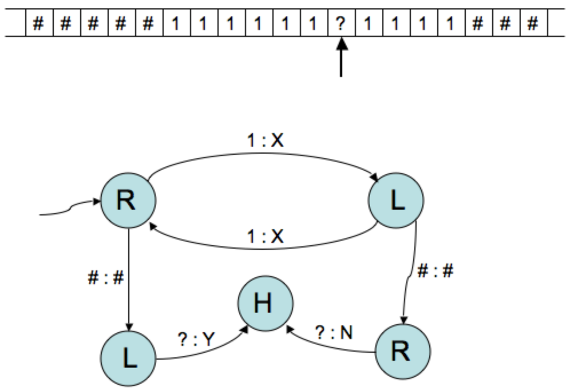
COS 126 **General Computer Science** **Fall 2007**

Exam 2 Solutions

1. **Turing Machines**

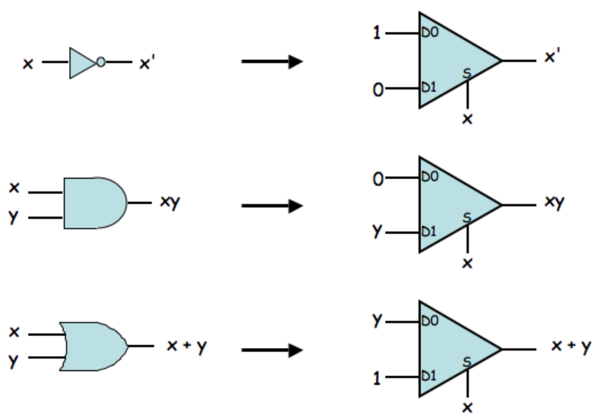


2. **Circuits**

a) Truth Table

S	D0	D1	
0	0	0	0
0	0	1	0
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	0
1	1	1	1

b)



3. **Audio list**

```
public class AudioPlayer {
    private Node start;  // first song
    private Node end;    // last song
    private Node cur;    // current song

   // a Node is a node in a linked list
    private class Node {
        private String filename;
        private Node next;
    }

    public AudioPlayer() {
        // create empty linked list
        start = null; end = null; cur = null;
    }

    // add song to the end of list
    public void addSong(String title) {
        Node tmp = new Node();
        tmp.filename = filename;
        tmp.next = null;
        if (start == null)
            end = start = tmp;
        else {
            end.next = tmp;
            end = end.next;
        }
    }

    // play and print the current song
    private void playCur() {
        System.out.println(``Now Playing: `` + cur.filename);
        StdAudio.play(cur.filename);
    }

    // play and print all songs
    public void playAll() {
        cur = start;
        while (cur != null) {
            this.playCur();
            cur = cur.next;
        }
    }
```

```
    // make requested song current, and play it and print it
    // assume it is in the list
    public void skipToThisSong(String filename) {
        cur = start;
        while (cur != null) {
          if (cur.filename.equals(filename)) {
            this.playCur();
            break;
          }
          cur = cur.next;
        }
    }

    // main (test client)
    public static void main(String[] args) {
        AudioPlayer player = new AudioPlayer();
        // read song filenames from StdIn and store in the
        // linked list
        while (!StdIn.isEmpty()) {
            String name = StdIn.readString();
            player.addSong(name);
        }
    }
}
```

4. **TOY**

```
//pop
60: 7101   R[1] <- 1              constant 1
61: 8202   R[2] <- mem[02]         stack pointer to R[2]
62: 2221   R[2] <- R[2] - R[1]    decrement stack pointer in R[2]
63: A302   R[3] <- mem[R[2]]      pop from stack and put result in R[3]
64: 9303   mem[03] <- R[3]        store popped item in memory
65: 9202   mem[02] <- R[2]        store new stack pointer
66: EF00   goto R[F]              TOY's return statement
```

5. **Object Oriented Programming**

```
public class STNew {

    private STLite list[];

     public STNew() {
         list = new STLite[10];
         for (int i = 0; i < 10; i++) list[i] = new STLite();

     }

     public void put(int key, String value) {
         list[key % 10].put(key, value);

     }

     public String get(int key) {
         return list[key % 10].get(key);

     }
}
```

6. **Queues**

```
public static Queue<Integer> QueueMerge(Queue<Integer> r, Queue<Integer> s){

    Queue<Integer> q = new Queue<Integer>();
    while ( !r.isEmpty() || !s.isEmpty() ) {
        if (r.isEmpty()) q.enqueue(s.dequeue());
        else if (s.isEmpty()) q.enqueue(r.dequeue());
        else if (r.peek() < s.peek()) q.enqueue(r.dequeue());
        else q.enqueue(s.dequeue());
    }
    return q;
}
```

7. **Regular Expressions**

a) (i) (A|B)(A|B) Answer: 4

(ii) AB+ Answer: ∞

(iii) AB* Answer: ∞

iv) AB Answer: 1

b) Answer: (i), (ii), (iii), and (iv)
Every regular expression specifies a set of strings that can be accepted by some deterministic finite state automaton.

c) In Java, the regular expression "\d" matches any digit. The equivalent is (0|1|2|3|4|5|6|7|8|9)

d) Each answer below is one or more of these strings.

A: `alphabet`
B: `abracadabra`
C: `babcock`
D: `hubbub`
E: `suburbia`
F: `dabchick`

(i) `ab` Answer: ABCF
(ii) `abc` Answer: CF
(iii) `a.*a` Answer: AB
(iv) `........*` (eight dots) Answer: ABCEF
(v) `bu(b|r)` Answer: DE

8. **Theory**

- T The Church-Turing Thesis is called a thesis and not a theorem because it is a statement about the real world that cannot be formally proved.
- T It's possible to write a program that can decide whether another program solves the halting problem.
- T In general, it is undecidable whether a Turing Machine will halt on a given input.
- F In general, it is undecidable whether a Turing Machine will halt on a given input after at most n steps.
- F If a problem is in P, then any program that solves that problem must run in polynomial time.
- T If a problem is in P, then it's possible to write a program that checks proposed solutions to that problem in polynomial time.
- T If a problem is in NP, then it's possible to write a program that checks proposed solutions to that problem in polynomial time.
- T If P=NP, then the Traveling Salesperson Problem can be solved in polynomial time.
- T If the Traveling Salesperson Problem can be solved in polynomial time, then P=NP.
- T When a DFA is processing a particular input string, its running time will always be polynomial in the length of that input string.