Exercise 9.2: Implement a BCD decoder using an Excess-3 decoder, a 2-input binary decoder and a NOR gate.

The relation between BCD code and the Excess-3 code is:

<table>
<thead>
<tr>
<th>$x$ (Ex-3)</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$ (BCD)</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

where $x$ is the radix-2 representation of the input vector and $z$ and $y$ are the indices of the outputs of the decoders with value 1.

From the table we see that for $x$ between 3 and 9, the output of the Excess-3 decoder can be relabeled to give some of the outputs of the BCD decoder. Since for $x$ between 0 and 2, no output of the Excess-3 decoder has value 1, it is necessary to decode these values separately. It's possible to do this using a 2-input binary decoder that has as inputs the bits $x_1$ and $x_0$ (the least significant bits) and making the enable input active when $x \leq 3$.

![Diagram](image_url)

**Figure 9.4: BCD decoder - Exercise 9.2**
Exercise 9.4: For a coincident decoder using $n = 12$ and $k = 4$, we use $r = n/k = 3$ 4-input decoders and $2^{12}$ 3-input AND gates.

The circuit is shown in Figure 9.6. In the figure only some of the AND gates are shown, with the corresponding output numbers. In general, if we partition the input into groups of 4 bits, we get:

$$u = 8x_{11} + 4x_{10} + 2x_9 + x_8$$
$$s = 8x_7 + 4x_6 + 2x_5 + x_4$$
$$t = 8x_3 + 4x_2 + 2x_1 + x_0$$

and the output $z_i = 1$ if $i = u2^8 + s2^4 + t$. 
Exercise 13.9

The networks generated for each case is shown in Figure 13.9.

Figure 13.9: Networks for Exercise 13.9
Exercise 13.10

The state diagrams corresponding to the VHDL descriptions on this Exercise are shown in Figure 13.10.

(a)  
(b)  
(c)  

Figure 13.10: State diagrams for Exercise 13.10
GRADING POLICY:

9.2) 20 pts.
Choosing correct range of outputs (5 points)
Using 2 Decoders (5 points)
NOR-OR logic (5 points)
Choosing output from decoders (5 points)

9.4) 20 pts.
3 decoders, 12 inputs (5 points)
Formula for i (5 points)
Diagram (10 points)

13.9) 10 points for each part

13.10) 10 points for each part