# Scientific Computing Lab  MA – 322  Lab – 9

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To calculate the exact value of the integral, I have used the inbuilt integral(f, a, b) function in MATLAB.

Absolute Error = | Exact Value – Approximate Value of the integral |

1)

a)

```
Question 1 Part a
Exact value of the integral = 0.1922593577
With n = 2,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 0.1922687064
Absolute Error = 0.0000093486

Using Gauss-Lagrange (Newton-Cotes) quadrature,
Approximate Value of the integral = 0.2280741233
Absolute Error = 0.0358147656

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = 0.2280741233
Absolute Error = 0.0358147656
```

b)

```
Question 1 Part b
Exact value of the integral = -0.1768200201
With n = 2,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = -0.1768189895
Absolute Error = 0.0000010307

Using Gauss-Lagrange (Newton-Cotes) quadrature,
Approximate Value of the integral = -0.1777643456
Absolute Error = 0.0009443255

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = -0.1777643456
Absolute Error = 0.0009443255
```

2)

a)

With n = 2,

```
Question 2 Part a
Exact value of the integral = 2.5886286325
With n = 2,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 2.5913247157
Absolute Error = 0.0026960832

Using Gauss-Lagrange (Newton-Cotes) quadrature,
Approximate Value of the integral = 4.1432596552
Absolute Error = 1.5546310227

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = 4.1432596552
Absolute Error = 1.5546310227
```

With n = 3,

```
Question 2 Part a
Exact value of the integral = 2.5886286325
With n = 3,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 2.5892580032
Absolute Error = 0.0006293707

Using Gauss-Lagrange (Newton-Cotes) quadrature,
Approximate Value of the integral = 2.5836964032
Absolute Error = 0.0049322293

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = 2.5836964032
Absolute Error = 0.0049322293
```

With n = 4,

```
Question 2 Part a
Exact value of the integral = 2.5886286325
With n = 4,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 2.5886327465
Absolute Error = 0.0000041140

Using Gauss-Lagrange (Newton-Cotes) quadrature,
Approximate Value of the integral = 2.5857890516
Absolute Error = 0.0028395809

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = 2.5877861301
Absolute Error = 0.0008425024
```

With n = 5,

```
Question 2 Part a
Exact value of the integral = 2.5886286325
With n = 5,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 2.5886286184
Absolute Error = 0.0000000141

Using Gauss-Lagrange (Newton-Cotes) quadrature,
Approximate Value of the integral = 2.5879684568
Absolute Error = 0.0006601757

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = 2.5886234981
Absolute Error = 0.0000051344
```

b)

With n = 2,

```
Question 2 Part b
Exact value of the integral = -0.7339691751
With n = 2,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = -0.7307230363
Absolute Error = 0.0032461388

Using Gauss-Lagrange (Newton-Cotes) quadrature,
Approximate Value of the integral = -0.8666666667
Absolute Error = 0.1326974916

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = -0.8666666667
Absolute Error = 0.1326974916
```

With n = 3,

```
Question 2 Part b
Exact value of the integral = -0.7339691751
With n = 3,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = -0.7337990223
Absolute Error = 0.0001701528

Using Gauss-Lagrange (Newton-Cotes) quadrature,
Approximate Value of the integral = -0.7391053391
Absolute Error = 0.0051361640

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = -0.7391053391
Absolute Error = 0.0051361640
```

With n = 4,

```
Question 2 Part b
Exact value of the integral = -0.7339691751
With n = 4,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = -0.7339603934
Absolute Error = 0.0000087816

Using Gauss-Lagrange (Newton-Cotes) quadrature,
Approximate Value of the integral = -0.7364276961
Absolute Error = 0.0024585210

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = -0.7342038638
Absolute Error = 0.0002346887
```

With n = 5,

```
Question 2 Part b
Exact value of the integral = -0.7339691751
With n = 5,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = -0.7339687248
Absolute Error = 0.0000004503

Using Gauss-Lagrange (Newton-Cotes) quadrature,
Approximate Value of the integral = -0.7341566684
Absolute Error = 0.0001874933

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = -0.7339804323
Absolute Error = 0.0000112573
```

We can observe that the approximate values of the integral by Gauss-Lobatto Quadrature and Gauss-Lagrange (Newton-Cotes) Quadrature

are the same for n = 2 and n = 3 and for n > 3, Gauss-Lobatto Quadrature is giving better approximate values of the given integrals.

3)

a)

With n = 2,

```
Question 3 Part a
Exact value of the integral = 0.6634936666
With n = 2,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 0.6658436940
Absolute Error = 0.0023500274

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = 1.9777954115
Absolute Error = 1.3143017449
```

With n = 4,

```
Question 3 Part a
Exact value of the integral = 0.6634936666
With n = 4,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 0.6634934393
Absolute Error = 0.0000002273

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = 0.6628177585
Absolute Error = 0.0006759082
```

b)

With n = 2,

```
Question 3 Part b
Exact value of the integral = 1.9334214962
With n = 2,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 1.9629727608
Absolute Error = 0.0295512646

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = 1.6674600503
Absolute Error = 0.2659614459
```

With n = 4,

```
Question 3 Part b
Exact value of the integral = 1.9334214962
With n = 4,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 1.9334168942
Absolute Error = 0.0000046020

Using Gauss-Lobatto quadrature,
Approximate Value of the integral = 1.9334666221
Absolute Error = 0.0000451259
```

4)

a)

With n = 2,

```
Question 4 Part a
Exact value of the integral = 0.7468241328
With n = 2,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 0.7465946883
Absolute Error = 0.0002294445
```

With n = 4,

```
Question 4 Part a
Exact value of the integral = 0.7468241328
With n = 4,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 0.7468244681
Absolute Error = 0.0000003353
```

With n = 6,

```
Question 4 Part a
Exact value of the integral = 0.7468241328
With n = 6,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 0.7468241329
Absolute Error = 0.0000000001
```

b)

With n = 2,

```
Question 4 Part b
Exact value of the integral = 2.6516353273
With n = 2,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 1.2631578947
Absolute Error = 1.3884774326
```

With n = 4,

```
Question 4 Part b
Exact value of the integral = 2.6516353273
With n = 4,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 2.0472850091
Absolute Error = 0.6043503183
```

With n = 6,

```
Question 4 Part b
Exact value of the integral = 2.6516353273
With n = 6,
Gaussian Quadrature:
Using Gauss-Legendre quadrature,
Approximate Value of the integral = 2.4116889286
Absolute Error = 0.2399463988
```