1. Write a program to determine the initial price of an American call and an American put option in the binomial model with the following data:

$$S(0) = 100; K = 100; T = 1; M = 100; r = 8\%; \sigma = 20\%.$$

Use the following set of u and d for your program:

$$u = e^{\sigma\sqrt{\Delta t} + \left(r - \frac{1}{2}\sigma^2\right)\Delta t}$$
; $d = e^{-\sigma\sqrt{\Delta t} + \left(r - \frac{1}{2}\sigma^2\right)\Delta t}$.

Here $\Delta t = \frac{T}{M}$, with M being the number of subintervals in the time interval [0,T]. Use the continuous compounding convention in your calculations (i.e., both in \tilde{p} and in the pricing formula).

Now, plot the initial prices of both call and put options by varying one of the parameters at a time (as given below) while keeping the other parameters fixed (as given above):

- (a) S(0).
- (b) *K*.
- (c) r.
- (d) σ .
- (e) M (Do this for three values of K, K = 95, 100, 105).
- 2. Write a program to determine the initial price of a *lookback* (European) option in the binomial model, using the basic binomial algorithm (used in earlier lab assignments), with the following data:

$$S(0) = 100; T = 1; r = 8\%; \sigma = 20\%.$$

The payoff of the lookback option is given by

$$V = \max_{0 \le i \le M} S(i) - S(M),$$

where $S(i) = S(i\Delta t)$ with $\Delta t = \frac{T}{M}$ (M being the number of subintervals of the time interval [0,T]). Use the continuous compounding convention in your calculations (i.e., both in \tilde{p} and in the pricing formula). Use the following values of u and d for your program:

$$u = e^{\sigma\sqrt{\Delta t} + \left(r - \frac{1}{2}\sigma^2\right)\Delta t}; \qquad d = e^{-\sigma\sqrt{\Delta t} + \left(r - \frac{1}{2}\sigma^2\right)\Delta t}$$

- (a) Obtain the initial price of the option for M = 5, 10, 25, 50.
- (b) How do the values of options at time t=0 compare for the above values of M that you have taken ?
- (c) Tabulate the values of the options at all intermediate time points for M=5.
- 3. Repeat Problem 2 using the (Markov based) computationally efficient binomial algorithm. Make a comparative analysis of the two algorithms, like computational time, the value of M it can handle, etc.