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On the UGC draft: Learning outcome based curriculum-2025 in mathematics for undergraduate program B.A./B.Sc. (general)

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Structure of the document

First we go over a number of courses that are highly objectionable and give brief comments on each. Then we say what a good mathematics curriculum could consist of. It is followed by a comparison to existing curricula in India and other countries. We end with the conclusion. To avoid suspense for the weak-hearted, the conclusion is that this draft curriculum is tragically misguided, must be abandoned in its entirety, and a new committee of mathematicians and experienced teachers of mathematics at UG level constituted.

List of courses in "Indian mathematics"

1) About Aryabhata/Brahmagupta/Mahavira/Bhaskara II (and Lilavati)/Ancient Indian System of Counting and Measurement

Unlike with novels, one does not study mathematics author by author. Most mathematical concepts are developed over centuries by many mathematicians cutting across national and temporal boundaries. One can of course learn history of mathematics for its own sake (and hence be interested in Aryabhata, for example), but that is not the same as learning mathematics. The last course fits in a history of Indian mathematics course (mentioned below).

2) Indeterminate Equations (Kuttaka and Chakravala)/Journey of Pi (π) /Some Sutras of Vedic Mathematics

Why is it important for students to learn this? How does it benefit them? The people who are suggesting this do not even understand what this piece of mathematics is and how it fits in with the rest of mathematics. Picking some isolated chunk of mathematics just because it was done by an Indian is utterly foolish.

3) Mathematics in Narada Purana/Bhartiya Magic Squares and Figures/Triplet Based Trigonometry

These combine the defects of all the previous ones. Absolutely no place for any of these in UG mathematics. Instead of magic squares, if one were to introduce a course in what is called "Recreational mathematics", that might at least be a worthwhile experiment and have some instructional/ entertainment value. As for the first and third, they cover material that have been learned in high school, if not before (e.g., Bodhayana/ Pythagoras' theorem) and spending a whole course on is a colossal waste of time.

4) Kaparekar and Ramanujan/Sutra Based Applications/About Jyeshtha Devan

The second and third fall into the categories already dismissed above. Take for example the Sutra based applications. Teaching divisibility tests by 2 to 9? Contrast it with a first semester course like "Mathematical reasoning" which talks about prime numbers, mathematical induction, countable and uncountable,... These are deep foundational topics in mathematics and surprisingly accessible to a first year undergraduate. In contrast, the Sutra based applications course is diluted water.

As for the first course, anyone who puts Kaprekar and Ramanujan on equal footing as mathematicians does not understand the first thing about mathematics. It is a ridiculous course (Ramanujan was a great mathematician, but there is no need for a course on him either. What he did pervades number theory, it can be learned there)

5) Development in Indian Mathematics/Geometry in Shulva Sutras/Sutra Based Arithmetic

The first course here and the Philosophy and History of Indian mathematics courses together could form one or at most two courses in the history of Indian mathematics. It is by no means essential to the learning of mathematics, but can be justified as electives of interest.

There is no sense in studying Geometry of Shulba sutras when in other courses one has learned coordinate geometry and Calculus! And the Sutra based arithmetic is even more ridiculous. After studyiing systems of linear equations in the matrices and linear algebra course in the first year, now students are being fed sutras (formulas, essentially) to solve linear equations in one variable! Even the way the equations were classified show the primitive level of understanding of that time. Bharati Krishna Tirtha's book has some tricks for fast calculation (and these tricks do not always

work, a point not understood by the author or the people who are referring to his book) and there is absolutely nothing Vedic about it. Which Veda which contains sutras like “Ekadhikena Purvena”?

6) Philosophy of Indian Mathematics/Bhaskaracharya’s Lilavati/Sutra Based

Algebra/History of Indian Mathematics

The first two and the last can be subsumed in the history package referred to above. By the way, the Philosophy course here has no philosophy whatsoever - perhaps the committee wanted a different name than other courses and stuck it in! Sutra based algebra has no place in any curriculum. Throwing around a Sanskrit word does not make a silly idea profound. All it means is formula based algebra (which is itself despicable, but it is further limited to the Indian formulas, which cuts down the content even further!). In ancient India, where bulk printing did not exist and few copies of books could be made, everything from grammar to mathematics to architecture to dance were expounded in forms of sutras or shlokas, to make them easy to remember. The need for it has long passed.

7) Kala Ganana/Sequence and Series (Bhartiya Contribution)/Bhartiya Geometry and Trigonometry

All three courses should be thrown out of the curriculum by any serious person. It is very interesting to know how time is measured (including how it was measured in the past). But why stop at the ancient Indian method, when we are using clocks and calendars of unimaginable accuracy today? Mention of auspicious and inauspicious muhurtas is startling for its regressive nature.

One should mention Madhava’s great contributions when covering infinite series, but a whole course on Indian contributions to it? Does that mean there will be no proofs? A whole course on series that will not mention Euler’s magnificent determination of sum of reciprocals of squares? Where does one begin and end with this kind of foolishness?! When you order a curry in restaurant, do you eat only ingredients of Indian origin and leave out potatoes, tomatoes, chillies etc.?

8) Ramanujan: Some Contributions/Bhartiya Innovations: World-wide Accepted

As already said, Ramanujan has a permanent place in mathematics, and some of what he did can be learned in various courses (number theory mainly, some in analysis courses too). There is no use to any student to

spend a semester learning mathematics that Ramanujan did! The second course is as ridiculous as the ill-formed title (and what little makes sense in it can be absorbed in the package of 2 courses in the history of Indian mathematics that I referred to earlier).

List of courses in Mathematics and xyz

1) Mathematics in Music/Mathematics in Daily Life

2) Mathematics in Drama/Mathematics in Chemistry

3) Mathematics in Arts/Mathematics in Physics

4) Mathematics in Banking/Mathematics in Life-Sciences

5) Mathematics in Business/Mathematics in Management

6) Mathematics in Finance/Mathematics in Meditation

7) Mathematical Data Science/Mathematics in Sustainability

8) Mathematics in Bio-Sciences/Mathematical Psychology

These courses are largely ill-conceived in a different way. Some are okay - such as Mathematics in Daily life (deals with basic mathematics that everyone should know) and the courses on Finance, which even if not well-designed can be modified (one each in Banking, Finance, Business and Management appears excessive). As for the Physics, Chemistry, Life-Sciences, in itself they would be okay, if taught by people who know these subjects to students who know the basics of these subjects. E.g., Maxwell's equations and Quantum Mechanics are mentioned. Do the students really know anything of these subjects? When did they learn these advanced physics matters when in mathematics itself they did not study real numbers till the previous semester and have had one single course in matrices!

Among the remaining, the ones on Music and Drama and Arts are overblown, at most they can form one course (the one on Music mentions Markov chains though the entire curriculum has no Markov chains, and there is only one course is probability or statistics!) And Fourier series is supposed to make sense to first year students! Sustainability is also overblown. Instead of the psychology course here (the contents sound good, but the requisite mathematics has not been covered!), one could instead have a proper statistics course that has numerous applications across fields. One can model it on the "Statistical methods" courses that ISI teaches B.Stat students (incidentally, the third reference book in the Mathematical psychology course does not seem to exist!).

Further, who will teach these courses? Do mathematics teachers in universities know anything about psychology? Or physics or chemistry or life sciences? It would be more fruitful for mathematics teachers and students to know more mathematics. And if a certain number of electives are left free to be taken across departments, then the students can benefit from basic courses in other subjects taught by instructors of those subjects, whether it is physics, history or linguistics.

Lastly, there is no need to say how ludicrous is the idea of a course "Mathematics in Meditation"! It would have been better for the committee members to do a little meditation on mathematics instead.

Some other ill-conceived courses

Programming in Fortran 90? Integral transform? Integral equations and Calculus of variations? Mechanics I and II? Vector analysis?

The problem with these is that either they are outdated or/and there are better replacements (by more basic things they could learn meaningfully). The programming courses seem way outdated. Instead of integral transform and Integral equations, a first course in functional analysis like in Simmons' book or a course in PDEs (just the basic methods and important 2nd order PDEs) could be taught. As for vector analysis, why is it separate from multivariable calculus which is already there?

Errors in the draft

So far we have focused on the big picture, suitability of courses etc. There are also errors of a nature that raise serious questions on how the draft was made.

- ✦The course objectives and outcomes of the Matrices and Linear algebra course have no relation to the course at hand (cut-paste error?). Any large document has some errors, this is not a serious one.
- ✦In the Mathematics in Physics course references, we see the resurrection of Walter Rudin from the dead, a miracle rivaled only by his choice to spend his extra time in writing the book "Mathematics for Physics". This book is perhaps for sale only in the spirit world, from where even Amazon is unable to deliver.
- ✦The last two books in the History of Indian Mathematics syllabus are in Hindi. One can question the content of these books. That apart, what about places where Hindi is not spoken?
- ✦S N Sarawati's Philosophy of Mathematics in the Philosophy of Indian Mathematics does not seem to exist.
- ✦Mechanics-I syllabus and the prescribed book is a rehash of class 11-12 physics syllabus with no mention of the Lagrangian formulation and other stuff which suits a university course in mechanics, particularly to mathematics students.

✦The same applies to Mechanics-II. The inclusion of Victorian era books like S.L Loney's, to the exclusion of the newer ones like that of Douglas Gregory, is questionable judgement.

✦Under the mathematics for meditation, Geometry in Meditation by Mirabai Starr does not exist.

✦ In Mathematics for Sustainability, the book Sustainable Mathematics by Glenn Ledder does not exist and this book "Mathematical Modelling of Environmental Systems by various authors (2020)" appears to be AI generated.

✦In the mathematical psychology course, the last reference is a non-existent book by Karlin and Taylor (authors of well-regarded probability books). For the second reference, even the authors seem to have been willed into existence, we can find them or their book nowhere.

✦Pearson and S Chand is heavily represented amongst the publishers (even more than Springer, Birkhauser and Cambridge Uni Press), which should raise the brows above any eye that has read some mathematics.

✦The committee members' own books are often given as references, when there are clearly better books, even Indian publications (e.g., Calculus and Analytical geometry). Chauthaiwale appears in references 10-15 times!

The non-existent references indicate that parts of this draft we prepared using GPT or some AI tool. Some of the course content descriptions also feel that way upon reading. This is supposed to be a draft created by experts, how did such errors creep into it?

What should have been there instead

If one cuts out most of the ridiculous courses outlined above, the following core topics could be taught and learned well.

Real analysis (subsuming multivariable calculus) can be spread out over three semesters and learned thoroughly (as of now, they are seeing properties of real numbers in their third year, too late!).

Linear algebra (matrix theory) can be spread out over two semesters.

Algebra (Groups mainly, may be also a bit of rings and fields) can also be spread out over two semesters (and it can subsume the "Theory of equations")

It is perhaps not understood by the committee how the above three form the core of mathematics that one can and should learn at this level. A student who is well-versed in these topics will easily pass the JAM exam and qualify in any Indian institute for a masters program.

Of course, the undergraduate curriculum should have more courses, on discrete mathematics, probability and statistics, programming etc. Many courses should be kept in electives, and offered where they can (e.g., metric spaces, topology, complex analysis, stochastic processes, PDE etc). These latter courses would in fact be necessary if the four year UG makes a student eligible to apply for Ph.D.

All the objections raised here apply to students heading towards a masters degree. But according to new rules, it appears that after a four year UG, they are eligible to write NET exam and enter a Ph.D. program. In that case, all the problems get exacerbated manyfold. For example, the courses mentioned as electives above (topology, complex analysis, etc) and a few others will have to be mastered in the fourth year, both to pass the NET exam and to be able to do a Ph.D.

The preliminary courses (coordinate geometry and the SEC courses of the first semester) are important too, as it cannot be assumed that students who enter B.Sc. are necessarily comfortable with all that was taught in class XII. In fact I would say that the *Laboratory in mathematics, Write mathematics right, Mathematical reasoning and Mathematical editing in Latex* can all be made into required courses (one each in the first four semesters). As of now, it appears that students can take only one of the first three (how does writing of mathematics obviate the need for mathematical reasoning?).

Most importantly, a list of courses is not all. Mathematics is not a body of facts, but a nervous system connected by reasoning. Problem solving (by thinking, not regurgitating formulas) is the best way to learn mathematical reasoning, and should be emphasized in all courses.

Comparison with other UG programs

Mathematics is being taught at undergraduate level all over the world. To think that everyone has been doing it wrong and that this committee is the first one to get it right, is not a serious person's position. Therefore, it makes sense to compare this with the curriculum in other places, within and outside India.

Within India we have many undergraduate programs in ISI, CMI, IISERs and IISc, some IITs, all having curricula decided by working mathematicians who also teach at undergraduate and graduate level. Why is it that none of them thought that introducing one course every semester on "Indian mathematics"? Is it that they missed so obvious a chance to benefit their students, or is it more reasonable that there is no benefit to the student by such courses?

Stepping out of India, one can simply pull up UG curricula from many different countries. I checked curricula in institutes of South Korea, Iran, Greece and several others. None of them have even a single core course in history of mathematics. Again, either they are all misled, or perhaps the designers of the proposed curriculum are. Incidentally, the reason for the choice of Iran and Greece is that like India, they are ancient civilizations, take pride in their history, and particularly have stellar contributions to mathematics and Science. But still, they have found it to be beneficial for their students in mathematics to learn the subject matter as we know it today, not by choosing random pieces of mathematics whose only reason for choice is that they were discovered in a particular geographical region.

Conclusion

The current draft syllabus is tragically misguided. It must be abandoned in its entirety, and a new committee consisting of mathematicians with knowledge of the subject, together with experienced instructors at UG level, should be constituted. The insistence on Indian contributions must be limited to pointing out those contributions in the context where they arise naturally, together with a course or two on the history of Indian mathematics. As it stands, the curriculum brings no benefit to anyone, and will irreparably damage a generation of students aspiring to learn mathematics. It will also make Indian higher education a laughing stock of the world.