

Mathematics 240—Syllabus and Core Problems

Course Description

Math 240. Calculus, Part III. Staff. Prerequisite(s): Calculus II.

Linear algebra: vectors, matrices, systems of linear equations, eigenvalues and eigenvectors. Vector calculus: functions of several variables, vector fields, line and surface integrals, Green's, Stokes' and divergence theorems. Series solutions of ordinary differential equations, Laplace transforms and systems of ordinary differential equations. Use of symbolic manipulation and graphics software.

Text: Zill, Dennis and Cullen, Michael *Advanced Engineering Mathematics, 3rd Edition*
©2006, Jones and Bartlett, Publishers

Linear Algebra and Vector Calculus

Core Problems (M)=Maple

Chapter 8: Matrices

8.1	Matrix Algebra 348	3, 12, 13, 15, 18, 23, 28, 33, 36
8.2	Systems of Linear Algebraic Equations 357	5, 7, 9(M), 21(M)
8.3	Rank of a Matrix 368	1, 5, 9, 13, 17
8.4	Determinants 373	3, 7, 21, 29
8.5	Properties of Determinants 378	4, 7, 12, 15, 21, 31, 33, 35, 39
8.6	Inverse of a Matrix 385	1, 5, 9, 11, 21, 25(M), 27, 49, 51
	8.6.1 Finding the Inverse 385	
	8.6.2 Using the Inverse to Solve Systems 391	
8.7	Cramer's Rule 395	1, 9, 11
8.8	The Eigenvalue Problem 398	1, 7, 15, 21, 27(M)
8.9	Powers of Matrices 404	3, 9, 13
8.10	Orthogonal Matrices 408	1, 7, 15, 19
8.12	Diagonalization 422	5, 15, 19(M), 25, 37
8.15	Method of Least Squares 440	3, 5, 7
8.16	Discrete Compartmental Models 443 (optional)	1, 6(M)

Chapter 9 Vector Calculus

9.1	Vector Functions 452	3(M), 7(M), 13, 15, 17, 23(M), 25, 29, 33, 39
9.7	Divergence and Curl 483	1(M), 9, 13, 27, 33, 39
9.8	Line Integrals 489	3, 5, 9, 15, 19, 25, 33
9.9	Independence of Path 498	3, 13, 17, 23, 27
9.10	Double Integrals 505	9, 11, 17, 23, 37, 45
9.11	Double Integrals in Polar Coordinates 514	3, 5, 9, 10, 13, 27, 31
9.12	Green's Theorem 519	1, 3, 9, 13, 15, 18, 23, 25
9.13	Surface Integrals 524	1,, 5, 11, 19, 27, 33, 37
9.14	Stokes' Theorem 533	1, 3, 5, 11, 15, 17
9.15	Triple Integrals 539	1, 5, 11, 17, 21, 53, 77
9.16	Divergence Theorem 550	3, 7, 11, 15, 17
9.17	Change of Variables in Multiple Integrals 556	1, 3, 5, 11, 17, 25

Ordinary Differential Equations

Chapter 2 First-Order Differential Equations

- 2.1 Solution Curves Without a Solution 36
 - 2.1.1 Direction Fields 36
 - 2.1.2 Autonomous First-Order DEs 38
- 2.5 Solutions by Substitutions 67

Core Problems (M)=Maple

- 1, 5(M), 11(M), 19, 39
- 5, 10, 13, 19, 25, 33

Chapter 3 Higher-Order Differential Equations

- 3.6 Cauchy-Euler Equation 140
- 3.7 Nonlinear Equations 145
- 3.8 Linear Models: Initial-Value Problems 150
 - 3.8.1 Spring/Mass Systems: Free Undamped Motion 150
 - 3.8.2 Spring/Mass Systems: Free Damped Motion 153
 - 3.8.3 Spring/Mass Systems: Driven Motion 156
 - 3.8.4 Series Circuit Analogue 159
- 3.9 Linear Models: Boundary-Value Problems 166
- 3.10 Nonlinear Models 174
- 3.11 Solving Systems of Linear Equations 183

- 1, 9, 11, 15, 27
- 1, 5, 13, 17
- 3, 7, 17, 25, 31, 43(M)
- 3(M), 9, 15, 22, 27
- 3, 9, 13
- 1, 7, 19

Chapter 4 The Laplace Transform

- 4.1 Definition of the Laplace Transform 194
- 4.2 The Inverse Transform and Transforms of Derivatives 199
 - 4.2.1 Inverse Transforms 199
 - 4.2.2 Transforms of Derivatives 201
- 4.3 Translation Theorems 207
 - 4.3.1 Translation on the s-axis 207
 - 4.3.2 Translation on the t-axis 210
- 4.4 Additional Operational Properties 218
 - 4.4.1 Derivatives of Transforms 218
 - 4.4.2 Transforms of Integrals 220
 - 4.4.3 Transform of a Periodic Function 223
- 4.5 The Dirac Delta Function 228
- 4.6 Systems of Linear Differential Equations 231

- 1, 7, 15, 19, 25, 31, 37
- 5, 11, 17, 23, 33, 39
- 5, 9, 11, 15, 23, 27, 43, 47, 55, 63, 75(M)
- 5, 11, 15, 23, 31, 41, 49, 55
- 5, 7, 11
- 5, 9, 15

Chapter 5 Series Solutions of Linear Differential Equations

- 5.1 Solutions about Ordinary Points 240
 - 5.1.1 Review of Power Series 240
 - 5.1.2 Power Series Solutions 242
- 5.2 Solutions about Singular Points 251
- 5.3 Special Functions 260
 - Functions 260
 - 5.3.2 Legendre Functions 267

- 3, 9, 11, 15, 21, 31
- 5, 11, 15, 21, 27, 33
- 1, 5, 9, 11, 15, 18, 25, 33, 44, 5.3.1 Bessel

46, 47(M)

Core Problems (M)=Maple

Chapter 10 Systems of Linear Differential Equations

10.1 Preliminary Theory	569	5, 7, 13, 19, 25
10.2 Homogeneous Linear Systems	576	5, 11, 16(M), 21
10.2.1 Distinct Real Eigenvalues	577	
10.2.2 Repeated Eigenvalues	580	
10.2.3 Complex Eigenvalues	584	
10.3 Solution by Diagonalization	589	1, 5, 10
10.4 Nonhomogeneous Linear Systems	592	3, 17, 21, 31, 37
10.4.1 Undetermined Coefficients	592	
10.4.2 Variation of Parameters	595	
10.4.3 Diagonalization	597	

NOTE: The following sections review topics covered in earlier courses (Math 104 & 114) and it will be assumed students are familiar with the material in these sections. Students are encouraged to review this material as needed. Instructors may review selected topics at their discretion.

Chapter 1: Introduction to Differential Equations

1.1 Definitions and Terminology	5
1.2 Initial-Value Problems	14
1.3 Differential Equations as Mathematical Models	21

Chapter 2: First-Order Differential Equations

2.2 Separable Variables	45
2.3 Linear Equations	52
2.4 Exact Equations	60

Chapter 3: Higher-Order Differential Equations 104

3.1 Preliminary Theory: Linear Equations	105
3.1.1 Initial-Value and Boundary-Value Problems	105
3.1.2 Homogeneous Equations	107
3.1.3 Nonhomogeneous Equations	112
3.2 Reduction of Order	116
3.3 Homogeneous Linear Equations with Constant Coefficients	119
3.4 Undetermined Coefficients	126
3.5 Variation of Parameters	135

Chapter 7: Vector Calculus

7.1 Vectors in 2-Space	301
7.2 Vectors in 3-Space	307
7.3 Dot Product	312
7.4 Cross Product	319
7.5 Lines and Planes in 3-Space	324

Chapter 9: Vectors 451

9.2 Motion on a Curve	458
9.3 Curvature and Components of Acceleration	463
9.4 Partial Derivatives	467
9.5 Directional Derivatives	474
9.6 Tangent Planes and Normal Lines	480