(1) (5 Points) Make a truth table for \((p \lor q) \rightarrow (p \land q)\).

\[
\begin{array}{c|c|c|c}
p & q & (p \lor q) \rightarrow (p \land q) \\
\hline
T & T & T \\
T & F & F \\
F & T & T \\
F & F & T \\
\end{array}
\]

(2) (5 Points) Use a truth table to determine if the following argument is valid.

\((p \land q) \rightarrow r \land p \lor q \land r\)

(3) (10 Points) Rewrite the following formally (that is with symbols and labeling the variables) and determine if it is valid argument.

If Sally solved the problem correctly, then Sally obtained the answer \(z = 54\).

Sally obtained the answer \(z = 54\).

\(\therefore\) Sally solved the problem correctly.

Formal restatement:

Valid or invalid? __________________________

Justification:
(4) (15 Points) Write out the negations of the following sentences:
   (a) If $x$ is an integer, then $x(x + 1)$ is even.
   
   (b) The sum of any two irrational numbers is irrational.
   
   (c) Every mathematics student studies hard.
   
   (d) For any student, if the student likes football, then this has been a good year for the student.
   
   (e) There is a student that does not study, but gets A’s.

(5) (10 Points) Define the following
   (a) $n$ is an even number.
   
   (b) $n$ is an odd number.
   
   (c) $n$ is a prime number.
   
   (d) $n$ is a composite number.
   
   (e) $b$ is a factor of $n$. 
(6) (5 Points) Is $p \leftrightarrow q$ logically equivalent to $(p \land \sim q) \lor (\sim p \land q)$. Justify your answer.

     Justification: ______________________________

     answer ______________________________

(7) (5 Points) Change the repeating decimal 4.545454545\ldots to a ratio of integers.

     ______________________________

(8) (5 Points) Change $53A D_{16}$ to base 10.

     ______________________________

(9) (5 Points) Change $789_{10}$ to base 2.

     ______________________________
(10) (35 Points) For each of the following statements say if is true or false. If true give a proof. If false give a counterexample.

(a) The sum of four consecutive integers is even. 
   True or False? _____________________________
   Proof or counterexample:

(b) The sum of two odd numbers is divisible by 3. 
   True or False? _____________________________
   Proof or counterexample:
(c) For real numbers $x$ and $y$, $(x + y)^3 = x^3 + y^3$.  
Proof or counterexample:  

Ture or False?  

(d) If $n$ is odd then $n(n + 1)$ is even.  
 Proof or counterexample:  

Ture or False?  

(e) If $n = 2k + 3$ with $k$ an integer, then $n^2 - 1$ is divisible by 4.  
Proof or counterexample:  

Ture or False?