

Math 174 Numerical Methods in Science and Engineering Fall 2003

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Office: 5763 Applied Physics & Mathematics Building (APM)
Office Hours: MW 2:00p-2:50p, or by appointment
Meeting Times: MWF 3:00p-3:50p
Room: 1315 Humanities and Social Sciences Building (HSS)
Textbook: Numerical Mathematics and Computing, fourth edition, Cheney and Kincaid (isbn:0-534-35184-0)
Prerequisites: Math 21D and 20F
Course Webpage: <http://scicomp.ucsd.edu/~spav/class/2003F-M174/>
Final Exam: Tuesday December 9, 3:00p-6:00p
Note: Discussion Session meets Fridays in 2112 Warren Lecture Hall (WLH).

Catalog Description. *174. Numerical Methods in Science and Engineering (4)* Floating point arithmetic, linear equations, interpolation, integration, differential equations, nonlinear equations, optimization, least squares. Students may not receive credit for both Math. 174 and Physics 105 or MAE 153 or 154. Students may not receive credit for Math. 174 if Math. 170 A,B, or C has already been taken. *Prerequisites: Math. 21D (2DA) and Math. 20F (2EA).*

Course Description. This course serves as an introduction to applied numerical mathematics. Numerical analysis, roughly speaking, is concerned with finding approximate numerical solutions to problems for which we lack sufficient data or have no analytic solution: for example, we will explore methods of finding approximate roots of functions for which we have no closed form solution; we will examine algorithms which approximate the integral of a “black box” function; we will use iterative solvers to find the approximate solutions to linear systems; we will use the method of least squares to find the “best” function to approximate a set of data points.

Grading Policy. Grading will be based upon performance in seven quizzes, two single hour exams and a comprehensive final. The final quarter grade is subdivided as follows: Quizzes: 21%; Exams: 21% each; Final: 37%. Quizzes will be administered in the discussion section¹; the material on the quizzes will be similar to that of the assigned homeworks. Homework will be assigned weekly but *not* collected. Students are encouraged to work together on homeworks (but prohibited from doing so on quizzes and exams). Homework will be assigned at least one week in advance of the quizzes, and will be posted on the course web page as well as announced in class.

Grade cutoffs are projected to be as follows: B+/A- cutoff: 90; C+/B-: 80; D/C-: 70; F/D: 60. Grade cutoffs may drift downwards but *not* upwards at quarter’s end, so that, for example, a grade of 89 will be no worse than a B-, but might be higher (and likely would be), while a grade of 90 will not be anything less than an A-.

Students are expected to adhere to the University’s policy on academic integrity.

Course Webpage. The course webpage, (<http://scicomp.ucsd.edu/~spav/class/2003F-M174/>) will include homework postings as well as distilled versions of the daily lectures.

¹Exception: the seventh quiz will be administered in class.

Course Schedule. The following course schedule is approximate.

week 0	F Sep 26	Syllabus, §1.2
	F Sep 26 disc	no meeting
week 1	M Sep 29	§1.2, 2.3
	W Oct 01	§3.1
	F Oct 03	§3.2
	F Oct 03 disc	quiz 1 , covering §1.2, 2.3, 3.1
week 2	M Oct 06	§3.3
	W Oct 08	§4.1
	F Oct 10	§4.2
	F Oct 10 disc	quiz 2 , covering §3.2, 3.3, 4.1
week 3	M Oct 13	§4.2,4.3
	W Oct 15	§4.3
	F Oct 17	§5.1
	F Oct 17 disc	review for exam 1. no quiz.
week 4	M Oct 20	exam 1, covering §1.2, 2.3, 3.1–3.3, 4.1–4.3
	W Oct 22	§5.2
	F Oct 24	§5.2,5.3
	F Oct 24 disc	quiz 3 , covering §5.1, 5.2
week 5	M Oct 27	§5.3,5.4
	W Oct 29	§5.4,5.5
	F Oct 31	§5.5
	F Oct 31 disc	quiz 4 , covering §5.3–5.5
week 6	M Nov 03	§6.1
	W Nov 05	§6.2
	F Nov 07	§6.2,6.4
	F Nov 07 disc	quiz 5 , covering §6.1, 6.2
week 7	M Nov 10	§6.4,6.5
	W Nov 12	§6.5
	F Nov 14	§7.1
	F Nov 14 disc	review for exam 2. no quiz.
week 8	M Nov 17	exam 2, covering §5.1–5.5, 6.1, 6.2, 6.4, 6.5
	W Nov 19	§7.2
	F Nov 21	§8.1
	F Nov 21 disc	quiz 6 , covering §7.1, 7.2
week 9	M Nov 24	§8.2
	W Nov 26	§9.1
	F Nov 28	Thanksgiving Holiday; no class
	F Nov 28 disc	Thanksgiving Holiday; no discussion
week 10	M Dec 01	§10.1
	W Dec 03	§10.2; quiz 7 covering §8.1, 8.2, 9.1, 10.1 \leftarrow note: quiz in class
	F Dec 05	§10.2, Review for Final Exam; Last class
	F Dec 05 disc	Review for Final Exam; Last Discussion
finals	T Dec 09	Final Exam. 3:00p-6:00p

Sample Exam Questions. What follows are a number of questions which might appear on the midterm exams or final exam. If you can easily answer them at start of semester, you may not need to take this class;

1. State Taylor's theorem.
2. Find a way of computing $\sqrt{x^4 + 4} - 2$ for x near 0 without incurring subtraction error.
3. Use Newton's method to demonstrate an algorithm which can solve $x = 1/R$, for a given R , *without using division*.
4. Find the polynomial of least degree that interpolates the following data:

x	1	2	3	7
y	2	1	12	146

5. Determine the error term of the approximation:

$$f''(x) \approx \frac{1}{h^2} [f(x-h) - 2f(x) + f(x+h)]$$

6. A function, $f(x)$ is said to be *convex* if its graph lies beneath every chord drawn between two points of a graph; for example x^2 is convex. What is the relationship between $\int_a^b f(x)dx$ and the three approximations: Left-hand, Right-hand, and Trapezoid, for convex $f(x)$?
7. Determine values of α, β, γ such that the quadrature rule

$$\int_{-1}^1 f(x)dx \approx \alpha f(-0.5) + \beta f(0) + \gamma f(0.5)$$

is exact for all polynomial $f(x)$ of degree ≤ 2 .

8. Use naïve Gaussian elimination to solve the linear system:

$$\begin{aligned} 2x + 4y - 2z &= 2 \\ 4x + 9y - 3z &= 8 \\ -2x - 3y + 7z &= 10 \end{aligned}$$

9. Determine the natural cubic spline interpolating the function $f(x) = x^6$ over the interval $[0, 2]$ using knots 0, 1, 2.
10. Find the parabola $f(x) = ax^2 + b$ that best represents (in the Least-Squares sense) the following data

x	-1	0	1
y	3.1	0.9	2.9