CSE-304 Compiler Design
Fall ’09
Mid-term Exam
October 5, 2009.

Duration: 55 minutes. Maximum Score: 25

INSTRUCTIONS
Read the following carefully before answering any question.

• Make sure you have filled in your name and USB ID number in the space above.
• Write your answers in the space provided; Keep your answers brief and precise.
• The exam consists of 4 questions, in 8 pages (including this page) for a total of 25 points. Page 8 of the exam is intentionally blank.

<table>
<thead>
<tr>
<th>Question</th>
<th>Max.</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Total:</td>
<td>25</td>
<td></td>
</tr>
</tbody>
</table>
1. [Total: 7 points] For this question, consider the following NFA $A_1$:

Note that in $A_1$ there are two transitions from state 3 to state 4. One is labeled $\epsilon$ (epsilon) and other is labeled $c$.

a. [1 point] Is the string $aabd$ in the language accepted by $A_1$? Justify.

b. [2 point] Is the string $aabbd$ in the language accepted by $A_1$? Justify.
c. [4 points] Construct a DFA that accepts the same language as $A_1$. Show either the steps you used to construct the DFA, or give a proof that your DFA accepts the same language as $A_1$. 


2. [5 points]
Consider the following Lex specification:

```plaintext
digit  [0-9]
alpha  [a-zA-Z]

"class"  {return(CLASS);}
{alpha}({alpha}|{digit})*  {return(ID);}
"return"  {return(RETURN);}
{digit}+  {return(INT);}
[ \t\n]  {}
.  {return(UNKNOWN);}
//.*  {return(COMMENT);}

For each of the following inputs, write the token stream that will be generated by the above Lex specification.

<table>
<thead>
<tr>
<th>Input</th>
<th>Token Stream</th>
</tr>
</thead>
<tbody>
<tr>
<td>class class1</td>
<td></td>
</tr>
<tr>
<td>int x;</td>
<td></td>
</tr>
<tr>
<td>class // Demo</td>
<td></td>
</tr>
<tr>
<td>class Demo extends Base</td>
<td></td>
</tr>
<tr>
<td>return x</td>
<td></td>
</tr>
</tbody>
</table>
3. [Total: 6 points] Consider the following grammar written in Extended Backus Naur Form (EBNF):

\[ S ::= ((ab)^*(bc)^{+})^2 \ a \ b \ | \ \epsilon \]

In the above grammar, \( a \), \( b \) and \( c \) are terminal symbols, and \( S \) is a non-terminal symbol.

a. [3 points] Rewrite the above grammar to use the standard grammar notation (i.e., where right hand sides of productions are sequences of terminal and non-terminal symbols).

b. [1 point] Give a derivation for string \texttt{abbcab} using your grammar from part (a) above.
c. [2 points] What is the set of all strings of length 4 generated by this grammar? Explain.
4. [Total: 7 points] Consider the following grammar $G_4$:

$$
S \rightarrow AD \mid B \\
A \rightarrow a \mid \epsilon \\
B \rightarrow b \\
D \rightarrow d \mid \epsilon
$$


c. [3 points] Write the LL(1) parsing table for $G_4$. 