Challenging topics

Representing data using binary, hexadecimal and binary coded decimal

Session 4: Binary coded decimal (BCD)

Introduction

Knowledge of binary, hexadecimal and binary coded decimals is needed to support the understanding of how computer data is represented and programs are coded in Information Technology (IT) and electronics.

Binary coded decimal (BCD) is still widely used in commercial and financial applications because it offers a speedy means to achieve decimal calculations. It is, however, a relatively inefficient way to store numbers, for example, 25 in BCD is 0010 0101 whereas in pure binary it is 11001. This session may be used to help learners to understand such examples.

Learning objectives and outcomes

Learners should be able to:

- use binary coded decimal (BCD) to represent numbers.

Note: The term 'decimal' is used in preference to 'denary' but either term is appropriate.

Resources required

For each small group of learners you will need:

- **Card set F: Binary coded decimal** (three pages)
- **Card set G: Impossible?** (two pages)

For each learner you will need:

- Mini-whiteboard

Starting points

This session is the last of a set of four linked sessions designed to be used with topics involving binary, hexadecimal and binary coded decimal. You can use each session separately or you can link sessions together. The sessions can also be broken down into smaller units, though learners would benefit if smaller units were delivered as consecutive sessions with the teacher making sure that the overall session coverage is achieved.

From previous sessions, or from their prior knowledge, learners will already have met index notation, binary to decimal conversion, and binary to hexadecimal conversion. This session extends these topics and explores binary coded decimal (BCD), where each set of four bits represents a decimal digit. The session is intended to help learners to understand the difference between BCD and hexadecimal. These are easily confused because they both use four bits per digit.

Planning learning in multiple environments

During the session, relate discussion to a range of vocational contexts by drawing on learners' own experiences from work and/or from their course.

Learners could practise by tackling vocationally relevant problems and tasks, for example, producing technical documentation.

Suggested approach

Stage 1

Start writing decimal numbers and their binary coded equivalent on the board without any explanation. As you continue to do this, ask learners to spot the technique you are using (as they did in the previous session when they identified a binary to hexadecimal conversion method). It should not take them too long this time. Explain why using binary coded decimal is useful in IT.

Stage 2

Divide learners into groups of three or four. Give each group **Card set F: Binary coded decimal**. If possible, photocopy the cards onto different coloured card so that one colour represents binary and another colour represents decimal. If this is not possible, identify the different types of card in some way by marking the backs.

Each group should place the two sets of coloured cards face down. Learners then take turns to turn over one card of each colour.

- If the learner thinks the two cards represent the same number, they keep the pair.
- If they are correct, they gain a point.
- If another learner in the group thinks that the cards are not equivalent, they can challenge. If the challenge is incorrect, the challenger loses a point. If the challenge is correct, the challenger gains a point and the learner who claimed the pair loses a point. If learners cannot agree, the teacher should act as mediator.
- If the learner turns over a pair that does not match and does not claim the pair, the cards are replaced face down and the next learner takes their turn.
- At the end of the game, the learner with the most points is the winner.

Note: While the activity is taking place, circulate between groups to confirm the matchings that learners have made. Where cards have been matched incorrectly, discuss the mismatched pair within the group. When the learners have resolved the mismatch, adjust the points score and replace the cards in the appropriate set, face down.

If possible, the game could be projected on a screen using a data projector. Each group then plays as a team in a whole class game.

Stage 3

Give each group of learners **Card set G: Impossible?** Ask them to sort the cards into two piles. One pile will be cards with numbers that can be represented in binary coded decimal and the other pile will be those that cannot. Learners should come up with an explanation as to why some cards have to go into the second pile and how they can be identified (that is, they are binary representations of numbers greater than 10). This can become the focus of discussion after the activity. Ask learners to refer back to converting binary to hexadecimal and ask them if the same restrictions apply. If not, why not?

Stage 4

Review of learning

1. Learners could assemble all the posters that have been completed in this series of four sessions and write a summary of the different representations. This should be aimed at a learner who might have missed the sessions, or be presented as revision notes for publication online. This could be done using lots of colour to aid recall.

2. Give each learner a mini-whiteboard. Give them two numbers using the same representation, for example, two numbers in binary. Ask them to give you an example of a number in hexadecimal that lies between these numbers. Learners can work in pairs to come up with a possible number. Write a selection of their answers on the board and, as a class, discuss which are correct and why. Repeat this for other combinations of types of number.

Finally, ask learners to summarise:

- what they learned
- what went well, and why
- what went less well, and why
- how they learned. For example, how did the card-matching activities help their understanding? How about the mini-whiteboards? What are the advantages of discussion in small groups? Where else could these approaches to learning be used?

Card set F: Binary coded decimal (page 1)

1001 1001	**0011 0001**
0110 1000	**0001 0111**
1000 0001	**1001 0110**
1001 0111	**1000 0101**
0110 0011	**0111 0110**

Card set F: Binary coded decimal (page 2)

0101 0101	**0011 0111**
0111 1000	**0001 1001**
0001 0101	**0110 0001**

Card set F: Binary coded decimal (page 3)

31	**81**
17	**78**
85	**99**
15	**68**
96	**97**
19	**55**
76	**63**
61	**37**

Card set G: Impossible? (page 1)

1101 1001	**0110 1000**
1000 0111	**1011 0001**
0101 0101	**0111 0100**
1111 0011	**0010 1100**
1011 1000	**0101 1011**

Card set G: Impossible? (page 2)

0111 0101	**0100 0011**
1011 1100	**0001 0101**
1000 1100	**1001 0111**