Contents

Introduction viii

AS LEVEL

1 Information representation and multimedia 1

1.1 Data representation 2
1.2 Multimedia 15
1.3 File compression 21

2 Communication 27

2.1 Networking 28
2.2 The internet 54

3 Hardware 68

3.1 Computers and their components 68
3.2 Logic gates and logic circuits 89

4 Processor fundamentals 107

4.1 Central processing unit (CPU) architecture 107
4.2 Assembly language 121
4.3 Bit manipulation 130

5 System software 136

5.1 Operating systems 136
5.2 Language translators 149

6 Security, privacy and data integrity 159

6.1 Data security 159
6.2 Data integrity 169

7 Ethics and ownership 178

7.1 Legal, moral, ethical and cultural implications 179
7.2 Copyright issues 186
7.3 Artificial intelligence (AI) 189

8 Databases 196

8.1 Database concepts 196
8.2 Database management systems (DBMSs) 208
8.3 Data definition language (DDL) and data manipulation language (DML) 211

9 Algorithm design and problem solving 217

9.1 Computational thinking skills 217
9.2 Algorithms 219

10 Data types and structures 238

10.1 Data types and records 238
10.2 Arrays 241
10.3 Files 249
10.4 Abstract data types (ADTs) 250

11 Programming 264

11.1 Programming basics 264
11.2 Programming constructs 271
11.3 Structured programming 275

12 Software development 283

12.1 Program development lifecycle 283
12.2 Program design 287
12.3 Program testing and maintenance 293

A LEVEL

13 Data representation 304

13.1 User-defined data types 304
13.2 File organisation and access 308
13.3 Floating-point numbers, representation and manipulation 312

14 Communication and internet technologies 328

14.1 Protocols 328
14.2 Circuit switching and packet switching 337

15 Hardware 346

15.1 Processors and parallel processing 346
15.2 Boolean algebra and logic circuits 354

16 System software and virtual machines 372

16.1 Purposes of an operating system (OS) 372
16.2 Virtual machines (VMs) 392
16.3 Translation software 394

17 Security 410

17.1 Encryption 410
17.2 Quantum cryptography 414
17.3 Protocols 416
17.4 Digital signatures and digital certificates 418

18 Artificial intelligence (AI) 425

18.1 Shortest path algorithms 425
18.2 Artificial intelligence, machine learning and deep learning 434

19 Computational thinking and problem solving 450

19.1 Algorithms 450
19.2 Recursion 490

20 Further programming 498

20.1 Programming paradigms 498
20.2 File processing and exception handling 525

Glossary 541

Index 553