Department of Mathematics and Statistics,
Indian Institute of Technology, Kanpur
MTH 101, 2007-2008 Semester I

Instructors :
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Text : G.B. Thomas & R.L. Finney, Calculus and Analytic Geometry.

Reference : T.M. Apostol, Calculus, Vol. I and Vol. II.

Course web site : http://www.iitk.ac.in/mth101

Supplementary Material:

Several copies of the text book (VI - IX editions) have been kept on reserve in the Central Library. As a supplement to the material in the text, we provide four handouts covering the topics : (i) Real number system (ii) Continuous function on a closed and bounded interval (iii) Riemann integral (iv) Functions of several variables. Handouts and detailed notes of some other topics are available on the course web site. Practice problems for some topics with hints/solutions are also available on the course web site.

Course Plan

Lecture 1: Real number system : Completeness axiom, density of rationals (irrationals) in $\mathbb{R}$.

Lecture 2: (8.1,8.2 [1]) Convergence of a sequence, Sandwich theorem, Monotone sequences.

Lecture 3: (8.1) Cauchy criterion, Subsequence, Every bounded sequence has a convergent subsequence, convergence of a sequence satisfying Cauchy criterion.

Lecture 4: (1.1-1.5) Limits and Continuity of functions, Boundedness of a continuous function on [a,b].

Lecture 5: (3.1,1.5,2.1) Existence of max of a continuous function on [a,b], Intermediate value property, Differentiability.

Lecture 6: (3.1-3.3) Necessary condition for local maxima, Rolles theorem and Mean value theorem.

Lecture 7: (3.2,3.4) L'Hospital rule, Sufficient conditions for increasing and decreasing functions, convexity.

Lecture 8: (3.4,3.5) Convexity, Point of inflection, Second derivative test for max and min, Curve sketching.

[1] Section from IX th edition of the text book.

Lecture 9 (3.1-3.4,8.10) Curve sketching (contd.), Taylor's theorem with remainder.

Lecture 10: (8.3) Convergence of series, Geometric and Harmonic series, Absolute convergence.

Lecture 11: (8.5) Comparison test, Cauchy condensation test : $\sum a_n$ conv. $\Leftrightarrow \sum 2^k a_{2^k}$ conv. for $a_n \geq 0$ and $a_{n+1} \leq a_n$. Examples: $\sum \frac{1}{n^p}, \sum \frac{1}{n(logn)^p}$.

Lecture 12: (8.6) Ratio test, Root test, Examples, Leibniz's theorem.

Lecture 13: (8.8-8.10) Power series, Radius of convergence, Taylor series, Maclaurin series.

I Mid Semester Examination : Aug. 30-Sept. 01 , 2007

Lecture 14: (4.5) Introduction to Riemann integration, Integrability.

Lecture 15: (4.5, 4.7) The integral existence theorem for continuous functions and monotone functions,

Lecture 16: (4.5, 4.7) Elementary properties of integral, Fundamental theorems of calculus.

Lecture 17: (4.7) Fundamental Theorems of calculus (contd.)

Lecture 18: (7.6) Improper integral of first & second kind, Comparison test, Absolute convergence.

Lecture 19: (5.1,9.6,9.7) Applications of definite integral: Area between two curves, Polar coordinates, Graphs of polar coordinates.

Lecture 20: (9.9,5.2) Area between two curves when their equations are given in polar coordinates, Volumes by slicing.

Lecture 21: (5.3-5.5) Volumes by Shells and Washers, Length of the curve.

Lecture 22: (5.6, 5.10) Area of surface of revolution, Pappus's Theorem.

Lecture 23: (10.1-10.5) Review of vector algebra, Equations of lines and planes.

Lecture 24: (11.1,11.3) Continuity and Differentiability of vector functions, Arc length for space curves, Unit tangent vector.

Lecture 25: (11.3-11.4) Unit normal and Curvature to plane and space curves, Binormal.

Lecture 26: (12.1-12.3) Functions of several variables, Continuity, Partial derivatives, differentiability.

Lecture 27: (12.4,12.5) Differentiability $\Rightarrow$ Continuity, Chain rule.

Lecture 28: (12.7) Gradient, Directional derivatives, Tangent plane and Normal line.

II Mid-Semester Examination : Oct. 08 - 10, 2007

Lecture 29: (12.10) Mixed derivative theorem, Mean value theorem (MVT), Extended MVT, Hessian.

Lecture 30: (12.8,12.10) Necessary and sufficient conditions for Maxima, Minima and Saddle point.

Lecture 31: (12.9) The method of Lagrange multipliers.

Lecture 32: (13.1,13.2) Double integral, Fubini's theorem, Volumes and Areas.

Lecture 33: (13.3,13.4) Change of variable in a double integral, special case: Polar coordinates, Triple integral, Applications.

Lecture 34: (13.6,14.5) Change of variables in a triple integral, Special cases : Cylindrical and Spherical coordinates, Surface area.

Lecture 35: (14.5,14.1) Surface area (contd.), Surface integrals, Line integrals.

Lecture 36: (14.4) Green's Theorem.

Lecture 37: (14.2) Vector fields, Divergence and Curl of a vector field.

Lecture 38: (14.7) Stoke's Theorem.

Lecture 39: (14.8) The divergence theorem.

End Semester Examination : Nov. 19 - Nov. 28, 2007
