

A complementary pair that creates magic

Why it is necessary that a good engineer must also imbibe good mathematical skills.

» PERSPECTIVE

P.V. NAVANEETHAKRISHNAN

Stressing the relevance of mathematics to engineering/technology anymore will only be like carrying coals to Newcastle. The redundancy is adduced by the view that a good part of all engineering can be called applied mathematics (and, therefore, many areas of mathematics can be termed as theoretical engineering!). Even areas once considered 'pure' in mathematics have found applications in applied sciences and engineering. Use of Ramanujan's Sums $C_q(n)$ in signal processing and computer vision, application of his Graphs in coding theory and of theory of partitions and q-series in statistical analysis and many of number theory concepts in discrete mathematics, communication engineering and modern and mathematical physics are only a few examples.



MATHS BEHIND THE MARVEL | Radomes at the Misawa Air Base Misawa Security Operations Center, Japan.

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ious decline in students' basic mathematical skills and level of preparation on entry into higher education. Many students embark on engineering degree programmes without the necessary mathematics skills required for the course..." This quote is from the website of the Engineering Subject Centre, a national centre delivering support to learning and teaching in the U.K. higher education community. With respect to Tamil Nadu, we are riddled with a paradox: the 'best' students (many securing 200/200 marks in Mathematics paper in the State Board Class XII examination) of the state are the students of CEG, the 'prime' engineering college of the state; but percentage of complete passes in the first semester examinations touched as low as 25 per cent within the past few years, Mathematics being one major culprit. A clear and major reason is that the skill they earned in that subject up to Class XII was not mathematical, but related only to memory testing. Clear grasping of concepts and readiness to apply

engineering and modern and mathematical physics are only a few examples.

All knowledge is the result of quest for answers to problems and most problems in engineering are first to be modelled into mathematical ones. Subsequently, testing the formulated problem for solvability, modifying it, if necessary, into one in feasible form, with approximations or simplifications, and actually solving, which may require newer methods or extensions of known methods involving numerous numerical techniques, if closed form solutions are not available... are all in the domain of mathematics. Interpretation of the solution in the engineering context, of course, is the engineering job. Thus a good engineer must also imbibe a good mathematical skill. A difference is that while a mathematician may design theoretically a new equipment, like a component of a space craft, an engineer would create and test the equipment or its prototype. It is said that mathematicians 'write' proofs while engineers 'produce' proofs. Mathematics, according to Aristotle, is 'science of quantity' and, to 'ingeniare' (Latin for 'engineer') is to 'contrive, devise'. Thus the two

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complement each other.

For this reason only, in most of the engineering branches/specialisations, engineering mathematics courses are offered mandatorily in at least the first three semesters of UG classes and the first semester of PG classes. For some UG branches, some additional mathematics-based courses are also offered, like Discrete Mathematics for CSE, and Numerical Analysis, Operational Research and/or Reliability Theory as regular/elective subjects for mechanical engineering. In some universities, even for biology-based branches like biotechnology, bioinformatics and biomedical engineering, the subject of mathematics is a must in the qualifying HSC examination; and the mathematics papers for them in BE/BTech are also the same as for the other branches.

Interestingly, in some universities like Queen's University, Canada, the subject of 'Mathematical Engineering' is offered as a PG programme/specialisation for engineers. Queensland University of Technology, Brisbane, Aus-

tralia, offers a 'BE(Hons) / Bachelor of Mathematics' dual degree programme of five years' duration in which students can choose any engineering major like civil, computer and software systems, medical or process engineering and specialise in applied and computational mathematics, decision theory or statistical science.

The reasons quoted for such clubbing include the growing need for application of mathematics in engineering, scientific and industrial areas, like IT, management, and finance involving planning, designing, construction, manufacture, quality assessment and control. A seemingly sound engineering structure may fail because of a mathematical instability which was not detected earlier. Phenomena as diverse as chaos in

semiconductor lasers, patterns in traffic jams and weather and devastating catastrophes like floods, tsunamis and global warming are subjects of mathematics which could be fully exploited for the better functioning of the engineer and to the good of the mankind. No mathematics knowledge would be complete without a workable computer knowledge which in turn is a basic tool for an engineer. Accordingly, 'Engineering Mathematics is at the heart of Engineering.' But not everything seems to be all right with the mathematical preparedness of our students aspiring to be engineers. There are two types of inadequacies in this regard. The first is that of the student and the second is that of the teacher.

"The past decade has seen a ser-

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subject up to Class XII was not mathematical, but related only to memory testing. Clear grasping of concepts and readiness to apply them in slightly different contexts are lacking in many of them.

Further, aiming only at high scores, many would have omitted to study some crucial sections of the syllabus, like Integration and Differential Equations, which are important for engineers, and even the entire Class XI portion. Change in medium of instruction, higher pace of teaching and learning, diffused individual attention and the like may be some more reasons. Smart engineering ('ingenium' = cleverness) students should waste no time in identifying and rectifying such deficiencies in them.

The above article is based on a lecture, delivered by the writer at Anna University, Chennai, a few years ago, for senior Mathematics faculty. The writer was formerly professor of mathematics, College of Engineering, Guindy, also heading Entrance Examinations and Admission, Anna University, Chennai.

Next week: Some guidelines for Mathematics teachers