1. (10 points)
It is a tautolgy. (2 points)
Proof: truth table (8 points) or symbolic reasoning

p	q	LHS	RHS
T	T	F	F
T	F	F	F
F	T	T	T
F	F	T	T

2. (6/6/8 points each)
a) $\forall x(x \neq Joseph \leftrightarrow C(Sanjay, x))$
b) $\exists x \forall y(x = y \leftrightarrow I(y))$
c) $\exists x \exists y(x \neq y \wedge \forall z(C(x,z) \vee C(y,z))$
or $\exists x \exists y(x \neq y \wedge \forall z(C(x,z) \wedge C(y,z))$

3. a) (10 points)
a proof by contraposition
We must prove the contrapositive: if n is odd, then 3n+ 2 is odd.
Assume that if n is odd, then n=2k+ 1 for some integer k.
Then 3n+ 2 = 6k+ 5, which is also odd. And our proof is complete.
b) (10 points)
a proof by contradiction:
Suppose if 3n+ 2 is even and n is odd. since 3n+ 2 is even, so is 3n,
If we subtract an odd number n from an even number 3n, we get an odd number, so 3n-n=2n=odd. But this is an contradiction.
Therefore our supposition was wrong, and the proof by contradiction is complete.

4. (5 points each)
a) $n^2 \log n$
b) $n^2 (\log n)^2$
c) n^{2^n}
d) $\log n$

5. a) (5 points)
A propositional operator can be viewed as a function from ordered pairs of truth values to truth values.
Example: OR ((F,T)) = T.
b) (5 points)
A set operator can be viewed as a function from pairs of sets to sets.
Example: Intersec (({1,3},{3,4})) = {3}

6. a) (5 points)
linear: 1,2,3,4, ... 32 , average #: 16.5
binary: 16 -> 1, 8/24 -> 2, 4/12/20/28 -> 3, 2/6/10/14/18/22/26/30 ->4,
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 -> 5, average= 144/32 = 4.5

b) (5 points)
linear search: 1->2->3->4 comparison, average 2.5
binary search: average 4
16 -> 8 -> 4 -> 2 -> 1
16 -> 8 -> 4 -> 2
16 -> 8 -> 4 -> 2 -> 3
16 -> 8 -> 4

7. (15/5 points each)
a) $O(s^3)$ - 5 points, Plausible explanation - 10 points
b) $O(s^2)$ - 5 points