MATHEMATICS EDUCATION AND THE ENGINEERING STUDENTS

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1. PREAMBLE :

Mathematics is the mother of all sciences. Without Mathematics, we can not think of the existence of engineering sciences even. Therefor, our modern civilization which is entirely the outcome of science and technology has got a very close touch with mathematical education. Consequently, the concept of mathematical education is as old as the human society itself. It plays a vital role in furthering gross national growth, well being and prosperty. For national development, therefore, right type of mathematical education and its associated technology is of utmost importance, for the educational technology develops generations having enduring values of life in society; thereby, yielding peace and tranquillity amongst men and to instill amongst generations how to live to the right values of life and bring the entire generation to enjoy a greater quota of intellectual poise, mental stability, health, social happiness and national well-being. Hence, the most significant objective of mathematics seems to be that the student becomes familiar with mathematical thinking. He should learn the guiding principles and ideas behind the scenes which are more important than formal manipulations. He should get the impression that mathematics is not a collection of tricks and recipes but a systematic science of practical importance, resting on a relativity small number of basic concepts and involving powerful unifying methods. He should convince himself of the necessity for applying mathematical procedures to engineering problems, and he will find that the theory and its applications are related to each other like a tree and its fruit.

An engineering student will see that the application of mathematics to an engineering problem consists essentially of three phases :

i. Modelling :

Transformation of the given physical information into a mathematical from. In this way, we obtain a math-

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ematical model of the physical situation. This model may be a differential equation, a system of linear equations or some other mathematical expression.

ii. Solving :

Treatment of the model by mathematical methods. This will lead to the solution of the given problem in mathematical form.

iii. Interpreting :

Interpretation of the mathematical result in physical terms.

2. SCOPE :

When we throw a glance over the historical development of engineering mathematics, it is divulged that it has become more important to engineering sciences, and that this trend will also continue in the future. It has got wide application in soil mechanics, bio-mechanics, biology, biotechnology, soil engineering, agricultural engineering and in many other conventional branches of engineering (e.g. civil, chemical, mechanical, electrical, metallurgical, ceramic etc.). In soil, agricultural, petroleum and aeronautical engineering, the concepts of fluid-mechanics are applicable. Fluid mechanics is concerned with the behaviour of the fluids in motion and is based on the burning concepts of mathematical modelling and on sound footing of sophisticated mathematical techniques. It is one of the oldest branches of applied mathematics. It is also the branch in which some of the most significant advances have been made during the last six decades. These advances have been motivated by exciting developments in science and technology and have been facilitated by the developments of sophisticated mathematical techniques. With the emergence of plastics, alloys, polymers etc. the work of fluid-mechanics has become more challenging and complex, as these materials have abnormal physical properties and empirical approach of mathematical modelling is not possible, at all. The work becomes still more rigorous as soon as high speeds, large forces, high temperatures or other abnormal conditions are involved. In these cases, boundary layer concept of the fluid-mechanics renders a valuable service in mathematical modelling.

Magnetohydrodynamics (MHD) is a by-product of applied mathematics and has been developed because of the astrophysical phenomena arising out of the existence of large magnetic fields in some stars and possibilities of magnetohydrodynamics generators as a new source of energy.

Likewise engineering mathematics has got tremendous importance in computeronics. Boolean algebra developed by George Boole (1815-1864) is applied now-a-days to the design of digital circuits. It remained a branch of pure mathematics until 1938, when Claude Shannon applied it to switching circuits. This algebra is based on logical statements and hence is also known as symbolic logic. It is possible to make systematic manipulations of large number of statements together with their relationships into simpler statements with the help of symbolic logic. Consequently, Boolean algebra is of prime

importance in the digital computer circuits, for computer is mainly a logic machine performing large number of logical operations at very high speed. Through researches on Vedic-Mathematics, mathematicians have come to know that the 'sutras' (formulate) of seventeenth appendix of 'Athurvaveda' were much useful in the hardware technology of computers. With the help of the 'sutras', problems of addition, subtraction and division can be solved within tremor of minutes without any difficulty.

Long before, a programme was televised on human-computer 'Shakuntala Devi' in which she was showing the magic game of her calculatory power. At that time she was having a thick book in her hands. One of the audience was very much eager to know the name of the book. So he stood up and asked the name. Shakuntala Devi told him that it was 'Athurvaveda'. From this event, the idea of application of Vedic-Mathematics to computer hardware technology becomes more authentic, for she has an astonishing calculatory power to her credit and can do calculations within seconds irrespective of their size. Mathematicians guess that she has got full command over the 'surtas' of 'Athurvaveda'.

So far as mathematical techniques are concerned, the integral transforms (e.g. Laplacetransform, Z-transform, Fourier transform) are used in computer digital signal processing, network synthesis and in control systems. In computer graphics, theory of matrices is used to manipulate the shape and size of any object to be displayed on computer screen. The computer is an information processing machine, a tool for storing, manipulating, and correlating data. We are able to generate or collect and process information on a scale never before possible. This information can help us make decision, understand our world, and control its operation. But as the volume of the information increases, a problem arises. How can this information be efficiently and effectively be transferred between machine and human ? The machine can easily generate tables of numbers hundred pages long. But such a print-out is worthless if the human reader does not have the time to understand it. Computer graphics strikes directly at this problem. It is also a study of techniques to improve communication between human and machine. A graph may replace that huge table of numbers and allow the reader to note the relevant patterns at a glance. Computer graphics allows communication through pictures, charts and diagrams in a required fashion using the theory of multiplication of matrices.

What to talk of engineering sciences, engineering mathematics is now-a-days going to be employed in medical sciences also. By making mathematical modelling, the chances of the diseases like stenosis, glycoma, hypertension, diabetes, etc. being fearful and fetal can be predicted and their proper treatment can be done. The flow of blood in veins is very much similar to the flow of water through tubes of non-uniform cress-section and hence proper mathematical modelling can be done based on certain

physical conditions. By solving the model and by making appropriate interpretation of the results so obtained, several hygienic problems can be cured before hand they become decisive. Similarly, a theoretical moded can be developed to describe the movement of water and salt along the long extra-cellular channels which appear to be the common structural feature of all epithelial membranes being found in ciliary processes of the eye, the gall-bladder and renal tubule. Also, the transport of aquous-humor in the eyes and in the excited ciliary body can be studied and eye-diseases can be cured.

Similarly, statistics is a branch of applied mathematics which specializes in data. In modern times, statistics is viewed not as a mere device for collecting numerical data but as a means of developing sound techniques for their handling, analysis and drawing valid inferences from them. As such it is not confined to the affairs of the state but is intruding constantly into various diversified spheres of life-social, economic, political. It is now finding applications in almost all the sciences-social as well as physical such as biology, psycology, education, economics, business management, etc. The association between statistical methods and biological theories was first studied by Francis Galton. According to Prof. Karl Person, the whole theory of heredity rests on statistical basis. In astronomy, the theory of Gaussian 'Normal Law of Errors' for the study of the movement of the stars and planets is developed by using the 'principle of least squares'. In medical science also, the statistical tools for the collection, presentation, analyses of observed facts related to the causes and incidence of diseases and results obtained from the use of various drugs and medicines are of great importance. Moreover, the efficiency of the manufactured drug or injection medicine is tested by using the tests of significance called T-test.

3. STUDENTS AND THE MATHEMATICS :

Actually, most of the engineering students are not acquainted with the baffling significance of the engineering mathematics in the field of modern science and technology. There is no branch of modern science and technology where mathematics is not used. With the development of sophisticated computer technology, the application of applied mathematics has risen to greater heights. In space-science, where there is consideration of very high temperature, velocity, pressure, force, etc. mathematical modelling yields generally non-linear differential equations, the analytical solutions of which are not possible at all. At that time, numerical methods are used to find their approximate solutions. Using graphics, curves can be plotted and physical interpretation of results so obtained can be done. Thus, applied mathematics paves the way for innovations in the field of science and technology which can be utilized for the emancipation of human-being. But engineering students generally take it for granted and study is only to get pass-mark. They do not aim at intensive study. As a result, perfection of the students in math-

ematics is meagre and far from satisfaction. Though it is capable of facing their growing demands, they are very completely unaware of these facts. Even they are very weak at fundamentals of mathematics like differentiation and integration. Because of this reason, they can not produce the steps of any problem the solution of which is mainly based on a mathematical technique. Although they understand the tactics involved in the solution of a particular problem, they can not employ that tactics because of the basic difficulties arising due to differentiation and integration of certain expressions. That is why, they are unable to solve the complete problem in the examination resulting in mass failures. Also, this poor fundamentalism gives rise to lack of interest in the subject. They come to the class only for the sake of attendance. They are physically present in the class, mentally they are some where else. They take it as a burden.

To remove this disparity, a student must try to become diligent and studious so as to have a conceptual knowledge of all the fundamentals, that is, a conceptual knowledge of all the courses of mathematics that he has studied upto his twelfth standard. Once the fundamentals are clear to him, he will be able to understand the problem completely in the class only and will be able to produce the steps involved in the solution. He will be full of confidence and an interest in mathematics will be created automatically.

The second reason of poor performance of the students in mathematics is lack of practice. There is an old saying that Practice makes a man Perfect. This saying is true to mathematics to a large extent. Practice brings what is called "mathematical intitution". This mathematical intitution suggests a trick to tackle any particular problem. For instance, when we study the topics of gamma and beta functions, we take certain substitutions so as to change the integrals to mathematical tactable forms. These mathematically tactable forms generally resemble the integrals giving the mathematical definitions of gamma and beta functions, so as to apply direct formulae to evaluate them. Students generally enquire of the rules and regulations behind these substitutions. So, at this juncture, we wish to tell them that there is not any hard and fast rule behind these substitutions. It is the mathematical common sense which suggests the appropriate substitutions depending on the nature of the integrates (expressions to be integrated).

So, to develop mathematical intuition, a regular study habit is required, so that a student can make full practice of mathematical problems. Just by craming the problems, they can not secure good marks in the examination. If any numerical problem has been done in the class by his teacher, he should try at least two problems of the same type on his own as a home work.

This will creat confidence in his mind and at the same time his mathematical calibre will be increased.

Third reason for their poor performance is the problem of backlogs. This is the major factor affecting the results of

mathematics in higher classes e.g. S.E.,T.E. . Once a student has taken backlog in Engineering Mathematics - I (EM-I), he can not think of Engineering Mathematics - II (EM-II). He goes to class of EM-II only for the sake of attendance. Even if the concerned teacher teaches methodologically in the class, he does not care for that. At last, he appears at the examination of EM-II only to collect the question paper, thereby, diminishing the percentage of the result of EM-II.

To get rid of this 'Virus-infection' the rules of ATKT (allowed to keep terms) must be abolished. This system permits the students to go to higher classes even with backlogs.

4. STEPS TAKEN TO IMPROVE RESULTS :

To improve the results of mathematics, the institute should adopt the following remedial steps :

(I) Preparation of Manuals :

Besides the regular text books, students should be provided manuals also. These manuals will provide hints to students to solve typical questions related to the subject matter. These manuals will give a comprehensive and systematic introduction to all those topics which are required by them. All the essential ideas of the subject should be explained with greater clarity. Each topic should follow important unsolved problems. In case of difficulties, students should contact the concerned teachers.

(II) Extra Coaching Classes :

To help the academically needy and the mediocre students, extra classes may be arranged in mathematics. These classes should be made compulsory for all those first year students whose performance in monthly tests were miserable. These extra classes should be different from regular classes in the sense that here the teacher will brushup only those topics which are important from university examination view points.

(III) Tutorial Classes :

One hour more than prescribed in the course structure should be provided in the time-table for tutorial classes in mathematics. In the tutorial classes, at least three teachers should be deputed to go to a class. Some important problems related to the topics that have been taught earlier should be written on the black board and students be asked to solve them. Teachers will be there to help and supervise the students.

(IV) Monthly Examinations :

To assess the ability and to creat confidence into the minds of the students, regular monthly tests should be conducted. Questions must be set on the university pattern. After examination the checked copies should be shown to the students in the class and proper suggestions should be given to them by the concerned teachers to remove their short -comings. Then tests should be made compulsory for all the students.

5. CONCLUSION :

Thus, we jump to the essence that the study of mathematics is a real boost to take the humanity to the realm of life full of happiness. It is the backbone of all the social and physical sciences. But it

does not mean that it is perfect, for every concept in mathematics is based on certain assumptions.

So to remove these assumptions we are required to take another assumption and there comes a new picture of mathematics called meta-mathematics. Even this meta-mathematics is full of assumptions for the removal of which another mathematics called meta-meta-mathematics is required. This trend continues forever. Thus it is a science of metamorphoses useful for the growing demands of the scientists and engineers to a great extent.

May God bless it with mathematicians with innovative bent of minds.

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