Department of Mathematics and Statistics,
Indian Institute of Technology Kanpur
MTH 111M, 2023-2024, I Semester

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Text : Thomas' Calculus.

Course web site : http://home.iitk.ac.in/∼ psraj/mth111

Course materials: Lecture-wise notes of all the lectures, assignments, practice problems with hints/solutions, course plan and necessary information will be available on this course web site.

Some proofs/remarks/examples in the lecture notes and some problems in the practice problems are marked (*). These have been provided to increase your understanding of the subject. However, these will not be asked in the exam and quiz.

Tutorial and discussion hours: Each student will be allotted a tutorial section. Each tutorial section will be assigned a tutor. There will be a tutorial hour and a discussion hour in each week. The tutor will conduct the tutorial and the discussion hour. The problems listed in the assignment sheets will be discussed during tutorial hours. The practice problems available on the course web site are usually not discussed in the tutorial classes; however, the students can discuss these problems with the tutors during discussion hours if they need help. The students can also discuss with the tutors during the discussion hours if they have any questions/doubts in the materials covered in the lectures.

Weightage for the exams and the quizzes : There will be one quiz of 40 minutes duration with a maximum score of 30. The date for this quiz will be announced in class. The final examination for this course will be of 2 hours duration and have a maximum score of 90.

Course Plan

Lecture 1: (A.1, A.6 [1]) Real number system : Completeness axiom, density of rationals (irrationals) in $\mathbb{R}$.

Lecture 2: (10.1 [2]) Convergence of a sequence, Sandwich theorem, Monotone sequences.

[1] Appendix from 13th edition of the text book.
[2] Section from 13th edition of the text book.

Lecture 3: (10.1) Monotone and Cauchy criteria, subsequences.

Lecture 4: Subsequences, Every bounded sequence has a convergent subsequence, convergence of a sequence satisfying Cauchy criterion.

Lecture 5: (2.1-2.6) Continuous functions, Boundedness of a continuous function on [a,b].

Lecture 6: (4.1,3.1) Existence of maximum of a continuous function on [a,b], Intermediate value property, Differentiability.

Lecture 7: (4.1-4.3) Necessary condition for local maxima, Rolle's theorem and Mean value theorem.

Lecture 8: Cauchy mean value theorem, L'Hospital rule.

Lecture 9: (4.4) Increasing and decreasing functions, Convexity, Second derivative test for max and min, Point of inflection, curve sketching.

Lecture 10 (4.4) Curve sketching (contd.), Taylor's theorem with remainder.

Lecture 8: (4.6) Fixed point iteration method (Picard's method), Newton's method.

Lecture 12: (10.2) Convergence of series, Geometric and Harmonic series, Absolute convergence.

Lecture 13: (10.4) 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 14: (10.5) Ratio test, Root test, Examples, Leibniz's theorem.

Lecture 15: (10.7,10.8) Power series, Radius of convergence, Taylor series, Maclaurin series.

Lecture 16: (5.3) Introduction to Riemann integration, Integrability.

Lecture 17: (5.3) The integral existence theorem for continuous functions and monotone functions, Elementary properties of integral.

Lecture 18: (5.4) Fundamental Theorems of calculus, Riemann Sum.

Lecture 19: (8.8) Improper integral of first & second kind, Comparison test, Absolute convergence.