



An Introduction to SAS® Certification Guide: Advanced Programming for SAS®9, Fourth Edition. Full book available for purchase [here](#).

Contents

<i>About This Book</i>	<i>xiii</i>
PART 1 SQL Processing with SAS	1
Chapter 1 • Performing Queries Using PROC SQL	3
Overview	4
PROC SQL Basics	4
Writing a PROC SQL Step	6
Selecting Columns	8
Specifying the Table	10
Specifying Subsetting Criteria	11
Ordering Rows	11
Querying Multiple Tables	13
Summarizing Groups of Data	17
Creating Output Tables	19
Additional Features	20
Summary	20
Quiz	22
Chapter 2 • Performing Advanced Queries Using PROC SQL	25
Overview	26
Viewing SELECT Statement Syntax	27
Displaying All Columns	28
Limiting the Number of Rows Displayed	29
Eliminating Duplicate Rows from Output	31
Subsetting Rows By Using Conditional Operators	32
Subsetting Rows By Using Calculated Values	40
Enhancing Query Output	42
Summarizing and Grouping Data	48
Subsetting Data By Using Subqueries	61
Subsetting Data By Using Noncorrelated Subqueries	63
Subsetting Data By Using Correlated Subqueries	69
Validating Query Syntax	71
Additional Features	72
Summary	73
Quiz	76
Chapter 3 • Combining Tables Horizontally Using PROC SQL	81
Overview	82
Understanding Joins	82
Generating a Cartesian Product	83
Using Inner Joins	85
Using Outer Joins	93
Creating an Inner Join with Outer Join-Style Syntax	100
Comparing SQL Joins and DATA Step Match-Merges	100
Using In-Line Views	105
Joining Multiple Tables and Views	109

Summary	116
Quiz	118
Chapter 4 • Combining Tables Vertically Using PROC SQL	125
Overview	126
Understanding Set Operations	127
Using the EXCEPT Set Operator	132
Using the INTERSECT Set Operator	139
Using the UNION Set Operator	144
Using the OUTER UNION Set Operator	151
Comparing Outer Unions and Other SAS Techniques	156
Summary	157
Quiz	159
Chapter 5 • Creating and Managing Tables Using PROC SQL	165
Overview	167
Understanding Methods of Creating Tables	168
Creating an Empty Table By Defining Columns	168
Displaying the Structure of a Table	173
Creating an Empty Table That Is like Another Table	174
Creating a Table from a Query Result	177
Inserting Rows of Data into a Table	180
Creating a Table That Has Integrity Constraints	187
Handling Errors in Row Insertions	193
Displaying Integrity Constraints for a Table	197
Updating Values in Existing Table Rows	198
Deleting Rows in a Table	207
Altering Columns in a Table	209
Dropping Tables	216
Summary	216
Quiz	221
Chapter 6 • Creating and Managing Indexes Using PROC SQL	225
Overview	226
Understanding Indexes	227
Deciding Whether to Create an Index	229
Creating an Index	231
Displaying Index Specifications	233
Managing Index Usage	235
Dropping Indexes	239
Summary	240
Quiz	242
Chapter 7 • Creating and Managing Views Using PROC SQL	247
Overview	248
Creating and Using PROC SQL Views	248
Displaying the Definition for a PROC SQL View	251
Managing PROC SQL Views	252
Updating PROC SQL Views	255
Dropping PROC SQL Views	257
Summary	258
Quiz	260
Chapter 8 • Managing Processing Using PROC SQL	263
Overview	264
Specifying SQL Options	264

Controlling Execution	265
Controlling Output	267
Testing and Evaluating Performance	271
Resetting Options	273
Using Dictionary Tables	275
Additional Features	279
Summary	279
Quiz	281

PART 2 SAS Macro Language 285

Chapter 9 • Introducing Macro Variables	287
Overview	288
Basic Concepts	289
Using Automatic Macro Variables	291
Using User-Defined Macro Variables	293
Processing Macro Variables	296
Displaying Macro Variable Values in the SAS Log	299
Using Macro Functions to Mask Special Characters	302
Using Macro Functions to Manipulate Character Strings	306
Using SAS Functions with Macro Variables	314
Combining Macro Variable References with Text	316
Summary	320
Quiz	323
Chapter 10 • Processing Macro Variables at Execution Time	327
Overview	328
Creating a Macro Variable during DATA Step Execution	329
Creating Multiple Macro Variables during DATA Step Execution	343
Referencing Macro Variables Indirectly	346
Obtaining Macro Variable Values during DATA Step Execution	352
Creating Macro Variables during PROC SQL Step Execution	354
Working with PROC SQL Views	361
Using Macro Variables in SCL Programs	362
Summary	364
Quiz	367
Chapter 11 • Creating and Using Macro Programs	371
Overview	372
Basic Concepts	373
Developing and Debugging Macros	378
Using Macro Parameters	381
Understanding Symbol Tables	387
Processing Statements Conditionally	396
Processing Statements Iteratively	407
Using Arithmetic and Logical Expressions	411
Summary	414
Quiz	417
Chapter 12 • Storing Macro Programs	421
Overview	422
Understanding Session-Compiled Macros	422
Storing Macro Definitions in External Files	423
Storing Macro Definitions in Catalog SOURCE Entries	425

Using the Autocall Facility	429
Using Stored Compiled Macros	433
Summary	439
Quiz	441

PART 3 Advanced SAS Programming Techniques 445

Chapter 13 • Creating Indexes	447
Overview	448
Using Indexes	448
Creating Indexes in the DATA Step	449
Managing Indexes with PROC DATASETS	452
Managing Indexes with PROC SQL	454
Documenting and Maintaining Indexes	455
Summary	461
Quiz	462
Chapter 14 • Combining Data Vertically	465
Overview	466
Using a FILENAME Statement	466
Using the FILEVAR= Option	469
Appending SAS Data Sets	477
Additional Features	485
Summary	486
Quiz	488
Chapter 15 • Combining Data Horizontally	495
Overview	496
Reviewing Terminology	497
Working with Lookup Values Outside of SAS Data Sets	500
Combining Data with the DATA Step Match-Merge	502
Using PROC SQL to Join Data	506
Comparing DATA Step Match-Merges and PROC SQL Joins	507
Combining Summary Data and Detail Data	516
Using an Index to Combine Data	521
Using a Transaction Data Set	525
Summary	528
Quiz	532
Chapter 16 • Using Lookup Tables to Match Data	537
Overview	538
Using Multidimensional Arrays	538
Populating an Array from a SAS Data Set	542
Using PROC TRANSPOSE	548
Merging the Transposed Data Set	553
Using Hash Objects as Lookup Tables	558
Summary	570
Quiz	573
Chapter 17 • Formatting Data	579
Overview	580
Creating Custom Formats Using the VALUE Statement	580
Creating Custom Formats Using the PICTURE Statement	583
Managing Custom Formats	588

Using Custom Formats	591
Creating Formats from SAS Data Sets	594
Creating SAS Data Sets from Custom Formats	598
Summary	601
Quiz	603
Chapter 18 • Modifying SAS Data Sets and Tracking Changes	607
Overview	608
Using the MODIFY Statement	609
Modifying All Observations in a SAS Data Set	610
Modifying Observations Using a Transaction Data Set	611
Modifying Observations Located by an Index	614
Controlling the Update Process	618
Understanding Integrity Constraints	620
Placing Integrity Constraints on a Data Set	622
Documenting Integrity Constraints	626
Removing Integrity Constraints	627
Understanding Audit Trails	628
Initiating and Reading Audit Trails	629
Controlling Data in the Audit Trail	631
Controlling the Audit Trail	634
Understanding Generation Data Sets	636
Initiating Generation Data Sets	637
Processing Generation Data Sets	638
Summary	641
Quiz	644
PART 4 Optimizing SAS Programs 649	
Chapter 19 • Introduction to Efficient SAS Programming	651
Overview	651
Overview of Computing Resources	652
Assessing Efficiency Needs at Your Site	652
Understanding Efficiency Trade-offs	654
Using SAS System Options to Track Resources	655
Using Benchmarks to Compare Techniques	656
Summary	658
Chapter 20 • Controlling Memory Usage	659
Overview	659
Controlling Page Size and the Number of Buffers	660
Using the SASFILE Statement	666
Additional Features	671
Summary	672
Quiz	673
Chapter 21 • Controlling Data Storage Space	675
Overview	676
Reducing Data Storage Space for Character Variables	677
Reducing Data Storage Space for Numeric Variables	677
Compressing Data Files	685
Using SAS DATA Step Views to Conserve Data Storage Space	696
Summary	703
Quiz	704

Chapter 22 • Using Best Practices	707
Overview	708
Executing Only Necessary Statements	708
Eliminating Unnecessary Passes through the Data	721
Reading and Writing Only Essential Data	725
Storing Data in SAS Data Sets	735
Avoiding Unnecessary Procedure Invocation	737
Summary	740
Quiz	742
Chapter 23 • Querying Data Efficiently	745
Overview	747
Using an Index for Efficient WHERE Processing	747
Identifying Available Indexes	750
Identifying Conditions That Can Be Optimized	754
Estimating the Number of Observations	756
Comparing Probable Resource Usage	759
Deciding Whether to Create an Index	761
Comparing Procedures That Produce Detail Reports	765
Comparing Tools for Summarizing Data	767
Summary	784
Quiz	787
Chapter 24 • Creating Functions with PROC FCMP	789
Overview	789
Using PROC FCMP	789
About PROC FCMP	790
PROC FCMP Statement	791
FUNCTION Statement	791
RETURN Statement	791
Using the Newly Defined Function	791
Using PROC FCMP to Create a Subroutine	792
Quiz	793

PART 5 Quiz Answer Keys 795

Appendix 1 • Quiz Answer Keys	797
Chapter 1: Performing Queries Using PROC SQL	798
Chapter 2: Performing Advanced Queries Using PROC SQL	799
Chapter 3: Combining Tables Horizontally Using PROC SQL	800
Chapter 4: Combining Tables Vertically Using PROC SQL	801
Chapter 5: Creating and Managing Tables Using PROC SQL	802
Chapter 6: Creating and Managing Indexes Using PROC SQL	803
Chapter 7: Creating and Managing Views Using PROC SQL	804
Chapter 8: Managing Processing Using PROC SQL	806
Chapter 9: Introducing Macro Variables	807
Chapter 10: Processing Macro Variables at Execution Time	808
Chapter 11: Creating and Using Macro Programs	809
Chapter 12: Storing Macro Programs	811
Chapter 13: Creating Indexes	812
Chapter 14: Combining Data Vertically	813
Chapter 15: Combining Data Horizontally	814
Chapter 16: Using Lookup Tables to Match Data	816
Chapter 17: Formatting Data	817

Chapter 18: Modifying SAS Data Sets and Tracking Changes	818
Chapter 19: Introduction to Efficient SAS Programming	819
Chapter 20: Controlling Memory Usage	819
Chapter 21: Controlling Data Storage Space	820
Chapter 22: Using Best Practices	820
Chapter 23: Querying Data Efficiently	821
Chapter 24: Creating Functions with PROC FCMP	822
Index	823