Homework 3

Code:

1. Mass Probability

```r
options(scipen = 999) # set the display format for large numbers

mass_prob <- function(){ # create a function named mass_prob to calculate
                         # the mass probability

  set.seed(304) # set seed to ensure that the random numbers generated
                # will be the same in each time

  p <- 0.1 # create a variable name p to store the probability of error that is 0.1

  n <- 4 # create a variable name n to store the number of bit transmitted that is 4

  outcomes <- 0:n # create a variable name outcomes to store the all possible outcomes

  prob <- dbinom(outcomes, size = n, prob = p) # calculate the mass probability
                                               # for all outcomes

  cat("The mass probabilities of all possible outcomes are", prob) # show the output of
                                                                   # the mass probability
                                                                   # for all outcomes
}

mass_prob() # run the function
```

2. Mean and Variance

```r
options(scipen = 999) # set the display format for large numbers

mean_var <- function(){ # create a function name mean_var to calculate
                        # the mean and the variance of this distribution

  set.seed(304) # set seed to ensure that the random numbers generated
                # will be the same in each time

  p <- 0.1 # create a variable name p to store the probability of error that is 0.1

  n <- 4 # create a variable name n to store the number of bit transmitted that is 4

  num_sim <- 100000 # create a variable name num_sim to store the number of simulations

  sim_data <- rbinom(num_sim, size = n, prob = p) # simulate 100000 sets of 4 bits transmission

  m <- mean(sim_data) # calculate the mean

  v <- var(sim_data) # calculate the variance

  cat("The mean of this distribution is", m, "\n") # show the output of the mean

  cat("The variance of this distribution is", v) # show the output of the variance

}

mean_var() # run the function
```

3. P(X =< 3)

```r
options(scipen = 999) # set the display format for large numbers

most_three <- function(){ # create a function name most_three to calculate
  # the probability that the most errors is 3

  set.seed(304) # set seed to ensure that the random numbers generated
  # will be the same in each time

  p <- 0.1 # create a variable name p to store the probability of error that is 0.1

  n <- 4 # create a variable name n to store the number of bit transmitted that is 4

  max <- 3 # Set the maximum number of errors to find the probability wanted

  prob_max_three <- pbinom(max, size = n, prob = p) # calculate the probability that
                                                    # the number of errors is less than
                                                    # or equal to the maximum number of errors

  cat("The probability that the most error are 3 is", prob_max_three) # show the output
                                                                      # of the probability
                                                                      # that the most
                                                                      # errors is 3

}

most_three() # run the function
```

4. Bar Graph

```r
options(scipen = 999) # set the display format for large numbers

bar <- function(){ # create a function name bar to show the bar graph of this distribution

  set.seed(304) # set seed to ensure that the random numbers generated
                # will be the same in each time

  p <- 0.1 # create a variable name p to store the probability of error that is 0.1

  n <- 4 # create a variable name n to store the number of bit transmitted that is 4

  outcomes <- 0:n # create a variable name outcomes to store the all possible outcomes

  prob <- dbinom(outcomes, size = n, prob = p) # calculate the mass probability
                                               # for all outcomes

  barplot(prob,names.arg = outcomes , col = "darkred", main = "Probability Distribution",
          xlab = "Number of Errors", ylab = "Probability") # plot the var graph

}

bar() # run the function
```

Result:

1. Mass Probability

```
> mass_prob() # run the function
The mass probabilities of all possible outcomes are 0.6561 0.2916 0.0486 0.0036 0.0001
```

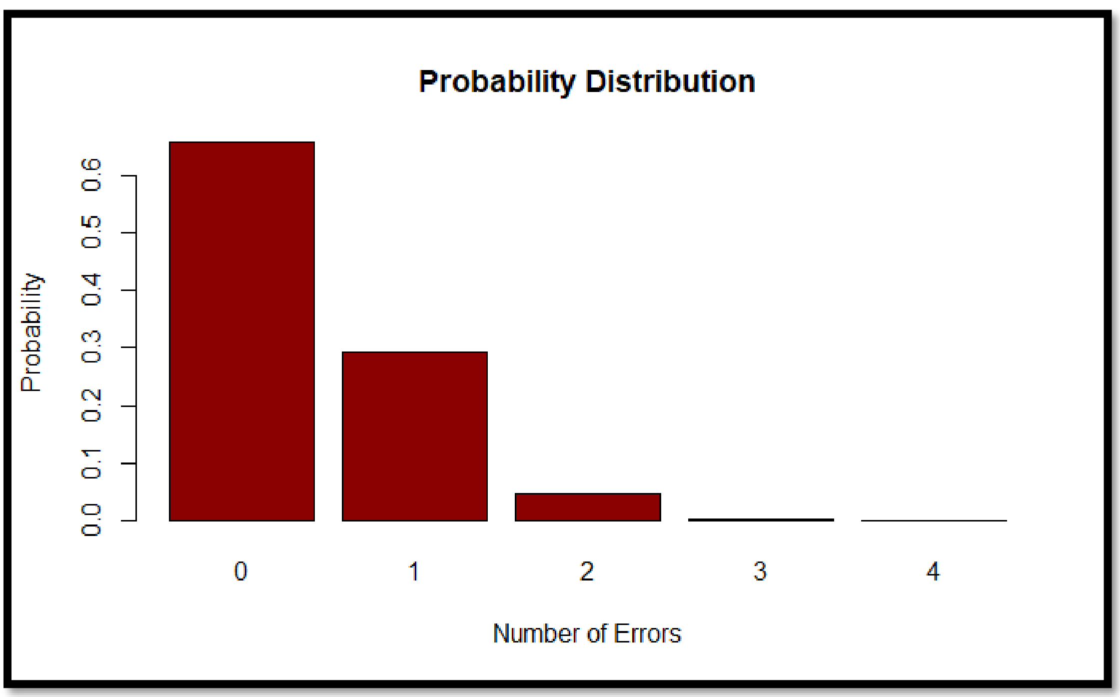
2. Mean and Variance

```
> mean_var() # run the function
The mean of this distribution is 0.39538
The variance of this distribution is 0.3586182
```

3. P(X =< 3)

```
> most_three() # run the function
The probability that the most error are 3 is 0.9999
```

4. Bar Graph



Conclusion:

From the experiment, the binomial distribution duplicates the probability of receiving a number of bit errors out of 4 transmitted bits, where the probability of error is 0.10. By calculating the probabilities, the outcome $P(X = 0)$ is the most probable outcome because it receives all 4 bits without any errors. The probabilities decrease as the number of errors increases. This is expected as getting more errors becomes less and less likely. The outcome $P(X = 4)$ is the least probable outcome because it is very unlikely to receive all 4 bits errors.