1. (a) Use the Laws of Logic to show: \( p \lor (\neg q \rightarrow r) \equiv r \lor (\neg p \rightarrow q) \)
(b) Find the negation of the following Universal Conditional:

\textbf{For all integers, } n \text{, if } n \text{ is odd, then } n \text{ is not divisible by 2.}

(c) Use the rules of inference to show the following is a valid argument:

\[
\begin{align*}
p & \rightarrow s \\
r & \land \neg s \\
(p \lor t) & \rightarrow \neg r \\
\therefore & \neg t
\end{align*}
\]

2. (a) Find \( A \times B \) for the sets \( A = \{0, 00\} \) and \( B = \{1, 11, 111\} \)
(b) Using the Properties of Sets, show that for any sets \( A \) and \( B \), \( A \cup (A \cap B) = A \)

3. (a) Find the inverse of the function \( F = \{(1,g), (2,d), (3,a), (4,b), (5,b)\} \).
(b) Why or why not is the inverse in (a) a function?
(c) Find \( F(G(x)) \) for the following Real-valued functions: \( F(x) = 2^{x+1} \) and \( G(x) = 3x - 5 \).
(d) Show that the function \( f: \mathbb{R} \rightarrow \mathbb{R} \) given by \( f(x) = 3(x + 2) \) is One-To-One and Onto.

4. (a) Use the Euclidean Algorithm to find \( \text{GCD}(444, 36) \).
(b) Find Big-O of the algorithm whose complexity is \( F(n) = [n^7(\log^2 n) + n^8 + 6n^3](n^5 + 3) \)

5. Prove 1 of the 2 Theorems below:

\textbf{Theorem 1:} For non-zero integers \( a, b, \) and \( c \), if \( (a \mod c) = (b \mod c) \), then \( a \equiv b \mod c \).

\textbf{Theorem 2:} The square root of 2 is irrational.

6. (a) Find the next 3 terms of the sequence \( s_n = (s_{n-1})(s_{n-2}) \) when \( s_0 = 1 \) and \( s_1 = 4 \).
(b) Calculate the following series: (i) \( \sum_{i=1}^{100} 5^i - 5^{i-1} \) (ii) \( \sum_{i=0}^{100} 5^i \)

7. Prove 1 of the 2 Theorems that follow by Mathematical Induction.

\textbf{Theorem 1:} If a set has \( n \) elements, then it has \( 2^n \) subsets.

\textbf{Theorem 2:} Is \( s_n = s_{n-1} + s_{n-2} + s_{n-3} + s_{n-4} \) when \( s_0 = s_1 = s_2 = s_3 = 1 \) then \( s_n < 4^n \) for all \( n \geq 4 \).

8. (a) A restaurant serves 5 soups, 6 salads, 20 entrees, 10 desserts, and 15 beverages. How many dinners can they create if each dinner consists of a soup or salad, an entree, and a dessert or beverage?
(b) How many binary strings of length 8 have: (i) 3 ones? (ii) at least seven zeros?
(c) (i) How many ways can 6 suspects form a viewing line? (ii) If a certain pair must stand next to one another?
(d) How many distinct piles of 100 coins (pennies, nickels, dimes, quarters, half-dollars, and dollars) can I create from a vast quantity of coins, if I must have at least 5 of each in a given pile?
9. Consider the following sets with corresponding number of elements indicated in each region:

(a) Find P(A)

(b) Find P(A \ (B \cap \ C))

10. (a) Find the inverse relation to

\[ R = \{(1,3),(2,2),(2,3),(3,1),(3,2),(3,3),(3,4),(3,5),(4,2),(4,5),(5,1)\}\]

\[ R^{-1} = \] ___________________________________________________________________

(b) Show that the relation \( S = \{(a,b) \mid a,b \text{ are integers and } a \mod 7 = b \mod 7\} \) is an Equivalence Relation.

(c) What partition of the integers does \( S \) induce?

11. (a) Find the truth table of the Boolean Polynomial \( F(x,y,z) = x'y + xy'z' \)

(b) Find the Disjunctive Normal Form of \( F(w,x,y,z) = x'y + xy'z' \)