellence

As is evident from our presentation above, there is a strong will among the Indian youth to get educated and every effort is to be made that their wishes are fulfilled irrespective of their background. The government on its part has been making policies so that people from all walks of life get an equal opportunity in getting education in the field of their choice. It becomes incumbent upon institutes like IITK to engage all students to actively and fully participate in the academic activities of the institute, taking advantage of the excellent opportunities the institute offers. Therefore, on the institute's part, it must be made sure that the education we offer

reaches the students effectively overcoming the barriers they may have for a variety of reasons, some of which have been listed in Section III. The aim of the proposed centre will be to find ways to do so based on research in all aspects of teaching and learning, thereby aiding faculty members of the institute to infuse their teaching with excellence. For example, to enhance teaching quality, the centre will provide support for a better and more efficient use of the time available to faculty members; it will also help them to effectively prepare and deliver the course content using technological aids. Since the challenges faced by all institutes of higher learning are the broadly similar in nature, it is envisaged that CERTEX will help other institutes also in achieving excellence in teaching and learning.

With a view to strengthening the five aforementioned pillars of teaching, viz., faculty, students, support staff, infrastructure and environment, we envision the following interconnected thrust areas for the centre:

1. **Education Research**
2. **Infrastructure Development**
3. **Support Staff Training**
4. **Outreach**

In what follows, we elaborate on each of these areas.

1. Education Research

Many competitive Universities across the world focus on Education Research in various fields [2], [3]. Subject-specific education research is also commonplace, with support and infrastructure for carrying out research. Education Research plays a vital role in addressing learning barriers, developing effective instructional methods, and making STEM and HSS subjects more accessible, engaging, and applicable. By refining teaching strategies based on empirical evidence, Education Research aids in the development of methodologies that can enhance the quality of learning. Although centres such as Homi Bhabha Centre for Science Education (HBCSE) and National Council of Educational Research and Training (NCERT) carry out research related to school education, no such centre exists for research in higher education. In light of this vacuum,

IITK — given its history of pioneering initiatives in higher education — is well positioned to take the lead in educational research with focus on the following areas:

a) Learning methodologies: Group versus Individual learning;
b) Effect of technologies such as ChatGPT in teaching and learning and their efficient usage;
c) Scientific analysis of student feedback;
d) Addressing the needs of diverse groups of students, including socially and economically disadvantaged groups;
e) Research into overcoming learning barriers for challenging topics.

With these objectives in mind, the following Human Resource are required at the centre:

i. 8-10 Faculty and/or Affiliate Faculty: Their primary objective would be carrying out education research in collaboration with faculty members across the institute and to carry out activities listed later in the charter to make teaching at IITK excellent;
ii. 4-5 Data Personnel: To facilitate collection and assimilation of data within and outside IITK;
iii. We also foresee that students of IITK and other institutes will get involved in Education Research at the centre as part of their internships and projects, thereby preparing themselves for a potential research career in this field.

In conclusion, the centre seeks to establish Education Research as one of the significant research areas of IITK.

2. Infrastructure Development

The centre will focus on the development of modern infrastructure support for teaching at IITK. Following is a glimpse of the support that the centre would provide:

a) Technical support to faculty members for the development of demonstrative lab experiments and simulations. This would require a workshop, computers and related software and appropriate human resource;
b) Help integrate AI/ML tools in relevant courses;

c) Establishing interface with industry to integrate their suggestions and needs in relevant courses;
d) Facilitate the creation of audio/visual content for effective classroom teaching;
e) Provide consultation related to Learning Management Systems (LMS) and other pertinent software;
f) Support for a faculty member to develop pedagogy related experiments;
g) Procurement of books and journals for Education Research;
h) Creation and maintenance of an online repository of lectures demonstrating excellence in teaching;
i) Setting up a common space for teachers and students to exchange ideas related to elevate classroom experience;
j) Development of software and apps toward facilitating teaching and learning.

3. Support Staff Training

An excellent science and engineering institute requires state-of-the-art laboratories/workshops together with highly knowledgeable and competent technical staff to run them. This requires their periodic training and skill upgradation. Therefore, imparting such training together with development of interpersonal skills for interaction with students/faculty members is envisaged to be one of the key responsibilities of the proposed centre. The above is envisioned to be achieved via both involving the staff in demonstrative experiments, utilizing them as a buffer between faculty and the centre, facilitating advanced certification programs where relevant, and enrolling them in advanced graduate courses for timely academic growth. To this end, among others, the following central activities have been envisaged for the centre:

a) Creating a certificate program on pedagogy for PhD students, post-doctoral fellows and faculty members from IITK as well as from other institutes;
b) Offering a course on pedagogy for prospective Tutors;
c) Since effective communication and other soft skills are important components of the teaching process, the centre will facilitate training in these through courses, workshops for the TA's and Tutors (and other interested students) who will also be helped with the tips on how to give lectures and presentations;

d) Arranging workshops for technical staff in laboratories on how to be more effective in interacting with students and guiding them. This includes the opportunity to learn relevant software;

e) Creating a system for appreciating and awarding students with exemplary performance as TAs and tutors.

4. <u>Outreach:</u>

The final thrust area of the centre is the sharing of information both internally and externally. This serves the dual purpose of sharing of information regarding best teaching practices and also projecting IITK as a leader in quality education in India and globally. This can also play a critical role in collaboration with other institutes and contributing towards the advancement of their pedagogical standards. Some of the possible activities in this thrust area are listed below:

a) International conferences on teaching and pedagogy;

b) Regular talks, seminars, and lecture series on pedagogy by teachers and scholars of repute;

c) An annual magazine of the centre's activities to be released on Teacher's Day, which will describe the successful teaching initiatives at IITK along with articles from other eminent educators outside IITK;

d) Facilitate the creation of a repository of course material, including lecture notes by faculty members. The repository will also have a collection of common mistakes by students in different courses;

e) Create a collection of informative articles on best teaching and learning (including integrity and value system) practices;

f) Dedicated sessions for new faculty members on effective teaching during their orientation to the institute;

g) Automated email every semester offering support to interested faculty members regarding teaching evaluations;

h) Facilitating publication of books and providing adequate technical support. This can eventually lead to the creation of an institute press for publishing books;

i) Creating a good website for the centre to disseminate information from the centre. This will also include links to online videos by eminent educators [4];

j) Setting up a collection of exemplary videos of classroom lectures, activities and lab demonstrations by IITK faculty;

k) Facilitating extra teaching sessions in other languages;

l) During orientation of new students, organising a workshop on best learning practices so that they can optimally plan their study methods in order to get most out of courses.

With the above four thrust areas, the goal of the centre is to build a space where excellence in teaching is bolstered and continually developed.

V. Implementation Timeline

Activities proposed in the charter are to be implemented in a phased manner as given below. To start these activities, interested faculty members from within the institute will be associated with CERTEX.

Phase I (Duration: First and Second years):

a) Creating a website for the centre to disseminate information from the centre. This will also include links to online videos by eminent educators.

b) Recruiting of appropriate staff members.

c) Procurement of computers, relevant software, and appropriate human resources so as to extend technical support to faculty members for the development of demonstrative lab experiments and simulations.

d) Help integrate AI/ML tools in relevant courses.

e) Support for faculty members to develop pedagogy related experiments.

f) Procurement of books and journals for Education Research.

g) Setting up a common space for teachers and students to exchange ideas related to elevate classroom experience.

h) Establishing interface with industry to integrate their suggestions and needs in relevant courses.

i) Facilitate the creation of a repository of course materials, including lecture notes by faculty members and common mistakes made by students.

j) Create a collection of informative articles on best teaching practices.

k) Organize regular talks, seminars, workshops, and lecture series on pedagogy by teachers and scholars of repute.

l) Regular dedicated sessions for new faculty members on effective teaching.

Phase II (Duration: Second and Third years):

a) Further recruitment of technical staff members.

b) Facilitating creation of voluntary student-faculty groups to conduct extra classes in in other languages.

c) Facilitate the creation of audio/visual content for effective classroom teaching.

d) Provide training related to Learning Management Systems (LMS) and other pertinent software.

e) Holding international conferences on teaching and pedagogy.

f) Setting up a collection of exemplary videos of classroom lectures, activities and lab demonstrations by IITK faculty.

g) An annual magazine of the centre's activities to be released on Teacher's Day, which will describe the successful teaching initiatives at IITK along with articles from other eminent educators outside IITK.

h) Providing adequate technical support for publication of books. This can eventually lead to the creation of an institute press for publishing books.

i) Development of software and apps toward facilitating teaching and learning.

Phase III (Third year onwards):

a) Hiring of faculty in the field of Education research with focus on discipline-based education research (DBER).

b) Automated email every semester offering support to interested faculty members to discuss their teaching evaluations.

c) Introducing various data-driven scientific analyses of course and teaching/learning data.

d) Introducing courses on pedagogy and certificate programs.

e) If the institute deems it fit, bringing several teaching and learning related administrative tasks (like collection of first-course hand out, student reaction survey, course/program revisions, support for book writing, etc.), currently scattered under various committees, under the purview of CERTEX.

f) Explore conversion of CERTEX into a department.

References:

[1] Based on feedback from alumni of different batches (some old and some new ones) and faculty members from the past (Available with MKH).

[2] Stanford Graduate School of Education (https://ed.stanford.edu/)

[3] The Simon Initiative Carnegie Mellon University (https://www.cmu.edu/simon/)

[4] Carl Wieman on Active Learning and new pedagogies for higher education (https://www.youtube.com/watch?v=9A13RWOs6oA&ab_channel=StanfordCEPA)

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