Zadání pro samostatnou práci č. 4

Diagnostika a spolehlivost číslicových systémů - PV171

**Příklad č. 1:**

Nalezněte nejdelší slovo dat, které je možno zabezpečit pěti bity Hammingova kódu.

***Řešení:***

Určení počtu zabezpečovacích bitů:

***2k ≥ k + m + 1***

***25 ≥ 5 + m + 1***

***32 ≥ 6 + m***

***32 ≥ 6 + 26*** *platí pro* ***k = 5.***

*Datové slovo má délku* ***26*** *bitů. Nejdelší slova zabezpečeného pěti bity Hammingova kódu činí* ***31*** *bitů.*

**Příklad č. 2:**

Odvoďte bity Hammingova kódu pro následující slovo dat:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 0 | 0 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |

***Řešení:***

Rozložení bitů ve slově je následující:



|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
| *p1* | *p2* | *0* | *p3* | *0* | *0* | *1* | *p4* | *0* | *1* | *1* | *1* | *0* | *1* | *0* | *p5* | *0* | *1* | *1* | *1* | *1* | *1* | *1* | *0* | *1* | *0* | *0* | *1* | *1* | *1* | *1* |

*Jednotlivé bity Hammingova kódu se generují sudou paritou podle následujících vztahů:*

*pro* ***p1*** *se sečítají pozice* ***b1, b3, b5, b7, b9, b11, b13, b15, b17, b19, b21, b23,b25,b27,b29,b31***

*pro* ***p2*** *se sečítají pozice* ***b2, b3, b6, b7, b10, b11, b14, b15, b18, b19, b22, b23,b26,b27,b30,b31***

*pro* ***p3*** *se sečítají pozice* ***b4, b5, b6, b7, b12, b13, b14, b15, b20, b21, b22, b23,b28,b29,b30,b31***

*pro* ***p4*** *se sečítají pozice* ***b8, b9, b10, b11, b12, b13, b14, b15, b24, b25, b26, b27,b28,b29,b30,b31***

*pro* ***p5*** *se sečítají pozice* ***b16, b17, b18, b19, b20, b21, b22, b23, b24, b25, b26, b27,b28,b29,b30,b31***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
| *0* |  | *0* |  | *0* |  | *1* |  | *0* |  | *1* |  | *0* |  | *0* |  | *0* |  | *1* |  | *1* |  | *1* |  | *1* |  | *0* |  | *1* |  | *1* |
|  | *0* | *0* |  |  | *0* | *1* |  |  | *1* | *1* |  |  | *1* | *0* |  |  | *1* | *1* |  |  | *1* | *1* |  |  | *0* | *0* |  |  | *1* | *1* |
|  |  |  | *1* | *0* | *0* | *1* |  |  |  |  | *1* | *0* | *1* | *0* |  |  |  |  | *1* | *1* | *1* | *1* |  |  |  |  | *1* | *1* | *1* | *1* |
|  |  |  |  |  |  |  | *1* | *0* | *1* | *1* | *1* | *0* | *1* | *0* |  |  |  |  |  |  |  |  | *0* | *1* | *0* | *0* | *1* | *1* | *1* | *1* |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | *1* | *0* | *1* | *1* | *1* | *1* | *1* | *1* | *0* | *1* | *0* | *0* | *1* | *1* | *1* | *1* |

**Příklad č. 3:**

Vypočtěte syndrom zabezpečeného slova z příkladu 2 pro porušený:

a) 10. bit zabezpečeného slova,

b) 24. bit zabezpečeného slova.

***Řešení:***

Interpretace syndromů:

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *pozice chyby* | *syndrom* | | | | |  | *pozice chyby* | *syndrom* | | | | |
| *c5* | *c4* | *c3* | *c2* | *c1* |  | *c5* | *c4* | *c3* | *c2* | *c1* |
| *0* | *0* | *0* | *0* | *0* | *0* |  | *16* | *1* | *0* | *0* | *0* | *0* |
| *1* | *0* | *0* | *0* | *0* | *1* |  | *17* | *1* | *0* | *0* | *0* | *1* |
| *2* | *0* | *0* | *0* | *1* | *0* |  | *18* | *1* | *0* | *0* | *1* | *0* |
| *3* | *0* | *0* | *0* | *1* | *1* |  | *19* | *1* | *0* | *0* | *1* | *1* |
| *4* | *0* | *0* | *1* | *0* | *0* |  | *20* | *1* | *0* | *1* | *0* | *0* |
| *5* | *0* | *0* | *1* | *0* | *1* |  | *21* | *1* | *0* | *1* | *0* | *1* |
| *6* | *0* | *0* | *1* | *1* | *0* |  | *22* | *1* | *0* | *1* | *1* | *0* |
| *7* | *0* | *0* | *1* | *1* | *1* |  | *23* | *1* | *0* | *1* | *1* | *1* |
| *8* | *0* | *1* | *0* | *0* | *0* |  | *24* | *1* | *1* | *0* | *0* | *0* |
| *9* | *0* | *1* | *0* | *0* | *1* |  | *25* | *1* | *1* | *0* | *0* | *1* |
| *10* | *0* | *1* | *0* | *1* | *0* |  | *26* | *1* | *1* | *0* | *1* | *0* |
| *11* | *0* | *1* | *0* | *1* | *1* |  | *27* | *1* | *1* | *0* | *1* | *1* |
| *12* | *0* | *1* | *1* | *0* | *0* |  | *28* | *1* | *1* | *1* | *0* | *0* |
| *13* | *0* | *1* | *1* | *0* | *1* |  | *29* | *1* | *1* | *1* | *0* | *1* |
| *14* | *0* | *1* | *1* | *1* | *0* |  | *30* | *1* | *1* | *1* | *1* | *0* |
| *15* | *0* | *1* | *1* | *1* | *1* |  | *31* | *1* | *1* | *1* | *1* | *1* |

*ad a)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
| *0* |  | *0* |  | *0* |  | *1* |  | *0* |  | *1* |  | *0* |  | *0* |  | *0* |  | *1* |  | *1* |  | *1* |  | *1* |  | *0* |  | *1* |  | *1* |

***c1 = 0***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
|  | *0* | *0* |  |  | *0* | *1* |  |  | *0* | *1* |  |  | *1* | *0* |  |  | *1* | *1* |  |  | *1* | *1* |  |  | *0* | *0* |  |  | *1* | *1* |

***c2 = 1***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
|  |  |  | *1* | *0* | *0* | *1* |  |  |  |  | *1* | *0* | *1* | *0* |  |  |  |  | *1* | *1* | *1* | *1* |  |  |  |  | *1* | *1* | *1* | *1* |

***c4 = 0***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
|  |  |  |  |  |  |  | *1* | *0* | *0* | *1* | *1* | *0* | *1* | *0* |  |  |  |  |  |  |  |  | *0* | *1* | *0* | *0* | *1* | *1* | *1* | *1* |

***c8 = 1***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | *1* | *0* | *1* | *1* | *1* | *1* | *1* | *1* | *0* | *1* | *0* | *0* | *1* | *1* | *1* | *1* |

***c16 = 0***

***Syndrom chyby = 010102 = 1010***

*ad b)*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
| *0* |  | *0* |  | *0* |  | *1* |  | *0* |  | *1* |  | *0* |  | *0* |  | *0* |  | *1* |  | *1* |  | *1* |  | *1* |  | *0* |  | *1* |  | *1* |

***c1 = 0***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
|  | *0* | *0* |  |  | *0* | *1* |  |  | *1* | *1* |  |  | *1* | *0* |  |  | *1* | *1* |  |  | *1* | *1* |  |  | *0* | *0* |  |  | *1* | *1* |

***c2 = 0***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
|  |  |  | *1* | *0* | *0* | *1* |  |  |  |  | *1* | *0* | *1* | *0* |  |  |  |  | *1* | *1* | *1* | *1* |  |  |  |  | *1* | *1* | *1* | *1* |

***c4 = 0***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
|  |  |  |  |  |  |  | *1* | *0* | *1* | *1* | *1* | *0* | *1* | *0* |  |  |  |  |  |  |  |  | *1* | *1* | *0* | *0* | *1* | *1* | *1* | *1* |

***c8 = 1***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| *1* | *2* | *3* | *4* | *5* | *6* | *7* | *8* | *9* | *10* | *11* | *12* | *13* | *14* | *15* | *16* | *17* | *18* | *19* | *20* | *21* | *22* | *23* | *24* | *25* | *26* | *27* | *28* | *29* | *30* | *31* |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | *1* | *0* | *1* | *1* | *1* | *1* | *1* | *1* | *1* | *1* | *0* | *0* | *1* | *1* | *1* | *1* |

***c16 = 1***

***Syndrom chyby = 110002 = 2410***