# Ma374-LAB 1

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*The no-arbitrage condition of the model has been checked in the functions for calculating prices of call and put options which can be seen in code files in the functions binomial_call and binomial_put.*

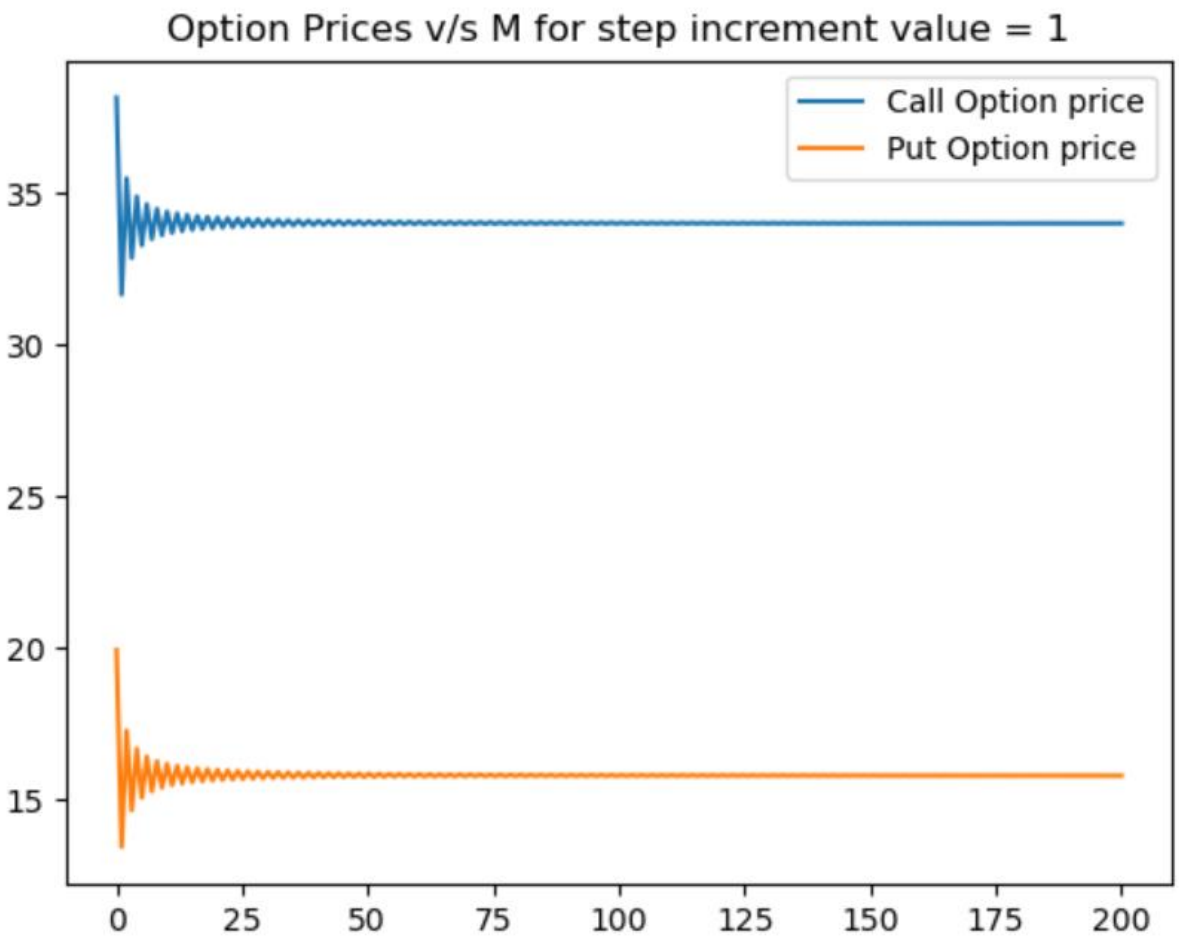
## Question 1.

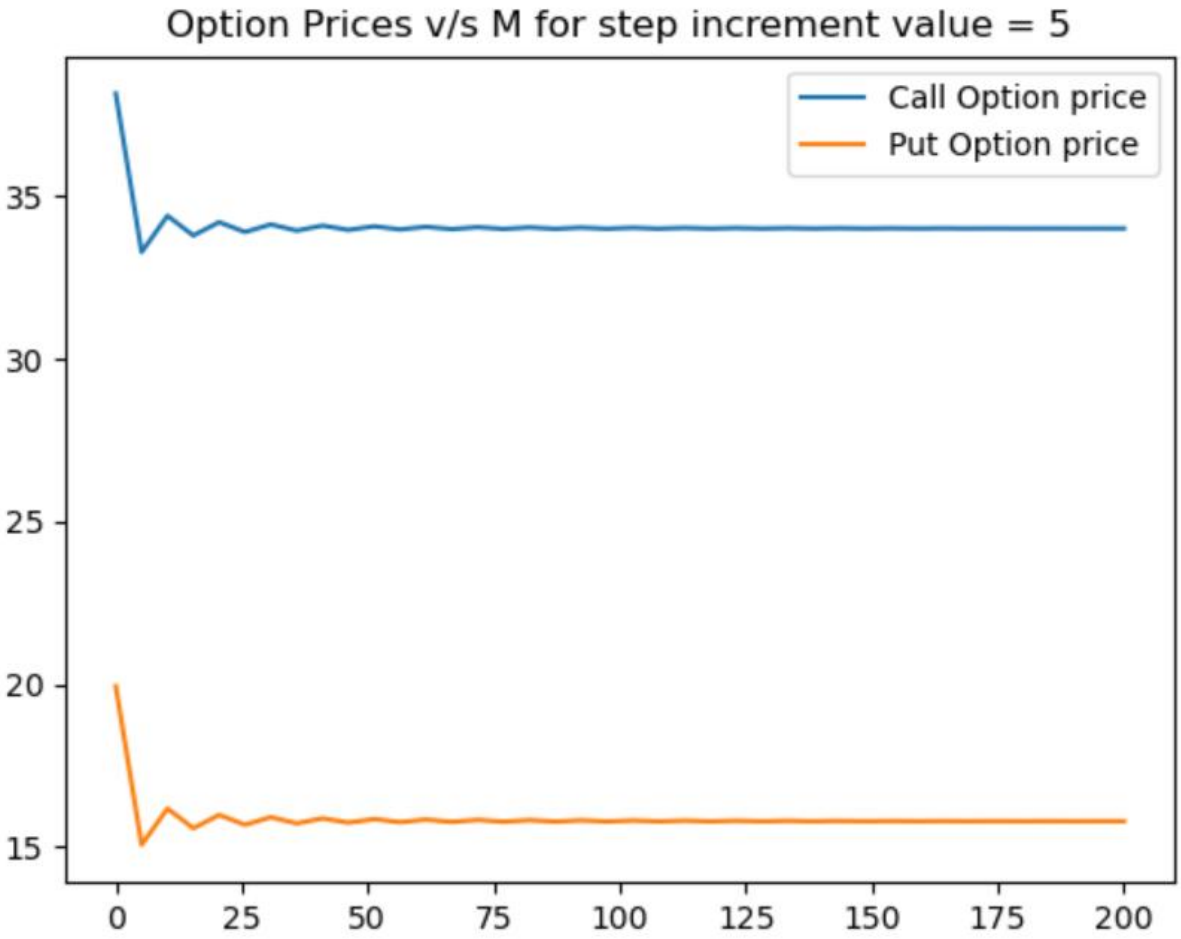
The initial option prices for varying values of M are tabulated below:

| M | Initial Call option price | Initial Put option price |
|---|---|---|
| **1** | 38.16763502522771 | 19.94171724772521 |
| **5** | 34.90653251138063 | 16.68061473387813 |
| **10** | 33.62502175314766 | 15.399103975645161 |
| **20** | 33.859449488493844 | 15.633531710991281 |
| **50** | 33.981184365719386 | 15.755266588217458 |
| **100** | 34.01116098479083 | 15.785243207287396 |
| **200** | 34.019578704408275 | 15.793660926904552 |
| **400** | 34.01913176900628 | 15.793213991506612 |

## Question 2.

The following plots were obtained varying M in steps of 1 and 5 ranging (0-200):






**As evident from the plots we can see that as M increases option prices converges.**

## Question 3.

According to the binomial pricing model the option prices can take (M+1) different values at the $M^{th}$ step depending on the number of UPs and DOWNs. The prices at different values of t are tabulated below:

| t | UPs | DOWNs | Call Price | Put Price |
|---|---|---|---|---|
| 0 | 0 | 0 | 33.859449488493844 | 15.633531710991281 |
| 0.5 | 0 | 2 | 15.095872513879765 | 24.67281716153607 |
| | 1 | 1 | 31.89325322224639 | 15.487143431401387 |
| | 2 | 0 | 59.9587689009226 | 8.47920422853985 |
| 1 | 0 | 4 | 5.15483112999247 | 35.96530361639755 |
| | 1 | 3 | 13.469716242796968 | 24.983286569394068 |
| | 2 | 2 | 29.803955121326947 | 15.269432108574843 |
| | 3 | 1 | 57.699994687175185 | 8.004223459740743 |
| | 4 | 0 | 100.66266571336138 | 3.504173897971972 |
| 1.5 | 0 | 6 | 1.1250032145209172 | 48.30495083519326 |
| | 1 | 5 | 4.1214046210274144 | 36.970072066516465 |
| | 2 | 4 | 11.767496962598836 | 25.27095963977737 |
| | 3 | 3 | 27.573204236383795 | 14.963371872697081 |
| | 4 | 2 | 55.29535567856727 | 7.436262009137822 |
| | 5 | 1 | 98.43886924880033 | 2.9982497452660715 |
| | 6 | 0 | 160.6113877530171 | 0.9424265244113356 |

| | | | | |
|---|---|---|---|---|
| 3 | 0 | 12 | 0.0 | 78.22822279375714 |
| | 1 | 11 | 0.0 | 72.35769482612886 |
| | 2 | 10 | 0.0 | 64.43331094390454 |
| | 3 | 9 | 0.11833014485168818 | 53.85484171072244 |
| | 4 | 8 | 1.2359711338578994 | 40.53331384641621 |
| | 5 | 7 | 6.148520463426529 | 25.95502392526393 |
| | 6 | 6 | 19.725206220102642 | 13.221828652306378 |
| | 7 | 5 | 46.97618778485105 | 4.958185582926971 |
| | 8 | 4 | 91.19343329629588 | 1.2357022342387147 |
| | 9 | 3 | 154.84169905359852 | 0.172102756885187 |
| | 10 | 2 | 242.03018282001366 | 0.008705281628291732 |
| | 11 | 1 | 359.93418379078935 | 0.0 |
| | 12 | 0 | 519.0996888507188 | 0.0 |
| 4.5 | 0 | 18 | 0.0 | 95.53406311515674 |
| | 1 | 17 | 0.0 | 93.12931642139074 |
| | 2 | 16 | 0.0 | 89.88324791682146 |
| | 3 | 15 | 0.0 | 85.50151375593354 |
| | 4 | 14 | 0.0 | 79.58679130640233 |
| | 5 | 13 | 0.0 | 71.60275111353513 |
| | 6 | 12 | 0.0 | 60.82542413915252 |
| | 7 | 11 | 0.0 | 46.2775544006557 |
| | 8 | 10 | 0.0 | 26.639984302677384 |
| | 9 | 9 | 8.149173872616739 | 8.281211219146936 |
| | 10 | 8 | 36.25149449124526 | 0.6015461682626717 |
| | 11 | 7 | 83.95057683153276 | 0.0 |
| | 12 | 6 | 149.14960563525577 | 0.0 |
| | 13 | 5 | 237.15908891136283 | 0.0 |
| | 14 | 4 | 355.9594650618289 | 0.0 |
| | 15 | 3 | 516.3231991518777 | 0.0 |
| | 16 | 2 | 732.7915980291059 | 0.0 |
| | 17 | 1 | 1024.993372815408 | 0.0 |
| | 18 | 0 | 1419.4245121000379 | 0.0 |