

# **COBOL**

# **PROGRAMMING**

**INCLUDING MS-COBOL AND COBOL-85**

**Second Edition**

**M K ROY**  
**D GHOSH DASTIDAR**

# CONTENTS

<i>Preface to this Edition</i>	vii
<i>Preface</i>	ix
1. INTRODUCTION TO COMPUTER SYSTEMS	1
1.1 Data Processing	1
1.2 Computer Organization	2
1.3 Microprocessor and Microcomputer	4
1.4 Internal Representation of Data and Instruction	4
1.4.1 Binary number system	4
1.4.2 Binary coding	6
1.4.3 Coding and numeric data	8
1.4.4 Operation codes	8
1.5 Computer Peripherals	9
1.5.1 Card reader	9
1.5.2 Printer	9
1.5.3 Keyboard and visual display unit	13
1.5.4 Magnetic disk	14
1.5.5 Magnetic tape drive	18
1.6 Computer Software	21
1.6.1 Assemblers and compilers	21
1.6.2 Linker and loader	22
1.6.3 Input output control system (IOCS)	23
1.6.4 Operating systems	23
1.6.5 Utilities: Text editor	25
Exercises	25
2. FILE CONCEPTS AND PROGRAM LOGIC	27
2.1 File Concepts	27
2.2 Record Layout	28
2.2.1 Card layout	28
2.2.2 Report layout	29
2.2.3 General record layout	31
2.3 PROGRAM LOGIC - ALGORITHM	31
2.4 Flow Chart Symbols	32
2.5 Sample Flow Charts	34
2.6 Additional Flow-Chart Symbols	36
2.7 More Examples of Flow-Charts	38
2.7.1 Sample problem - card to tape with validation	38
2.7.2 Sample problem - recognition of sequence break	38
2.8 Decision Tables	42
2.9 Documentation	45
Exercises	45

3.	INTRODUCTION TO COBOL	47
3.1	History of COBOL	47
3.2	Coding Format for COBOL Programs	47
3.3	Structure of a COBOL Program	48
3.4	Character Set	51
3.5	COBOL Words	52
3.6	Data Names and Identifiers	53
3.7	Literals	53
3.8	Figurative Constants	55
3.9	Continuation of Lines	55
3.10	Language Description Notation	56
3.11	Implementation Differences	58
	<i>Exercises</i>	59
4.	IDENTIFICATION AND ENVIRONMENT DIVISION	60
4.1	IDENTIFICATION DIVISION	60
4.2	ENVIRONMENT DIVISION	61
	4.2.1 CONFIGURATION SECTION	61; 4.2.2 INPUT-OUTPUT SECTION
		63
4.3	Implementation Differences	64
	<i>Exercises</i>	65
5.	FIRST LOOK AT DATA DIVISION	67
5.1	Introduction	67
5.2	Level Structure	68
5.3	Data Description Entries	69
	5.3.1 PICTURE clause	70; 5.3.2 VALUE clause
		73
5.4	FILE SECTION	74
5.5	WORKING-STORAGE SECTION	76
5.6	Editing	76
	5.6.1 Edit characters for numeric data	76;
	5.6.2 Editing of alphabetic and alphanumeric data	82;
	5.6.3 Examples of editing	82; 5.6.4 SPECIAL-NAMES paragraph
		83
5.7	Classes and Categories of Data	83
5.8	Implementation Differences	85
	<i>Exercises</i>	86
6.	PROCEDURE DIVISION AND BASIC VERBS	89
6.1	Structure of the PROCEDURE DIVISION	89
6.2	Data Movement Verb: MOVE	91
6.3	Arithmetic Verbs	94
	6.3.1 ADD	94; 6.3.2 SUBTRACT
		95; 6.3.3 MULTIPLY
		96;
	6.3.4 DIVIDE	96
6.4	Sequence Control Verbs	98
	6.4.1 GO TO	98; 6.4.2 STOP
		98

6.5	Input and Output Verbs	99	
	6.5.1 OPEN	99;	
	6.5.2 READ	100;	
	6.5.3 WRITE	101;	
	6.5.4 CLOSE	102	
	6.5.5 ACCEPT	103;	
	6.5.6 DISPLAY	104	
6.6	Conditional Verb: IF	104	
6.7	Categories of COBOL Statements	108	
6.8	Implementation Differences	109	
	<i>Exercises</i>	111	
7.	WRITING COMPLETE PROGRAMS		115
7.1	Introduction to Program Writing	115	
7.2	A Sample Program	116	
7.3	How to Run a COBOL Program	121	
7.4	Program Testing	123	
7.5	Programming Style	124	
	<i>Exercises</i>	125	
8.	MORE ABOUT DATA DIVISION		126
8.1	Usage Clause	126	
8.2	SYNCHRONIZED Clause	129	
8.3	JUSTIFIED Clause	130	
8.4	REDEFINES Clause	130	
8.5	RENAMES Clause	131	
8.6	Qualification of Data Names	132	
8.7	SIGN Clause	134	
8.8	Implementation Differences	135	
	<i>Exercises</i>	138	
9.	MORE ABOUT DATA MOVEMENT VERB AND ARITHMETIC VERBS		141
9.1	Elementary and Group Moves	141	
9.2	CORRESPONDING Option	145	
	9.2.1 MOVE CORRESPONDING	145;	
	9.2.2 ADD and SUBTRACT CORRESPONDING	146;	
	9.2.3 General rules concerning CORRESPONDING option	147	
9.3	ROUNDED Option	148	
9.4	ON SIZE ERROR Option	149	
9.5	COMPUTE Verb	150	
9.6	Implementation Differences	152	
	<i>Exercises</i>	153	
10.	CONDITIONAL AND SEQUENCE CONTROL VERBS		155
10.1	Condition	155	
	10.1.1 Relational condition	154;	
	10.1.2 Sign condition	157;	
	10.1.3 Class condition	158;	
	10.1.4 Condition-name condition	159;	
	10.1.5 Negated simple condition	161;	
	10.1.6 Compound condition	162	

10.2	IF Statement	164	
	10.2.1 Nested IF sentence	166;	
	10.2.2 Coding style for IF sentences	168;	
	10.2.3 Decision tables and IF statements	169	
10.3	GO TO with DEPENDING Phrase	171	
10.4	ALTER Statement	171	
10.5	PERFORM Statement	173	
10.6	EXIT Statement	174	
10.7	A Sample Validation Program	175	
	<i>Exercises</i>	182	
11.	TABLE HANDLING		185
11.1	OCCURS Clause and Subscripting	185	
11.2	Assigning Values to Table Elements	188	
11.3	Multi-dimensional Tables	190	
11.4	PERFORM Verb and Table Handling	192	
	11.4.1 PERFORM with TIMES option	192;	
	11.4.2 PERFORM with UNTIL option	193;	
	11.4.3 PERFORM with VARYING option	195;	
	11.4.4 PERFORM with the VARYING-AFTER option	196	
11.5	Indexed Tables and Indexing	199	
11.6	SET Verb	201	
11.7	SEARCH Verb	202	
	11.7.1 Sorted tables and binary search	207;	
	11.7.2 Searching a multi-dimensional table	208	
11.8	OCCURS DEPENDING Clause	209	
11.9	Sorting a Table	211	
11.10	Index Data Item	213	
11.11	Use of Indexes and Index Data Items	214	
11.12	Implementation Differences	215	
	<i>Exercises</i>	216	
12.	STRUCTURED PROGRAMMING		220
12.1	Program Design	220	
12.2	Current Trends in Data Processing	220	
12.3	Objectives and Methodologies of Structured Programming	221	
	12.3.1 Structuring of control flow	221;	
	12.3.2 Modular programming	223;	
	12.3.3 Top-down approach	224;	
	12.3.4 Summing-up	226	
12.4	Structured Programming in COBOL	226	
	12.4.1 Three basic structures	226;	
	12.4.2 Modular programming in COBOL	227;	
	12.4.3 Combination of basic structures	228;	
	12.4.4 A complete structured program	230	
12.5	Weaknesses of COBOL as a Language for Structured Programming	231	

12.6	Structured Flow Charts	236	
	<i>Exercises</i>	237	
13.	SEQUENTIAL FILES		239
13.1	File Characteristics	239	
13.2	File-control Entries for Sequential Files	240	
13.3	File Description - Fixed Length Records	241	
	13.3.1 BLOCK CONTAINS clause	244;	
	13.3.2 RECORD CONTAINS clause	245;	13.3.3 LABEL RECORD clause 245;
	13.3.4 VALUE OF clause	245;	13.3.5 DATA RECORD clause 246;
	13.3.6 CODE-SET clause	246;	13.3.7 Nonstandard clause 247;
	13.3.8 Examples of file-description entries	247	
13.4	Statements for Sequential Files	248	
	13.4.1 OPEN statement	249;	13.4.2 CLOSE statement 249;
	13.4.3 WRITE statement	250;	13.4.4 REWRITE statement 250
13.5	Examples of Sequential File Processing (Fixed-length Records)	250	
13.6	Sequential Files with Variable-length Records	253	
	13.6.1 FD entry for variable-length records	253;	
	13.6.2 Record description for variable-length records	254;	
	13.6.3 Example of sequential file processing (with variable-length records)	255	
13.7	Features for Unit-record Files	257	
	13.7.1 Special features for line-printer files	257	
13.8	Special Features for Magnetic-tape Files	260	
13.9	I-O-CONTROL Paragraph	263	
13.10	Implementation Differences	269	
	<i>Exercises</i>	274	
14.	SORTING AND MERGING OF FILES		276
14.1	The Simple Sort Verb	276	
14.2	File Updation	279	
14.3	Variations of Updation	284	
	14.3.1 Updation without insertion and more than one transaction record for a master record	284;	14.3.2 File matching 286;
	14.3.3 File merging	288	
14.4	Simple MERGE Verb	289	
14.5	INPUT and OUTPUT PROCEDURE in SORT Statement	291	
14.6	An Example of SORT Statement with INPUT/OUTPUT PROCEDURES	294	
14.7	MERGE Verb with OUTPUT PROCEDURE	295	
14.8	SAME SORT AREA Clause	295	
14.9	MEMORY SIZE Clause	296	
14.10	Implementation Differences	296	
	<i>Exercises</i>	297	

15.	MORE ABOUT STRUCTURED PROGRAMMING	299
15.1	Constrained Use of GO TO	299
15.2	GO TO Statement and SORT-MERGE Feature	300
15.3	GO TO with DEPENDING ON in Structured Programs	300
15.4	Summing-up	302
15.5	Disciplined Use of COBOL Statements	303
15.6	Control Breaks and Structured Programming	304
	<i>Exercises</i>	313
16.	DIRECT ACCESS FILES	314
16.1	Relative Files	314
	16.1.1 FILE-CONTROL paragraph for relative files	314;
	16.1.2 PROCEDURE DIVISION statements for relative files	315
16.2	Indexed Sequential Files	320
	16.2.1 File-control paragraph for indexed files	321;
	16.2.2 Procedure division statements for index files	322;
	16.2.3 Updation of relative and indexed files	326;
	16.2.4 An example of handling index file	327;
	16.2.5 File descriptions for relative and index files	329;
	16.2.6 DECLARATIVES and file status clause	329;
	16.2.7 Direct organization	331;
	16.2.8 Selection of file organization	331
16.3	Implementation Differences	332
17.	CHARACTER HANDLING	338
17.1	EXAMINE Verb	338
17.2	INSPECT Verb	341
17.3	STRING and UNSTRING Verbs	344
17.4	Implementation Differences	353
	<i>Exercises</i>	353
18.	REPORT WRITER	355
18.1	General Format of a Report	355
18.2	File Section - Report Clause	356
18.3	Outline of Report Section	357
18.4	Report Section - Report-description Entry	358
18.5	Report-group Description	360
18.6	PROCEDURE DIVISION Statements	366
18.7	Sample Program	369
18.8	Implementation Differences	369
	<i>Exercises</i>	375

19.	COBOL SUBROUTINES	376
19.1	Structure of a COBOL Subroutine	377
19.2	The Calling of a Subroutine	378
19.3	State of a Subroutine and CANCEL Statement	380
19.4	An Example Illustrating Use of Subroutine	381
19.5	Advantages and Disadvantages of COBOL Subroutines	383
19.6	Implementation Differences	384
	<i>Exercises</i>	388
20.	SEGMENTATION AND LIBRARY FACILITY	390
20.1	Segmentation	390
	20.1.1 Segmentation restrictions	391;
	20.1.2 Planning for segmentation	392
20.2	Library Facility	393
20.3	Implementation Differences	395
	<i>Exercises</i>	395
21.	COBOL FOR PERSONAL COMPUTERS	397
21.1	Introduction	397
21.2	The Hardware	397
21.3	The Keyboard	398
21.4	DOS - The Operating System for PC	400
	21.4.1 File specification	400;
	21.4.2 Some important internal commands	401
21.5	Creation of COBOL Source/Data File Through EDLIN	403
	21.5.1 Creating a new source file	403;
	21.5.2 Editing on existing source file	404;
	21.5.3 Creation and editing of data files	405
21.6	Compilation and Linking of COBOL Programs	406
21.7	Major Implementation Differences of MS-COBOL Features	408
21.8	File Handling	411
	21.8.1 Printer file	411;
	21.8.2 Disk file	411
21.9	Sort/Merge Features	413
21.10	Inter-program Communication	414
21.11	Debug and Communication Modules	415
21.12	Screen and ACCEPT/DISPLAY Verbs	415
	21.12.1 Scrolling and non-scrolling modes	416;
	21.12.2 Simple ACCEPT/DISPLAY verbs	416;
	21.12.3 ACCEPT/DISPLAY verbs with position specification	417;
	21.12.4 Two programs showing the use of ACCEPT/DISPLAY with position specification	421
21.13	ACCEPT/DISPLAY Verbs with Screen Section	423
	21.13.1 Program with screen section	423
21.14	A Case-study in Interactive Programming	428
21.15	Remarks on MS-COBOL	434
	<i>Exercises</i>	435

22.	FEATURES OF COBOL-85	438
22.1	Introduction	438
22.2	COBOL-85 Features for General Improvement of the Language	438
	22.2.1 Program structure	439;
	22.2.2 Nameless data description	entry 442;
	22.2.3 De-editing	442;
	22.2.4 ADD with giving	phrase 442;
	22.2.5 Relational condition	443;
	22.2.6 Class	condition 443;
	22.2.7 Redefines clause	444;
	22.2.8 Table	handling 444;
	22.2.9 Initialize verb	445;
	22.2.10 Set verb with	true phrase 446;
	22.2.11 Reference modification	447;
	22.2.12 Inspect verb with converting option	448;
	22.2.13 Continue	verb 449;
	22.2.14 File handling	449;
	22.2.15 Usage clause	451;
	22.2.16 COBOL subroutines	451;
	22.2.17 Display verb	452
22.3	COBOL-85 Features for Structured Programming	453
	22.3.1 IF verb	453;
	22.3.2 Enhancements for conditional verbs	455;
	22.3.3 Evaluate verb	456;
	22.3.4 Perform verb	461
22.4	Sample Programs	465
	22.4.1 File encryption	465;
	22.4.2 File updation	465;
	22.4.3 Sample nesting of programs	470
	Exercises	472
Appendix A : Bibliography		476
Appendix B : Reserved Word List		478
Appendix C : Data Division Formats		484
Appendix D : COBOL-85 Formats for Perform Verb		487