Part\_a,b.R

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# Black Scholes ----  
CallOption <- function(S,k, tau, r, sigma) {  
 d1 <- (log(S/k) + (r + sigma^2/2 ) \* tau) / (sigma \* sqrt(tau))  
 d2 <- d1 - sigma\*sqrt(tau)  
 price = S\*pnorm(d1) - k \* exp(-r\*tau)\*pnorm(d2)  
 return(price)  
   
   
}  
  
PutOption <- function(S,k, tau, r, sigma){  
   
 d1 <- (log(S/k) + (r + sigma^2/2 ) \* tau) / (sigma \* sqrt(tau))  
 d2 <- d1 - sigma\*sqrt(tau)  
 price <- k \* exp(-r\*tau) \* pnorm(-d2) - S\*pnorm(-d1)  
 return(price)  
}  
  
# ############Question 3 Exotic Options##########  
#part a ----  
EUpandOutCall <- function(S0,k,tau,r,sigma,div,H,N){  
 dt <- tau / N  
 nu <- r - (0.5 \* sigma^2)  
 dxu <- sqrt(sigma^2 \* dt + (nu \* dt)^2)  
 dxd <- -dxu  
 pu <- 0.5 + 0.5 \* ((nu \* dt) / dxu)  
 pd <- 1 - pu  
 disc <- exp(-r\*dt)  
   
 dpu <- disc \* pu  
 dpd <- disc \* pd  
 edxud <- exp( dxu - dxd)  
 edxd <- exp(dxd)   
   
   
 S <- c()  
 S[1] = S0 \* exp(N\*dxd)  
 S  
   
 for(i in 2:(N+1) ){  
 S[i] = S[i-1] \* exp(dxu - dxd)   
   
 }  
 S  
 C <- c()  
 for(i in 1:(N+1)) {  
 if(S[i] < H){  
 C[i] <- max(0 , (S[i] - k))  
 } else C[i] = 0  
 }  
 S  
 C  
 for(i in N:1) {  
 for(j in 1:i){  
 S[j] = disc \* (pu\*S[j+1] + pd \* S[j])  
 # S[j] = S[j] / exp(dxd)  
 if(S[j] < H){  
 C[j] = disc \* (pu \* C[j+1] + pd \* C[j])  
 } else  
 C[j] = 0  
 }  
 }  
 # print(S)  
 return(C[1])  
}   
  
EUpandOutCall(10,10,0.3,0.01,0.2,0,11,32)

## [1] 0.05359057

# part b----  
  
  
EUpandOutFormula <- function(S,k,tau,r,sigma,H,div){  
 v = r-div-(sigma^2/2)  
 dbs <- function(S,k) {  
 v = r-div-(sigma^2/2)  
 ans = (log(S/k) + v\*tau )/ (sigma\*sqrt(tau))  
 ans  
 return(ans)  
 }  
 part1 = CallOption(S,k,tau,r,sigma) - CallOption(S,H,tau,r,sigma) -  
 (H-k)\*exp(-r\*tau)\*pnorm(dbs(S,H))  
 part1  
 part2 = (H/S)^((2\*v)/sigma^2)\*(CallOption((H^2/S),k,tau,r,sigma) -  
 CallOption((H^2/S),H,tau,r,sigma)  
 -(H-k)\*exp(-r\*tau)\*pnorm(dbs(H,S)))  
 part2  
 answer = part1 - part2  
 answer  
 return(answer)  
}  
EUpandOutFormula(10,10,0.3,0.01,0.2,11,0)

## [1] 0.0530928

EUpandOutCall(10,10,0.3,0.01,0.2,0,11,32)

## [1] 0.05359057