3.1 Data representation

3.1.1 User-defined data types

• show understanding of why user-defined types are necessary

• define and use non-composite types: enumerated, pointer

Enumerated data type: a list of possible data values

Pseudocode:

Type

TDirection = (North, East, South, West)

Tdays= (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday, Sunday)

DECLARE Direction1: TDirections

DECLARE StartDay: TDays

Direction1 🡨 North

StartDay 🡨 Wednesday

• define and use composite data types: set, record and class/object

• choose and design an appropriate user-defined data type for a given problem

3.1.2 File organisation and access

• show understanding of methods of file organisation: serial, sequential (using a key field) and random (using a record key)

• show understanding of methods of file access:

– sequential access for serial and sequential files

– direct access for sequential and random files

• select an appropriate method of file organisation and file access for a given problem

3.1.3 Real numbers and normalised floating-point representation

• describe the format of binary floating-point real numbers

• convert binary floating-point real numbers into denary and vice versa

• normalise floating-point numbers

• show understanding of the reasons for normalisation

• show understanding of the effects of changing the allocation of bits to mantissa and exponent in a floating-point representation

• show understanding of how underflow and overflow can occur

• show understanding of the consequences of a binary representation only being an approximation to the real number it represents (in certain cases)

• show understanding that binary representations can give rise to rounding errors

3.2 Communication and Internet technologies

3.2.1 Protocols

• show understanding of why a protocol is essential for communication between computers

• show understanding of how protocol implementation can be viewed as a stack, where each layer has its own functionality

• show understanding of the function of each layer of the TCP/IP protocol suite

• show understanding of the application of the TCP/IP protocol suite when a message is sent from one host to another on the Internet

• show understanding of how the BitTorrent protocol provides peer-to-peer file sharing

• show an awareness of other protocols (HTTP, FTP, POP3, SMTP) and their purposes

3.2.2 Circuit switching, packet switching and routers

• show understanding of circuit switching and where it is applicable

• show understanding of packet switching

• show understanding of the function of a router in packet switching

• explain how packet switching is used to pass messages across a network, including the Internet

3.2.3 Local Area Networks (LAN)

• show understanding of a bus topology network and the implications of how packets are transmitted between two hosts

• show understanding of a star topology network and the implications of how packets are transmitted between two hosts

• show understanding of a wireless network

• explain how hardware is used to support a LAN: switch, router, servers, Network Interface Cards (NICs), wireless access points

• show understanding of Ethernet and how collision detection and avoidance (such as CSMA/CD) works

3.3 Hardware

3.3.1 Logic gates and circuit design

• produce truth tables for common logic circuits including half adders and full adders

• derive a truth table for a given logic circuit

3.3.2 Boolean algebra

• show understanding of Boolean algebra

• show understanding of De Morgan’s Laws

• perform Boolean algebra using De Morgan’s Laws

• simplify a logic circuit/expression using Boolean algebra

3.3.3 Karnaugh Maps

• show understanding of Karnaugh Maps

• show understanding of the benefits of using Karnaugh Maps

• solve logic problems using Karnaugh Maps

3.3.4 Flip-flops

• show understanding of how to construct a flip-flop (SR and JK)

• describe the role of flip-flops as data storage elements

3.3.5 RISC processors

• show understanding of the differences between RISC and CISC processors

• show understanding of the importance/use of pipelining and registers in RISC processors

• show understanding of interrupt handling on CISC and RISC processors

3.3.6 Parallel processing

• show awareness of the four basic computer architectures: SISD, SIMD, MISD, MIMD

• show awareness of the characteristics of massively parallel computers

3.4 System software

3.4.1 Purposes of an operating system (OS)

• show understanding of how an OS can maximise the use of resources

• describe the ways in which the user interface hides the complexities of the hardware from the user

• show understanding of processor management: multitasking, including:

– the concept of multitasking and a process

– the process states: running, ready and blocked

– the need for scheduling

– the concept of an interrupt

– how the kernel of the OS acts as the interrupt handler and how interrupt handling is used to manage low-level scheduling

• show understanding of paging for memory management: including: – the concepts of paging and virtual memory

– the need for paging

– how pages can be replaced

– how disk thrashing can occur

3.4.2 Virtual machine

• show understanding of the concept of a virtual machine

• give examples of the role of virtual machines

• show understanding of the benefits and limitations of virtual machines

3.4.3 Translation software

• show understanding of how an interpreter can execute programs without producing a translated version

• show understanding of the various stages in the compilation of a program: lexical analysis, syntax analysis, code generation and optimisation

• show understanding of how the grammar of a language can be expressed using syntax diagrams or Backus-Naur Form (BNF) notation

• show understanding of how Reverse Polish Notation (RPN) can be used to carry out the evaluation of expressions

3.5 Security

3.5.1 Asymmetric keys and encryption methods

• show understanding of the terms: public key, private key, plain text, cipher text, encryption and asymmetric key cryptography

• show understanding of how the keys can be used to send a private message from the public to an individual/organisation

• show understanding of how the keys can be used to send a verified message to the public

3.5.2 Digital signatures and digital certificates

• show understanding of how a digital certificate is acquired

• show understanding of how a digital certificate is used to produce digital signatures

3.5.3 Encryption protocols

• show awareness of the purpose of Secure Socket Layer (SSL)/Transport Layer Security (TLS)

• show awareness of the use of SSL/TLS in client-server communication

• show awareness of situations where the use of SSL/TLS would be appropriate

3.5.4 Malware

• show understanding of malware: viruses, worms, phishing, pharming

• describe vulnerabilities that the various types of malware can exploit

• describe methods that can be used to restrict the effect of malware

3.6 Monitoring and control systems

3.6.1 Overview of monitoring and control systems

• show understanding of the difference between a monitoring system and a control system

• show understanding of sensors and actuators and their usage

• show understanding of the additional hardware required to build these systems

• show understanding of the software requirements of these systems

• show understanding of the importance of feedback in a control system

3.6.2 Bit manipulation to monitor and control devices

• show understanding of how bit manipulation can be used to monitor/control a device

• carry out bit manipulation operations: test a bit and set a bit (using bit masking) using the instructions from Section 1.4.3 and those listed below

• show understanding of how to make use of appropriate bit manipulation in monitoring systems and control systems

