**GROUP A & B –**

A. Exact Solutions of One-Factor Plain Options

1. OUTPUT – matches with provided prices

Call Price of Batch 1: 2.13337

Put Price of Batch 1: 5.84628

Call Price of Batch 2: 7.96557

Put Price of Batch 2: 7.96557

Call Price of Batch 3: 0.204058

Put Price of Batch 3: 4.07326

Call Price of Batch 4: 92.1757

Put Price of Batch 4: 1.2475

1. OUTPUT – matches with part a.

Call Price Based on Put-Call Parity –

Batch 1 - Call Price corresponding to Put Price (5.84628) is 2.13337

Batch 2 - Call Price corresponding to Put Price (7.96557) is 7.96557

Batch 3 - Call Price corresponding to Put Price (4.07326) is 0.204058

Batch 4 - Call Price corresponding to Put Price (1.2475) is 92.1757

Put Price Based on Put-Call Parity -

Batch 1 - Put Price corresponding to Call Price (2.13337) is 5.84628

Batch 2 - Put Price corresponding to Call Price (7.96557) is 7.96557

Batch 3 - Put Price corresponding to Call Price (0.204058) is 4.07326

Batch 4 - Put Price corresponding to Call Price (92.1757) is 1.2475

Test if Options comply with Put-Call Parity -

For Batch 1: Put-Call Parity stands Validated

For Batch 2: Put-Call Parity stands Validated

For Batch 3: Put-Call Parity stands Validated

For Batch 4: Put-Call Parity stands Validated

1. OUTPUT –

On changing one parameter affecting option pricing -

|  |
| --- |
| Underlying Price Call Price Put Price |
| 60 0.152364 18.5683 |
| 61 0.201482 17.6174 |
| 62 0.262747 16.6786 |
| 63 0.338135 15.754 |
| 64 0.429724 14.8456 |
| 65 0.539648 13.9555 |
| 66 0.670065 13.086 |
| 67 0.823109 12.239 |
| 68 1.00085 11.4167 |
| 69 1.20525 10.6211 |
| 70 1.43811 9.854 |
| 71 1.70107 9.11697 |
| 72 1.99554 8.41143 |
| 73 2.32267 7.73857 |
| 74 2.68339 7.09929 |
| 75 3.07833 6.49422 |
| 76 3.50784 5.92374 |
| 77 3.97201 5.38791 |
| 78 4.47067 4.88656 |
| 79 5.00338 4.41927 |
| 80 5.56947 3.98537 |

**\*It is observed that as the price of the underlying asset increases the price of the put options falls while the price of the call options is increasing\***

1. OUTPUT -

| **Time** | **Strike** | **Volatility** | **Rate** | **Underlying** | **Dividend** | **Call Price** | **Put Price** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0.25 | 80 | 0.3 | 0.08 | 60 | 0 | 0.152364 | 18.5683 |
| 0.5 | 85 | 0.35 | 0.1 | 65 | 0.01 | 1.78203 | 17.9607 |
| 1 | 90 | 0.4 | 0.12 | 70 | 0.02 | 6.9795 | 18.1884 |
| 1.25 | 95 | 0.45 | 0.14 | 75 | 0.03 | 11.6235 | 19.1324 |
| 1.5 | 100 | 0.5 | 0.16 | 80 | 0.04 | 16.9055 | 20.2272 |
| 2 | 105 | 0.55 | 0.18 | 85 | 0.05 | 24.5944 | 20.9392 |
| 0.25 | 110 | 0.6 | 0.2 | 90 | 0.06 | 5.23243 | 21.2076 |

**Option Sensitivities, aka the Greeks**

1. OUTPUT-

Delta of Batch 6 call option: 0.594629

Delta of Batch 6 put option: -0.356601

Gamma of Batch 6 call and put option: 0.0134936

1. OUTPUT –

On changing one parameter affecting option sensitivity -

Underlying Price Call Delta Put Delta

85 0.289765 -0.661465

86 0.305241 -0.645989

87 0.320867 -0.630363

88 0.33661 -0.61462

89 0.352438 -0.598792

90 0.368319 -0.58291

91 0.384223 -0.567007

92 0.400118 -0.551111

93 0.415977 -0.535252

94 0.431772 -0.519457

95 0.447475 -0.503754

96 0.463062 -0.488168

97 0.478508 -0.472721

98 0.493791 -0.457438

99 0.50889 -0.442339

100 0.523785 -0.427444

101 0.538459 -0.412771

102 0.552894 -0.398335

103 0.567076 -0.384153

104 0.580992 -0.370237

105 0.594629 -0.356601

1. OUTPUT –

On changing multiple parameters affecting option sensitivity -

Time Strike Volatility Rate Underlying Dividend Call Delta Put Delta

0.25 85 0.3 0.1 85 0 0.595481 -0.404519

0.5 80 0.35 0.1 105 0.01 0.915305 -0.0797079

1 95 0.4 0.12 90 0.02 0.611208 -0.368991

1.25 90 0.45 0.14 95 0.03 0.709307 -0.253887

1.5 110 0.5 0.16 100 0.04 0.63254 -0.309225

2 105 0.55 0.18 85 0.05 0.610031 -0.294807

0.25 100 0.6 0.2 95 0.06 0.530105 -0.455007

d. OUTPUT –

The actual values of Call and Put Delta are – 0.530105 and -0.455007, respectively.

Slowly increasing the difference value(h) makes the value of delta/gamma less accurate. See below:

h Call Delta Approximation Put Delta Approximation Gamma Approximation

0.0001 0.530105 -0.455009 6.86278e-07

0.0011 0.530101 -0.455026 7.54988e-06

0.0021 0.530055 -0.455085 1.44145e-05

0.0031 0.529969 -0.455186 2.1281e-05

0.0041 0.529841 -0.455327 2.81502e-05

0.0051 0.529672 -0.45551 3.5023e-05

0.0061 0.529462 -0.455734 4.19003e-05

0.0071 0.529211 -0.455999 4.87829e-05

0.0081 0.528918 -0.456305 5.56716e-05

0.0091 0.528584 -0.456653 6.25673e-05

B. Perpetual American Options

1. OUTPUT –

Call Price of American Option: 18.5035

Put Price of American Option: 3.03106

1. OUTPUT –

On changing one parameter affecting option pricing -

Underlying Price Call Price Put Price

105 15.9316 4.04761

106 16.4249 3.81598

107 16.9286 3.5996

108 17.4429 3.39733

109 17.9678 3.20813

110 18.5035 3.03106

We observe that as the price of underlying increases, the price of call option increases and price of put option falls.

1. OUTPUT -

On changing multiple parameters affecting option pricing -

Strike Volatility Rate Underlying B-value Call Price Put Price

80 0.3 0.08 95 0 29.387 18.0135

120 0.25 0.1 100 0.01 18.2051 29.5114

90 0.1 0.12 105 0.02 18.6106 1.67569

95 0.15 0.14 90 0.03 13.2213 8.98532

100 0.05 0.16 110 0.04 16.4612 0.0383175

105 0.25 0.18 115 0.05 29.414 9.40949

110 0.2 0.2 120 0.06 27.605 5.78121