



**Knowledge Network of
Indian Institute of Technology, Gandhinagar
Under TEQIP-II Initiative**

**Short Course on
Teaching Methodologies for Engineering Mathematics**

Date: 15/02/2017 to 17/02/2017 (3-days)
Time: 10:00 am reporting time on 15 Feb 2017
Venue: IIT Gandhinagar, Palaj Campus
Target group: Faculty members, PG & Senior UG Students
Register At: www.iitgn.ac.in/kn
Dead line: 10th February 2017

This Workshop aims to discuss and create teaching methodologies for mathematics courses meant for undergraduate engineering students. We would like to suggest some methodology which has essentially three features: (i) focus on tricks of the trade, (ii) use the main theorems as tools; (iii) no compromise on rigour. Perhaps, it is a good time to do some experiments on this methodology and see if it turns out to be more fruitful for an undergraduate engineering student who is struggling to appreciate the abstractions of a mathematical theory.

There will be an attempt to draw some broad outlines of the syllabus. We divide the whole content into six broad modules along with a module on Riddles and Puzzles. Some sessions with mathematical puzzles would show how mathematics connects with the real world in lay man's terms. The listing of topics under each module can be seen as those which are pivotal from the view point of applications. This listing should not be misunderstood as a complete listing of all the important and/or interesting topics. We will take an approach where we will only discuss some illustrative exercises under each topic with very little detailing on the general frame work. The necessary mathematical detailing can be given to a student who shows interest in mastering the methods.

Module 1: Analysis (3 hours)

Calculus of one variable: Mean value theorems; Taylor's theorem; Extrema problems in one variable;; Differentiation under the sign of integration.

Calculus of several variables: Jacobian matrix and total derivative; Extrema for functions of several variables; Lagrange's method of multipliers; Integrations along curves and surfaces.

Integration: Integration by parts; Trigonometric integrals; Trigonometric substitution; Integration of rational functions by partial fractions; Strategy of integration; Improper integrals.

Complex Analytic Methods: Residues and Integration of real-valued rational functions by means of contour integration.

Module 2: Numerical Techniques (2hours)

Interpolation; Numerical Integration; System of Linear Equations; LU factorization; Cholesky Decomposition; Bisection, secant and Newton methods for solving nonlinear equation; Euler, Runge-Kutta methods for DE

Module 3: Linear Algebra (3 hours)

Gaussian elimination; Linear independence & dependence of vectors in \mathbf{R}^n and \mathbf{C}^n ; Basis; Eigen values and Eigen vectors; Similarity of matrices; Basis change matrix; Diagonalization of matrices.

Module 4: Ordinary Differential Equations (3 hours)

Exact equations; Integrating Factors; Independence; Wronskian; Abel-Liouville Formula; Linear ODE with constant coefficients; Method of undetermined coefficients; variation of parameters; Laplacetransformations; Fourier transformations; Legendre; Bessel and other special functions; Surm-Liouville.

Module 5: Partial Differential Equations (3 hours)

The three equations; First Order PDE; Classification of Second Order Equations; Variable Separable method; Fourier Series.

Module 6: Probability & Statistics (3 hours)

Basic Probability: Random experiments, events, probability, conditional probability, independence, Bayes' theorem.

Random Variables: Discrete and continuous random variables; examples; distribution functions; probability mass functions (p.m.f.); probability density functions (p.d.f.); expectation; moments of random variables.

Multiple random variables: Joint and marginal distributions of several random variables; joint and marginal p.m.f. and p.d.f.; conditional distributions.

Asymptotics: Laws of large numbers; central limit theorem.

Statistics: Maximum likelihood parameter estimation; confidence intervals; hypothesis testing; goodness of fit.

Module 7: Riddles and Puzzles in Mathematics (3 hours)

Some interesting mathematical puzzles.

Course Coordinator - Prof. Indranath Sengupta (IIT Gandhinagar)