UNIVERSIDADE FEDERAL DE SANTA MARIA
CENTRO DE CIÊNCIAS NATURAIS E EXATAS
DEPARTEMENTO DE MATEMÁTICA

DISCIPLINA: MTM224 – Métodos Numéricos Computacionais
CURSO: Ciências da Computação - Bacharelado
HORAS/AULA: 60 hrs **ANO/PERÍODO:** 2024/02 **TURMA:** 15/307
PROFESSOR: Paulo F. C. Tilles

ATIVIDADE AVALIATIVA 05
TEORIA DE APROXIMAÇÃO

QUESTÃO 01

Obtenha a aproximação de mínimos quadrados polinomial de ordens 1 e 2 para o conjunto de pares ordenados disposto no banco de dados.

A solução deve conter a tabela com os valores calculados dos produtos x_i^n e $x_i^n y_i$, os valores das soma necessárias para construir o sistema linear, a estimativa dos parâmetros a_i de cada aproximação e um gráfico mostrando os pontos e as duas funções polinomiais ajustadas.

Os bancos de dados a serem utilizados por cada aluno estão especificados na **TABELA I** e definidos na **TABELA II**.

QUESTÃO 02

Obtenha a aproximação de mínimos quadrados com transformação logarítmica adequada para os dados apresentados nas tabelas dos bancos de dados.

A solução deve conter a tabela com os valores calculados dos produtos e das soma necessárias para construir o sistema linear, a estimativa dos parâmetros e o gráfico apropriadamente linearizado (na escala adequada) mostrando os pontos e a função de ajuste.

Os bancos de dados a serem utilizados por cada aluno estão especificados na **TABELA III** e definidos nas **TABELA IV** e **TABELA V**.

QUESTÃO 03

Considere a função

$$f(x) = \cos\left[c_0 + \frac{\sin(c_1 x)}{x^2+1}\right] + \sin\left(c_2 x^2\right).$$

I. Considere a aproximação da função $f(x)$ no intervalo $[-1, 1]$ em termos da expansão em polinômios de Legendre, definida por

$$f(x) \approx P_N(x) = \sum_{n=0}^{N} a_n \mathcal{P}_n(x).$$

Obtenha a aproximação de ordem $N = 10$ e construa gráficos comparando as aproximações P_0, P_2, P_4, P_6, P_8 e P_{10} com a função $f(x)$.

II. Considere a aproximação da função $f(x)$ no intervalo $[-1, 1]$ em termos da expansão em polinômios trigonométricos, definida por

$$f(x) \approx S_N(x) = \frac{a_0}{2} + \sum_{n=1}^{N} \left[a_n \cos(n\pi x) + b_n \sin(n\pi x)\right].$$

Obtenha a aproximação de ordem $N = 10$ e construa gráficos comparando as aproximações S_0, S_2, S_4, S_6, S_8 e S_{10} com a função $f(x)$.

A solução numérica deve ser apresentada na forma de uma tabela contendo a ordem k de iteração, o valor dos coeficientes de cada expansão, e os erros absoluto $EA_k^{(g)}$ e relativo $ER_k^{(g)}$ globais.

Os parâmetros $\{c_0, c_1, c_2\}$ a serem utilizados por cada aluno estão definidos na **TABELA VI**.

DIRETRIZES

1. Todos os resultados devem ser exibidos com no mínimo 6 dígitos significativos.

2. A solução deve ser enviada por email na forma de um único arquivo no formato pdf, com páginas ordenadas e numeradas. Cada aluno deve nomear o seu arquivo conforme descrito na **TABELA VII**.

3. Caso a solução apresentada não esteja em conformidade com alguma destas diretrizes a nota será nula.

TABELA I

Aluno	Banco de dados	Aluno	Banco de dados
ALAN BESSAUER LENCINA	Data 01	ALEXANDRE CHAGAS BRITES	Data 02
ANA LILIAN ALFONSO TOLEDO	Data 03	ANDERSON DALMOLIN CATTELAN	Data 04
ARTHUR BOGACKI VERISSIMO	Data 05	BIANCA SABRINA BUBLITZ	Data 06
BRUNO DOS SANTOS UMPIERRE	Data 07	BRUNO PERUSSATTO	Data 08
CARLOS EDUARDO VELOZO CORREA	Data 09	CELSO MAIA DA SILVA NETO	Data 10
DAVI DE CASTRO MACHADO	Data 11	DIEGO RIBEIRO CHAVES	Data 12
DOUGLAS MAGALHAES SILVA	Data 13	ENZO HAHN VERONEZE	Data 14
FERNANDO KALIKOSQUE LAYDNER JUNIOR	Data 15	FERNANDO MARINO MELCHIOR	Data 16
GABRIEL ATARAO DENARDI	Data 17	GABRIEL DA SILVA FRANCA	Data 18
GABRIEL PORTO DE FREITAS	Data 19	GABRIEL SOUZA BAGGIO	Data 20
GABRIEL STIEGEMEIER	Data 21	GUILHERME BRIZZI	Data 22
GUILHERME MENEGHETTI EINLOFT	Data 23	IGOR GUIMARAES	Data 24
JAIME ANTONIO DANIEL FILHO	Data 25	JOAO PEDRO AZENHA RIGHI	Data 26
JOAO PEDRO DA SILVA MARQUES	Data 27	JOAO VITOR DA SILVA	Data 28
LARISSA RODRIGUES SILVEIRA	Data 29	LEANDRO BRUM DA SILVA LACORTE	Data 30
LEANDRO OLIVEIRA GALBARINO DO NASCIMENTO	Data 31	LUCAS XAVIER PAIRE	Data 32
LUIS FERNANDO DA CRUZ ANTUNES	Data 33	LUIS GUSTAVO WERLE TOZEVICH	Data 34
LUIS HENRIQUE SILVEIRA POZZEBON	Data 35	MATHIAS ECKERT RECKTENVALD	Data 36
MIGUEL BRONDANI	Data 37	MIGUEL MIRON SILVA	Data 38
PEDRO DE ANDRADE SANTOS	Data 39	RAFAELA DA ROSA SOARES	Data 40
TOBIAS VIERO DE OLIVEIRA	Data 41	VIVIANE DILKIN ENDLER	Data 42
WESLEY LOPES DE OLIVEIRA	Data 43		

TABELA II | PARTE 01/02

		Data 01		Data 02		Data 03		Data 04		Data 05		Data 06		Data 07
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	4.74	19.37	4.9	23.1	5.85	28.42	5.79	27.89	4.38	18.62	4.53	17.95	4.28	23.75
2	6.81	30.59	7.87	28.85	7.87	27.85	7.87	27.21	6.57	30.27	6.09	28.67	7.43	31.17
3	9.11	36.93	8.25	29.07	9.13	34.35	8.63	34.09	9.	30.72	8.619	29.46	8.48	28.92
4	10.48	40.87	10.32	38.52	10.21	36.03	10.71	42.81	10.25	41.31	11.74	44.69	10.18	37.38
5	13.5	44.46	12.39	40.65	12.78	48.13	13.67	47.49	13.07	47.33	12.84	49.19	12.97	48.67
6	14.32	48.48	14.07	49.17	15.9	51.5	14.68	51.16	14.32	47.92	14.87	55.17	15.72	54.2
7	16.7	53.41	16.8	59.52	16.77	60.75	17.5	58.9	16.8	55.64	16.64	60.24	17.37	56.43
8	19.98	66.56	19.18	60.78	19.47	65.76	18.12	58.91	18.85	62.83	18.62	65.9	19.67	68.33
9	21.14	72.34	20.23	68.93	21.51	71.89	20.36	71.72	20.26	71.74	21.84	68.72	20.92	68.
10	23.95	79.	22.64	71.44	22.16	76.28	22.56	70.95	23.32	75.64	23.05	76.71	22.04	76.

		Data 08		Data 09		Data 10		Data 11		Data 12		Data 13		Data 14
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	4.46	19.22	5.31	23.57	5.1	22.22	4.	18.6	5.72	26.12	4.59	18.12	5.12	25.
2	7.42	26.97	7.28	26.68	6.09	25.27	7.58	30.66	7.68	29.16	7.88	32.44	6.24	23.47
3	8.01	31.99	8.89	34.31	8.43	28.45	8.039	28.51	9.41	33.71	8.59	30.29	9.93	33.55
4	10.83	38.77	11.72	39.56	11.25	37.39	10.77	38.31	10.15	33.73	11.35	41.09	10.66	35.54
5	13.18	46.58	12.55	40.69	13.08	47.44	12.14	46.38	13.15	44.89	12.79	48.84	12.97	48.59
6	14.27	46.48	15.64	56.8	15.14	56.3	15.72	54.08	14.11	50.61	15.22	53.5	15.83	53.05
7	16.93	54.51	17.07	56.88	17.64	59.08	16.45	53.59	17.62	57.53	17.55	56.49	16.57	57.51
8	19.67	69.21	18.26	63.42	19.98	69.2	19.41	62.35	19.87	65.2	19.12	63.6	18.1	64.14
9	20.66	68.22	20.31	69.16	21.27	73.61	20.7	72.38	21.72	70.39	20.88	70.64	21.66	74.5
10	23.61	75.26	22.23	77.45	22.81	78.58	23.93	79.83	22.34	70.5	22.84	79.11	23.6	81.08

		Data 15		Data 16		Data 17		Data 18		Data 19		Data 20		Data 21
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	5.019	21.94	5.52	25.52	5.04	22.64	4.82	17.82	4.07	18.85	4.5	18.06	4.03	16.93
2	7.06	27.46	7.	29.32	6.71	23.29	6.09	28.87	7.88	31.64	6.47	28.21	7.08	29.12
3	9.95	36.92	9.8	38.4	8.57	36.67	8.42	31.45	9.09	32.74	9.06	37.42	9.07	37.05
4	11.51	44.93	11.35	42.05	11.96	43.	10.03	40.84	11.97	45.07	10.83	38.01	11.84	44.44
5	12.4	47.44	12.05	44.99	13.73	48.55	13.73	48.03	12.3	44.9	13.96	50.8	13.94	48.54
6	14.23	50.57	15.68	55.64	15.83	51.05	15.74	57.34	14.93	53.71	14.88	52.64	15.81	56.03
7	16.82	55.45	16.03	51.49	17.43	56.69	17.46	56.18	17.68	60.76	17.18	57.18	16.84	58.04
8	19.87	65.09	19.41	68.39	19.18	65.41	19.12	64.83	19.46	66.5	18.9	62.98	18.19	60.85
9	20.63	69.17	20.05	67.47	21.48	69.24	21.16	73.56	21.5	68.1	21.71	72.33	21.36	71.28
10	22.82	75.22	23.38	75.22	23.6	76.32	23.44	80.28	22.67	78.73	22.11	73.81	22.29	75.15

		Data 22		Data 23		Data 24		Data 25		Data 26		Data 27		Data 28
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	5.16	23.68	5.49	22.47	5.78	26.78	4.13	20.87	5.75	27.37	4.57	19.99	5.75	26.45
2	7.76	32.64	6.81	30.91	7.22	29.05	7.62	30.3	6.61	28.55	6.1	25.45	7.57	27.19
3	9.289	32.79	8.8	36.16	9.56	39.6	9.56	36.75	9.57	34.59	8.619	31.38	9.91	39.77
4	11.34	44.09	10.15	37.89	11.96	40.68	11.69	41.15	11.39	40.53	10.89	42.75	10.37	35.5
5	12.59	41.49	12.47	42.65	12.24	44.32	13.01	49.75	12.98	47.46	12.43	42.53	12.35	46.16
6	15.01	52.55	15.27	49.88	14.72	48.2	14.99	54.49	14.28	46.66	15.9	55.02	14.75	49.53
7	17.22	60.26	16.11	54.85	16.26	54.22	16.59	56.45	17.39	56.29	17.52	58.12	17.92	61.2
8	18.84	62.55	18.7	63.21	18.85	66.67	19.66	62.06	19.84	68.95	19.07	66.51	19.69	66.35
9	21.54	73.22	20.01	66.87	21.72	73.28	20.57	71.31	21.03	70.73	21.05	66.43	20.64	67.72
10	23.42	74.54	23.88	80.28	22.15	77.	23.96	78.39	22.19	75.05	23.02	79.82	23.	74.08

TABELA II | PARTE 02/02

		Data 29		Data 30		Data 31		Data 32		Data 33		Data 34		Data 35
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	4.89	23.79	4.41	22.95	4.1	17.93	4.09	17.87	5.05	25.43	4.309	21.05	4.03	22.13
2	7.91	33.93	6.41	26.91	7.3	26.82	7.5	25.86	7.85	33.5	7.639	30.32	6.55	28.65
3	9.83	35.05	8.789	30.52	8.42	29.45	9.07	36.57	9.95	35.72	8.369	34.03	9.67	34.49
4	11.57	42.91	10.73	37.34	11.71	42.73	10.03	36.04	11.38	40.38	11.39	40.17	10.26	36.82
5	12.09	42.99	12.22	40.62	12.45	46.74	12.43	42.21	13.48	45.4	12.06	47.01	12.78	46.01
6	15.99	58.25	15.61	51.23	14.17	53.15	14.82	54.18	15.72	53.32	15.49	51.51	14.4	54.12
7	16.62	56.29	16.7	59.34	16.43	57.76	16.5	52.65	16.19	54.29	16.41	55.99	16.36	53.88
8	19.35	64.81	18.62	60.86	19.9	63.73	19.47	66.56	18.11	59.57	19.28	64.03	18.02	61.78
9	21.64	71.32	21.71	75.93	20.76	69.48	21.31	72.73	21.68	70.03	20.27	67.81	20.98	70.53
10	22.17	76.75	23.43	74.44	22.67	72.29	23.16	79.28	23.79	78.21	23.61	80.26	23.99	76.56

		Data 36		Data 37		Data 38		Data 39		Data 40		Data 41		Data 42
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	5.54	20.18	5.6	24.08	4.96	17.92	4.769	20.95	5.67	26.93	4.12	22.64	5.17	19.34
2	7.84	26.55	7.73	29.83	6.34	25.3	6.59	29.21	7.41	32.35	7.82	26.78	6.82	27.42
3	9.25	32.11	8.289	35.3	9.869	35.69	9.539	39.05	9.35	32.8	9.64	37.68	8.46	34.14
4	10.55	39.97	10.31	41.05	10.91	43.57	10.28	35.12	11.79	38.84	11.08	38.68	10.47	41.45
5	12.68	45.28	12.34	41.13	13.02	42.94	12.	42.08	12.74	46.06	12.45	44.94	12.25	44.71
6	15.69	56.03	15.66	55.7	15.23	55.53	14.12	51.84	15.86	52.98	14.08	49.04	15.96	57.4
7	17.45	58.03	16.12	54.07	17.45	55.63	17.87	58.17	17.87	63.21	16.21	56.11	17.66	62.62
8	18.67	65.89	20.	67.95	18.57	60.45	19.76	67.44	18.48	62.26	18.44	58.48	19.81	66.58
9	21.48	69.56	21.78	69.5	21.91	71.65	21.77	74.15	21.91	72.85	21.94	70.46	21.65	75.5
10	23.85	82.55	23.82	79.78	23.39	76.53	23.56	75.44	22.7	74.25	23.66	79.58	23.46	73.86

		Data 43
k	x_k	y_k
1	5.88	24.64
2	6.769	29.3
3	8.5	30.82
4	10.72	42.28
5	13.62	44.14
6	14.42	48.78
7	16.93	60.86
8	18.32	62.23
9	20.12	63.48
10	22.6	76.36

TABELA III

Aluno	Banco de dados		Aluno	Banco de dados	
ALAN BESSAUER LENCINA	Data A01	Data B01	ALEXANDRE CHAGAS BRITES	Data A02	Data B02
ANA LILIAN ALFONSO TOLEDO	Data A03	Data B03	ANDERSON DALMOLIN CATTELAN	Data A04	Data B04
ARTHUR BOGACKI VERISSIMO	Data A05	Data B05	BIANCA SABRINA BUBLITZ	Data A06	Data B06
BRUNO DOS SANTOS UMPIERRE	Data A07	Data B07	BRUNO PERUSSATTO	Data A08	Data B08
CARLOS EDUARDO VELOZO CORREA	Data A09	Data B09	CELSO MAIA DA SILVA NETO	Data A10	Data B10
DAVI DE CASTRO MACHADO	Data A11	Data B11	DIEGO RIBEIRO CHAVES	Data A12	Data B12
DOUGLAS MAGALHAES SILVA	Data A13	Data B13	ENZO HAHN VERONEZE	Data A14	Data B14
FERNANDO KALIKOSQUE LAYDNER JUNIOR	Data A15	Data B15	FERNANDO MARINO MELCHIOR	Data A16	Data B16
GABRIEL ATARAO DENARDI	Data A17	Data B17	GABRIEL DA SILVA FRANCA	Data A18	Data B18
GABRIEL PORTO DE FREITAS	Data A19	Data B19	GABRIEL SOUZA BAGGIO	Data A20	Data B20
GABRIEL STIEGEMEIER	Data A21	Data B21	GUILHERME BRIZZI	Data A22	Data B22
GUILHERME MENEGHETTI EINLOFT	Data A23	Data B23	IGOR GUIMARAES	Data A24	Data B24
JAIME ANTONIO DANIEL FILHO	Data A25	Data B25	JOAO PEDRO AZENHA RIGHI	Data A26	Data B26
JOAO PEDRO DA SILVA MARQUES	Data A27	Data B27	JOAO VITOR DA SILVA	Data A28	Data B28
LARISSA RODRIGUES SILVEIRA	Data A29	Data B29	LEANDRO BRUM DA SILVA LACORTE	Data A30	Data B30
LEANDRO OLIVEIRA GALBARINO DO NASCIMENTO	Data A31	Data B31	LUCAS XAVIER PAIRE	Data A32	Data B32
LUIS FERNANDO DA CRUZ ANTUNES	Data A33	Data B33	LUIS GUSTAVO WERLE TOZEVICH	Data A34	Data B34
LUIS HENRIQUE SILVEIRA POZZEBON	Data A35	Data B35	MATHIAS ECKERT RECKTENVALD	Data A36	Data B36
MIGUEL BRONDANI	Data A37	Data B37	MIGUEL MIRON SILVA	Data A38	Data B38
PEDRO DE ANDRADE SANTOS	Data A39	Data B39	RAFAELA DA ROSA SOARES	Data A40	Data B40
TOBIAS VIERO DE OLIVEIRA	Data A41	Data B41	VIVIANE DILKIN ENDLER	Data A42	Data B42
WESLEY LOPES DE OLIVEIRA	Data A43	Data B43			

TABELA IV | PARTE 01/02

	Data A01		Data A02		Data A03		Data A04		Data A05		Data A06		Data A07		Data A08	
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	11.24	17.45	10.92	21.	10.63	15.03	10.73	15.88	11.18	16.17	10.38	19.55	11.2	20.23	11.64	19.33
2	13.34	26.57	12.78	21.56	13.64	29.52	13.06	22.31	12.36	21.52	12.72	26.63	12.74	26.6	13.45	24.65
3	15.1	33.24	14.7	29.53	14.91	30.04	14.74	32.11	14.56	29.46	15.3	30.31	14.68	29.06	15.43	33.97
4	16.68	34.69	17.2	40.64	16.56	35.64	17.51	39.07	16.63	35.37	16.94	40.34	17.28	42.2	16.6	37.1
5	18.97	48.57	19.28	49.29	19.5	52.38	19.59	48.06	19.44	48.99	18.34	45.81	18.73	43.17	18.52	47.73
6	21.6	57.6	21.66	58.68	20.48	53.52	20.98	57.94	20.91	54.74	20.55	54.15	20.84	52.83	21.3	58.2
7	23.08	64.95	22.53	66.74	22.62	65.59	23.28	68.64	23.6	70.78	23.26	68.11	22.82	65.6	23.01	63.72
8	25.28	74.27	25.32	77.01	25.38	80.43	25.18	78.64	24.82	72.16	24.54	74.4	24.9	78.54	24.83	74.76
9	27.26	85.69	26.81	85.01	27.46	91.14	27.54	87.39	27.09	84.39	26.43	80.86	27.31	87.91	26.76	85.28
10	28.86	97.36	28.86	99.46	28.38	94.58	29.03	96.73	28.64	96.19	29.36	99.58	29.19	102.1	29.11	100.
11	30.72	109.7	31.42	111.3	30.74	105.5	31.43	111.2	30.68	108.9	30.49	105.2	30.37	104.2	30.37	104.9
12	32.75	122.7	32.63	121.3	32.78	119.4	33.25	122.6	33.42	127.2	32.77	122.9	33.38	126.5	33.28	123.8
13	34.37	132.3	35.06	135.	34.47	131.6	34.93	133.1	34.75	131.6	35.27	138.3	34.68	132.3	34.94	137.7
14	37.38	153.1	37.34	150.2	37.03	150.5	37.12	147.1	36.36	143.4	37.65	152.5	36.94	147.2	37.46	155.
15	39.28	166.1	39.42	163.5	39.28	166.3	39.11	164.9	38.56	163.4	38.38	162.3	39.19	163.	38.47	156.6

	Data A09		Data A10		Data A11		Data A12		Data A13		Data A14		Data A15		Data A16	
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	10.68	20.54	10.65	19.02	11.57	17.7	10.84	18.72	10.74	16.63	10.52	18.46	10.78	16.18	11.36	18.32
2	12.5	23.03	13.45	25.39	12.9	23.69	13.46	29.28	12.33	21.74	13.58	23.77	13.63	26.33	12.7	23.11
3	14.36	28.59	14.47	27.87	15.51	32.5	15.42	31.29	15.4	35.64	15.5	35.54	15.09	29.76	14.84	32.24
4	17.26	41.12	17.64	43.22	17.56	38.46	16.56	35.58	16.76	38.03	16.54	36.67	16.65	39.18	16.64	40.16
5	18.98	50.36	19.13	48.42	19.	46.51	19.06	48.84	18.64	47.04	19.54	47.92	19.51	48.71	18.84	44.63
6	20.78	53.56	20.89	54.74	20.88	55.98	21.35	58.98	20.73	58.14	20.34	56.22	21.34	57.71	21.6	57.37
7	23.5	66.88	23.21	66.01	22.38	63.16	23.26	64.11	22.89	62.33	22.57	61.37	22.35	61.17	22.55	64.07
8	25.48	79.63	25.12	74.36	25.06	78.25	24.98	74.72	24.7	73.03	24.73	77.64	25.56	76.52	24.78	74.58
9	27.37	91.51	26.78	84.96	27.36	90.48	26.5	82.05	26.89	83.85	27.62	93.17	26.77	85.39	27.62	93.04
10	28.96	99.17	29.64	104.4	28.82	94.66	29.46	101.4	28.96	96.68	29.59	103.6	28.6	96.58	28.52	96.79
11	30.45	104.8	31.04	109.5	31.19	111.5	31.5	113.4	30.95	109.6	31.42	111.2	30.93	109.7	30.5	108.2
12	33.3	125.7	32.64	120.3	33.24	123.2	32.92	124.3	33.43	128.8	32.52	122.4	32.9	121.3	32.43	121.6
13	34.85	135.1	34.82	131.7	35.49	140.8	35.17	137.1	35.57	139.1	35.03	137.6	35.1	137.7	34.75	135.2
14	36.5	146.	36.34	141.8	37.62	150.5	37.04	151.7	36.46	148.8	36.36	141.9	37.01	149.6	36.79	149.4
15	38.63	158.	38.91	163.7	38.93	160.	39.43	169.3	38.48	161.7	39.14	163.1	38.61	161.7	38.8	160.8

	Data A17		Data A18		Data A19		Data A20		Data A21		Data A22		Data A23		Data A24	
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	10.98	17.34	10.73	16.21	11.38	20.28	10.41	20.21	11.52	22.81	10.36	16.23	10.92	16.63	11.09	21.92
2	13.06	23.6	13.43	27.55	12.8	21.67	13.36	24.93	13.08	22.41	13.35	27.05	12.88	24.83	12.52	20.64
3	14.96	31.41	15.2	30.77	14.33	29.47	14.44	26.31	14.9	28.01	15.18	29.43	15.66	35.35	15.	34.88
4	16.4	35.86	17.14	42.3	16.46	35.95	16.64	36.06	17.66	44.9	17.27	39.54	17.44	38.74	16.53	38.55
5	18.67	46.79	19.46	49.68	19.41	49.84	19.56	47.52	18.38	44.34	19.3	45.47	19.03	49.76	19.14	48.98
6	20.62	57.86	21.33	61.22	20.54	52.12	21.41	60.43	20.78	58.62	21.46	56.88	21.51	60.1	20.74	56.9
7	22.86	64.53	23.22	68.45	23.23	63.78	22.9	63.46	22.36	61.03	23.07	69.39	23.17	63.71	23.08	63.62
8	25.26	78.53	25.28	74.34	25.17	76.04	24.5	71.26	24.8	76.15	25.64	80.01	24.56	74.74	25.56	77.95
9	27.3	86.57	26.82	88.31	26.95	84.81	27.62	91.17	27.28	90.06	26.63	81.65	26.88	89.28	26.9	87.75
10	28.78	94.26	29.47	103.9	28.81	94.02	28.72	94.78	28.96	100.3	29.47	100.	28.46	94.52	29.17	98.42
11	30.72	106.5	30.58	108.3	30.36	107.4	31.28	110.7	31.64	112.9	30.67	110.8	30.88	107.6	31.16	109.8
12	32.52	122.7	32.78	120.2	33.62	126.5	33.42	127.2	33.62	127.9	32.91	123.5	33.02	123.4	33.61	128.9
13	35.54	136.5	34.85	132.1	34.72	130.7	34.6	136.1	34.54	134.9	35.59	141.6	34.94	132.8	34.92	132.8
14	37.	152.2	37.4	153.4	37.42	154.1	36.91	149.	37.12	148.	36.62	144.	37.43	149.7	37.14	147.6
15	39.03	164.	38.7	160.4	38.62	161.4	38.86	164.4	39.57	169.6	38.73	160.1	39.43	169.9	39.03	163.2

TABELA IV | PARTE 02/02

	Data A25		Data A26		Data A27		Data A28		Data A29		Data A30		Data A31		Data A32	
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	10.92	17.98	11.44	22.64	11.18	20.2	10.35	15.84	11.42	22.07	11.1	21.2	11.6	18.02	10.95	16.31
2	13.57	27.72	13.06	23.38	12.36	23.92	13.53	23.29	13.2	23.24	12.62	21.74	13.54	26.63	12.83	25.31
3	15.33	32.04	15.39	34.72	14.78	31.85	14.53	29.33	15.4	30.31	14.8	31.02	15.36	30.96	14.64	28.79
4	16.89	38.56	16.83	39.09	16.37	37.76	17.26	40.48	16.9	35.65	17.13	42.28	17.06	39.72	16.94	42.14
5	19.56	52.58	18.85	49.72	19.19	50.82	18.96	49.74	18.62	42.79	18.69	44.74	18.52	43.73	18.5	47.12
6	21.59	58.27	20.42	56.71	20.6	54.9	21.39	60.23	20.34	53.12	21.21	55.73	21.54	59.92	20.46	55.73
7	23.55	67.68	23.51	67.71	23.36	68.88	23.65	67.61	22.87	68.6	23.56	69.51	23.58	67.84	23.04	68.05
8	24.51	70.66	24.53	75.27	24.4	74.31	25.66	78.05	25.63	76.78	25.3	79.34	24.71	72.07	24.47	73.16
9	27.66	87.92	27.42	92.45	26.7	87.35	27.54	92.89	26.37	81.	26.46	83.87	26.36	82.62	27.49	90.89
10	28.98	98.49	28.78	98.13	29.24	97.24	29.4	101.3	28.7	93.73	29.51	101.6	29.66	99.56	28.91	99.03
11	31.54	114.6	30.69	107.5	31.22	112.6	30.73	111.	30.43	106.6	30.93	107.3	31.54	111.1	31.05	108.3
12	32.47	117.1	33.07	122.3	33.3	126.9	33.29	124.1	33.03	126.	33.06	121.9	32.93	121.5	33.25	124.6
13	34.47	130.2	34.56	133.4	35.25	135.	34.83	132.	34.96	138.3	35.02	133.2	35.2	133.9	35.56	140.6
14	37.26	154.1	36.52	143.3	36.4	145.4	36.62	145.1	37.43	151.4	36.69	147.1	36.74	149.	36.48	148.9
15	38.49	162.	39.25	164.	39.57	167.1	39.46	164.8	38.64	164.3	38.75	163.6	39.52	169.5	38.99	160.4

	Data A33		Data A34		Data A35		Data A36		Data A37		Data A38		Data A39		Data A40	
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	11.1	21.42	11.5	21.64	10.58	19.53	10.67	16.27	10.5	17.8	11.18	20.76	10.47	20.08	11.38	21.19
2	13.06	22.28	12.47	25.99	12.66	25.74	13.32	26.73	12.41	25.63	12.76	24.54	13.02	22.87	13.23	22.92
3	15.51	34.17	15.6	36.19	14.42	27.8	14.45	29.36	14.92	28.63	14.89	30.8	14.72	29.47	14.76	32.99
4	17.44	42.01	17.38	42.83	16.56	34.84	17.16	40.38	16.92	40.7	16.72	39.74	17.12	39.66	17.51	43.64
5	19.47	51.94	18.52	43.77	19.53	49.5	19.65	49.43	18.43	47.94	18.42	43.88	19.38	48.62	18.37	42.95
6	20.58	55.21	21.48	56.57	21.55	58.25	20.38	50.87	20.34	53.95	20.9	56.04	21.42	59.92	21.16	57.64
7	23.66	66.98	22.57	63.6	22.78	63.77	22.9	64.13	22.76	61.78	23.54	69.94	22.99	64.29	23.3	69.88
8	24.52	71.13	24.85	76.63	24.42	75.15	24.34	69.57	24.36	69.61	25.16	80.	24.71	75.4	24.74	72.84
9	26.34	86.12	26.48	80.92	27.02	84.18	27.49	92.62	27.6	88.52	26.91	86.93	26.6	84.6	27.32	87.75
10	29.6	98.99	29.59	102.	29.04	97.37	28.65	95.06	28.74	93.59	28.82	99.06	29.11	98.6	28.43	93.06
11	30.72	108.6	30.64	110.1	31.4	114.7	31.16	112.6	30.47	108.2	30.74	106.4	30.58	110.5	30.65	110.9
12	33.02	122.1	33.35	127.6	33.63	129.7	33.48	123.	32.82	121.8	33.39	127.5	32.54	118.1	33.25	121.5
13	35.04	135.2	35.49	137.4	34.86	134.6	34.51	134.6	34.88	133.4	34.96	135.9	34.78	133.	34.33	130.3
14	37.65	156.7	36.79	150.8	37.32	154.1	37.48	149.5	36.6	148.1	37.45	153.8	36.55	145.9	36.47	147.1
15	38.76	164.2	39.51	166.3	39.3	168.5	39.19	166.	38.38	158.8	38.81	159.9	39.44	165.2	38.71	158.2

	Data A41		Data A42		Data A43	
k	x_k	y_k	x_k	y_k	x_k	y_k
1	11.17	18.88	10.34	13.92	10.56	16.35
2	12.4	21.29	13.51	28.72	12.57	20.81
3	14.45	29.46	14.96	29.67	14.65	32.3
4	16.46	35.29	16.73	36.22	17.1	39.54
5	18.85	48.55	18.79	47.9	18.64	44.11
6	20.92	58.87	21.39	55.87	20.8	57.98
7	22.64	62.06	22.52	64.21	22.89	67.96
8	24.75	73.07	25.54	80.45	25.17	74.77
9	27.08	90.12	27.43	88.28	26.84	84.49
10	29.33	101.4	28.62	94.3	28.97	101.4
11	31.36	111.7	30.33	105.1	30.78	112.
12	33.64	125.7	32.6	118.6	33.18	125.2
13	35.19	139.6	35.27	136.6	35.33	139.8
14	37.54	152.5	36.64	144.7	36.57	145.3
15	38.53	157.5	38.66	162.	39.64	164.9

TABELA V | PARTE 01/02

	Data B01		Data B02		Data B03		Data B04		Data B05		Data B06		Data B07		Data B08	
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	12.42	5.543	11.97	3.735	12.68	4.112	12.24	4.719	11.93	3.183	12.66	6.422	12.59	6.97	12.48	2.869
2	14.03	3.737	14.47	5.628	14.78	5.592	14.52	8.232	14.89	7.263	13.97	6.202	14.03	3.632	14.26	4.678
3	16.63	7.622	16.65	8.8	16.38	7.382	16.6	10.48	16.38	10.53	16.18	9.15	16.29	9.719	16.35	6.892
4	19.23	14.55	18.68	13.54	18.45	14.12	18.69	11.71	18.55	12.29	18.97	14.57	18.81	10.05	19.25	15.25
5	21.5	17.13	20.78	15.18	21.15	16.57	20.57	14.07	21.38	19.32	21.39	18.29	21.27	16.78	21.17	20.48
6	23.32	24.04	23.09	25.54	23.37	26.69	22.74	24.26	23.14	24.41	22.7	21.32	23.62	27.6	23.13	24.92
7	25.54	37.99	25.85	36.47	25.85	39.47	25.4	32.98	25.68	36.99	25.03	32.03	25.71	36.71	25.77	35.51
8	27.65	50.49	27.27	46.35	27.28	44.98	27.78	50.16	27.43	47.21	27.76	50.78	27.82	51.09	28.06	54.91
9	29.58	65.88	29.96	73.34	30.05	73.24	30.1	71.96	29.72	71.44	29.64	66.47	30.17	73.66	29.48	64.43
10	32.06	98.98	32.44	104.1	32.13	102.7	31.8	94.84	31.57	93.84	32.42	105.3	31.94	96.49	31.72	94.99
11	34.04	134.9	33.89	132.6	33.73	130.	34.29	142.1	34.43	144.2	33.98	136.4	34.03	137.1	34.33	143.5
12	36.55	204.1	36.57	205.	36.82	211.6	36.14	191.4	36.7	207.2	36.83	209.	36.01	185.9	36.32	195.9
13	38.14	260.	38.31	268.1	38.85	288.4	38.31	266.4	38.46	270.7	38.36	266.6	38.14	261.5	38.25	262.9
14	40.46	374.1	41.04	407.7	40.4	368.	40.61	381.7	41.27	423.6	41.17	416.3	40.49	374.1	40.74	388.6
15	43.27	577.8	42.86	543.4	42.83	543.1	43.03	557.3	43.02	556.	43.05	559.	43.04	557.9	42.75	536.7

	Data B09		Data B10		Data B11		Data B12		Data B13		Data B14		Data B15		Data B16	
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	12.38	4.468	12.61	7.206	11.7	4.308	12.57	4.006	12.28	2.894	12.42	4.793	12.19	4.256	11.97	2.981
2	14.73	6.921	14.52	8.277	14.78	6.172	14.15	5.449	14.27	7.938	14.07	4.244	13.99	7.375	14.02	5.373
3	16.83	6.812	16.9	7.531	16.23	9.14	16.28	6.999	16.72	9.83	17.09	8.018	16.37	7.525	16.35	6.717
4	19.25	13.38	19.01	12.99	18.65	13.43	18.99	14.27	18.44	11.15	18.63	14.42	18.73	10.73	18.47	12.48
5	20.67	14.24	21.39	16.53	21.01	17.38	21.08	15.88	20.65	16.23	21.49	21.31	20.79	16.72	20.69	16.96
6	22.87	21.11	23.36	27.45	23.21	23.67	23.12	23.73	23.03	22.63	23.2	26.41	23.32	26.06	22.77	24.02
7	25.73	39.27	25.86	40.18	25.78	39.04	25.08	32.16	25.63	37.17	25.7	38.5	25.27	35.05	25.1	32.44
8	27.46	46.81	27.8	52.49	28.05	52.42	27.68	51.24	27.62	48.7	27.82	48.8	27.51	48.33	27.27	49.31
9	29.44	65.21	29.69	69.73	29.7	69.42	29.94	70.21	29.77	67.88	30.14	75.44	30.22	73.8	30.04	72.6
10	32.	101.1	31.84	95.34	32.47	104.1	32.09	98.58	31.75	96.16	31.72	95.67	31.71	96.72	32.19	102.7
11	33.91	132.6	34.3	140.6	34.35	142.4	34.35	140.6	34.46	145.7	33.7	129.3	34.65	149.8	34.07	134.8
12	36.67	203.8	36.63	203.9	36.05	188.4	35.93	182.7	36.58	201.3	36.28	193.5	36.75	210.6	36.03	187.8
13	38.29	266.8	38.69	281.5	38.46	274.4	38.67	281.2	38.81	289.9	38.9	294.2	38.37	268.2	38.95	293.7
14	40.85	398.3	40.81	393.2	41.05	410.9	40.84	394.6	41.09	413.9	40.49	376.9	40.51	377.5	40.64	383.8
15	43.41	593.1	43.17	569.5	42.77	537.9	43.45	596.	43.09	565.1	42.66	529.	42.64	525.7	42.52	513.2

	Data B17		Data B18		Data B19		Data B20		Data B21		Data B22		Data B23		Data B24	
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	12.14	2.228	11.73	6.052	12.1	3.169	12.63	3.75	12.6	2.999	12.2	6.691	12.21	3.67	11.95	6.321
2	14.15	6.699	14.77	7.662	14.15	6.444	14.45	5.208	14.67	5.804	14.88	6.972	14.27	6.633	14.31	8.096
3	16.64	6.536	16.75	8.223	16.28	8.374	16.53	6.741	16.9	9.831	16.8	7.812	16.93	10.05	16.11	10.52
4	19.07	13.71	19.1	14.78	19.17	15.31	18.72	11.53	19.16	15.16	19.24	11.51	18.54	13.52	18.71	13.49
5	20.84	16.69	20.6	14.56	21.13	16.6	21.33	20.98	20.97	17.17	21.	19.49	21.24	17.06	20.55	15.86
6	22.96	23.62	23.08	23.2	22.73	24.08	22.83	25.81	23.41	27.79	23.01	22.61	23.11	26.74	23.46	24.57
7	25.06	31.26	25.19	36.19	25.28	36.03	25.05	30.73	25.36	34.84	25.44	35.21	25.71	37.28	25.3	34.11
8	27.38	47.55	27.81	49.76	27.58	48.44	27.22	44.23	27.74	52.92	27.57	49.33	27.18	45.45	27.51	51.04
9	30.11	74.47	29.53	68.45	30.25	74.85	29.74	70.3	29.49	68.08	29.91	73.3	29.35	66.33	29.98	72.94
10	31.86	98.22	32.23	100.7	31.87	95.1	31.96	97.77	31.57	94.06	32.09	101.2	32.28	104.2	32.34	101.9
11	34.46	146.7	34.69	149.4	34.66	149.4	34.55	148.2	34.03	138.	33.94	133.	34.33	144.9	33.88	134.2
12	35.94	182.9	36.55	203.5	36.56	200.6	35.98	185.4	36.18	188.7	35.91	181.	36.61	205.5	36.22	192.7
13	39.	297.7	38.38	271.	38.2	264.	38.79	285.9	38.31	263.8	38.25	264.	38.6	281.1	38.55	275.8
14	40.37	367.9	41.1	415.1	40.95	402.	40.62	383.3	40.37	370.3	40.57	380.4	40.96	403.4	41.28	425.6
15	43.04	558.7	43.49	601.1	43.11	565.7	42.56	518.2	43.48	597.4	42.52	515.9	43.24	579.	43.06	562.

TABELA V | PARTE 02/02

	Data B25		Data B26		Data B27		Data B28		Data B29		Data B30		Data B31		Data B32	
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	11.93	5.805	12.01	3.887	12.34	6.686	11.95	6.546	12.08	6.056	12.4	5.857	12.26	5.305	12.09	6.337
2	14.8	5.463	14.14	7.334	14.45	4.058	14.37	5.855	14.64	7.548	14.22	7.61	14.15	3.669	14.06	7.385
3	16.53	9.235	16.57	7.815	16.97	10.48	17.09	11.94	16.71	10.65	16.43	6.324	16.8	10.63	16.69	6.481
4	18.57	14.34	19.16	11.16	18.52	9.663	18.87	11.34	18.52	13.93	18.62	13.4	18.39	14.08	19.27	12.81
5	20.91	17.35	21.26	16.52	20.98	18.35	20.59	18.48	21.48	18.26	20.68	18.08	21.49	19.26	21.42	17.79
6	23.64	27.59	23.6	27.37	23.64	26.24	23.08	24.85	23.15	26.67	23.51	24.35	23.08	23.58	23.11	26.14
7	25.1	32.79	25.9	39.72	25.84	39.97	25.51	33.89	25.6	38.23	25.75	34.99	25.34	33.31	25.76	38.85
8	27.95	50.46	27.79	50.86	27.34	45.73	27.39	47.85	27.79	53.3	27.59	48.27	27.23	45.99	27.83	50.08
9	29.46	65.69	29.57	67.07	29.93	70.5	30.21	75.51	30.18	73.56	30.17	75.06	29.87	69.98	30.07	72.07
10	31.82	96.56	31.99	98.74	32.34	103.5	32.02	100.	32.04	101.2	31.83	94.97	31.97	98.03	31.68	95.8
11	33.97	132.4	34.56	147.4	33.79	129.3	33.98	135.2	34.	135.4	34.42	146.1	34.17	141.4	34.21	139.6
12	36.75	207.8	36.56	200.9	36.45	197.4	36.22	192.6	35.93	181.2	36.41	196.3	35.9	183.2	36.77	209.4
13	38.57	276.1	39.	296.2	38.81	287.	38.32	266.6	38.14	258.4	38.8	286.3	38.22	262.1	38.93	291.8
14	40.81	395.3	40.31	366.1	40.4	370.4	41.09	413.	40.88	399.9	40.8	393.9	40.34	366.9	40.75	392.7
15	42.6	523.3	43.25	577.8	43.42	592.2	43.5	602.	43.09	561.5	43.41	590.9	43.48	600.3	42.77	536.2

	Data B33		Data B34		Data B35		Data B36		Data B37		Data B38		Data B39		Data B40	
k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k	x_k	y_k
1	11.83	3.039	12.51	2.912	12.52	2.919	12.62	4.993	12.04	4.078	12.32	6.172	12.38	3.243	11.76	4.243
2	13.98	8.266	14.69	7.554	14.61	7.623	14.72	7.28	14.3	6.992	14.51	8.572	14.03	6.337	13.94	7.354
3	16.5	8.526	17.04	9.061	16.84	10.95	16.39	7.652	16.78	7.29	16.61	8.27	16.98	8.205	16.72	9.273
4	18.36	9.259	18.73	13.23	19.17	11.88	19.02	12.5	18.49	11.28	18.52	10.78	19.02	12.37	18.57	13.19
5	20.59	14.91	21.01	18.52	20.69	16.21	20.9	19.24	20.73	18.34	20.62	17.04	21.37	20.47	20.76	16.74
6	23.43	26.77	23.21	26.57	22.92	24.57	23.14	25.18	23.53	25.58	23.05	23.91	23.13	24.14	22.86	25.99
7	25.05	33.01	25.15	32.73	25.38	34.35	25.87	36.65	25.42	35.89	25.28	35.83	25.81	39.02	24.9	32.08
8	27.47	49.51	27.93	51.83	27.73	52.98	27.25	45.14	27.97	52.85	27.2	46.76	27.47	47.12	27.47	47.86
9	29.47	65.58	29.65	70.48	29.98	73.19	29.44	68.09	29.87	71.63	29.33	65.6	30.17	72.9	30.16	73.11
10	32.04	99.84	31.96	100.3	31.88	99.07	32.07	99.57	32.38	104.4	32.27	104.1	32.03	100.3	31.9	98.71
11	34.19	137.1	34.24	140.8	34.66	151.8	33.79	130.3	33.93	133.7	34.13	138.7	33.94	131.9	34.27	141.
12	36.82	210.6	36.36	197.4	36.12	189.1	36.11	190.5	36.82	210.7	35.94	184.3	36.26	195.2	36.27	191.1
13	38.47	270.6	38.87	288.5	38.17	259.9	38.55	276.9	38.57	275.	38.55	278.3	38.39	270.3	38.28	264.1
14	40.99	403.8	40.86	396.5	40.5	375.5	41.19	419.7	40.66	384.9	40.36	366.4	40.38	370.2	40.53	375.1
15	43.05	560.5	42.64	526.6	43.41	595.1	42.5	515.9	43.41	595.	43.18	573.2	43.06	560.2	42.7	529.9

	Data B41		Data B42		Data B43	
k	x_k	y_k	x_k	y_k	x_k	y_k
1	12.5	2.226	12.32	6.525	12.56	2.498
2	13.98	7.891	14.24	5.259	14.16	4.878
3	16.13	5.986	16.98	9.33	16.11	10.3
4	18.98	10.54	19.	14.79	19.18	15.22
5	21.5	19.95	21.47	16.45	21.04	19.15
6	23.51	26.6	23.22	27.14	23.58	26.94
7	24.9	32.64	25.26	32.62	25.63	36.3
8	27.45	48.48	27.77	50.5	27.32	46.14
9	30.05	70.36	30.05	73.26	29.84	71.17
10	32.28	104.	31.71	95.5	32.36	106.3
11	34.37	144.	34.19	139.7	34.44	146.1
12	36.04	184.3	36.39	195.3	35.91	182.3
13	38.43	271.1	38.41	271.7	38.16	259.7
14	40.57	381.7	40.31	365.6	40.34	364.3
15	43.04	561.	42.95	550.7	43.23	574.3

TABELA VI

Aluno	c_0	c_1	c_2
ALAN BESSAUER LENCINA	9.0697	−2.5878	7.4121
ALEXANDRE CHAGAS BRITES	−3.644	6.3563	3.6436
ANA LILIAN ALFONSO TOLEDO	−2.1033	−7.6035	2.3964
ANDERSON DALMOLIN CATTELAN	−3.4045	1.0037	8.9962
ARTHUR BOGACKI VERISSIMO	−3.7198	7.9465	2.0534
BIANCA SABRINA BUBLITZ	7.8064	4.5642	5.4357
BRUNO DOS SANTOS UMPIERRE	0.82198	4.9935	5.0064
BRUNO PERUSSATTO	−9.154	2.4369	7.563
CARLOS EDUARDO VELOZO CORREA	1.9277	4.2503	5.7496
CELSO MAIA DA SILVA NETO	−1.8536	4.0597	5.9402
DAVI DE CASTRO MACHADO	6.0419	−5.4537	4.5462
DIEGO RIBEIRO CHAVES	−7.6905	−2.4603	7.5396
DOUGLAS MAGALHAES SILVA	7.1782	1.5231	8.4768
ENZO HAHN VERONEZE	−1.2148	−2.3649	7.635
FERNANDO KALIKOSQUE LAYDNER JUNIOR	8.2923	2.8822	7.1177
FERNANDO MARINO MELCHIOR	4.811	−8.3339	1.666
GABRIEL ATARAO DENARDI	2.4009	6.297	3.7029
GABRIEL DA SILVA FRANCA	5.5422	−6.4028	3.5971
GABRIEL PORTO DE FREITAS	−3.3616	−1.7956	8.2043
GABRIEL SOUZA BAGGIO	9.545	6.5748	3.4251
GABRIEL STIEGEMEIER	−9.8668	2.5312	7.4687
GUILHERME BRIZZI	−8.14	3.4227	6.5772
GUILHERME MENEGHETTI EINLOFT	0.41226	6.7914	3.2085
IGOR GUIMARAES	−6.7239	4.9012	5.0987
JAIME ANTONIO DANIEL FILHO	5.2959	−7.2712	2.7287
JOAO PEDRO AZENHA RIGHI	7.9636	−3.9202	6.0797
JOAO PEDRO DA SILVA MARQUES	2.8287	−1.255	8.7449
JOAO VITOR DA SILVA	−7.4696	8.4362	1.5637
LARISSA RODRIGUES SILVEIRA	5.1011	5.2005	4.7994
LEANDRO BRUM DA SILVA LACORTE	−5.1593	6.3088	3.6911
LEANDRO OLIVEIRA GALBARINO DO NASCIMENTO	−1.9088	−1.0235	8.9764
LUCAS XAVIER PAIRE	−1.3831	−3.0331	6.9668
LUIS FERNANDO DA CRUZ ANTUNES	−2.7059	−1.227	8.7729
LUIS GUSTAVO WERLE TOZEVICH	−9.2121	−6.7319	3.268
LUIS HENRIQUE SILVEIRA POZZEBON	8.8517	−5.8538	4.1461
MATHIAS ECKERT RECKTENVALD	1.3837	2.0604	7.9395
MIGUEL BRONDANI	2.722	5.0239	4.976
MIGUEL MIRON SILVA	−0.4817	−1.1147	8.8852
PEDRO DE ANDRADE SANTOS	−0.68047	−4.9997	5.0002
RAFAELA DA ROSA SOARES	5.7682	1.4995	8.5004
TOBIAS VIERO DE OLIVEIRA	2.2215	3.71	6.2899
VIVIANE DILKIN ENDLER	−0.98287	−8.0896	1.9103
WESLEY LOPES DE OLIVEIRA	4.9922	−8.5931	1.4068

TABELA VII

ALAN BESSAUER LENCINA CCB_MNC_AA05_AL01_ABL.pdf	ALEXANDRE CHAGAS BRITES CCB_MNC_AA05_AL02_ACB.pdf	ANA LILIAN ALFONSO TOLEDO CCB_MNC_AA05_AL03_ALAT.pdf
ANDERSON DALMOLIN CATTELAN CCB_MNC_AA05_AL04_ADC.pdf	ARTHUR BOGACKI VERISSIMO CCB_MNC_AA05_AL05_ABV.pdf	BIANCA SABRINA BUBLITZ CCB_MNC_AA05_AL06_BSB.pdf
BRUNO DOS SANTOS UMPIERRE CCB_MNC_AA05_AL07_BSU.pdf	BRUNO PERUSSATTO CCB_MNC_AA05_AL08_BP.pdf	CARLOS EDUARDO VELOZO CORREA CCB_MNC_AA05_AL09_CEVC.pdf
CELSO MAIA DA SILVA NETO CCB_MNC_AA05_AL10_CMSN.pdf	DAVI DE CASTRO MACHADO CCB_MNC_AA05_AL11_DCM.pdf	DIEGO RIBEIRO CHAVES CCB_MNC_AA05_AL12_DRC.pdf
DOUGLAS MAGALHAES SILVA CCB_MNC_AA05_AL13_DMS.pdf	ENZO HAHN VERONEZE CCB_MNC_AA05_AL14_EHV.pdf	FERNANDO KALIKOSQUE LAYDNER JUNIOR CCB_MNC_AA05_AL15_FKLJ.pdf
FERNANDO MARINO MELCHIOR CCB_MNC_AA05_AL16_FMM.pdf	GABRIEL ATARAO DENARDI CCB_MNC_AA05_AL17_GAD.pdf	GABRIEL DA SILVA FRANCA CCB_MNC_AA05_AL18_GSF.pdf
GABRIEL PORTO DE FREITAS CCB_MNC_AA05_AL19_GPF.pdf	GABRIEL SOUZA BAGGIO CCB_MNC_AA05_AL20_GSB.pdf	GABRIEL STIEGEMEIER CCB_MNC_AA05_AL21_GS.pdf
GUILHERME BRIZZI CCB_MNC_AA05_AL22_GB.pdf	GUILHERME MENEGHETTI EINLOFT CCB_MNC_AA05_AL23_GME.pdf	IGOR GUIMARAES CCB_MNC_AA05_AL24_IG.pdf
JAIME ANTONIO DANIEL FILHO CCB_MNC_AA05_AL25_JADF.pdf	JOAO PEDRO AZENHA RIGHI CCB_MNC_AA05_AL26_JPAR.pdf	JOAO PEDRO DA SILVA MARQUES CCB_MNC_AA05_AL27_JPSM.pdf
JOAO VITOR DA SILVA CCB_MNC_AA05_AL28_JVS.pdf	LARISSA RODRIGUES SILVEIRA CCB_MNC_AA05_AL29_LRS.pdf	LEANDRO BRUM DA SILVA LACORTE CCB_MNC_AA05_AL30_LBSL.pdf
LEANDRO OLIVEIRA GALBARINO DO NASCIMENTO CCB_MNC_AA05_AL31_LOGN.pdf	LUCAS XAVIER PAIRE CCB_MNC_AA05_AL32_LXP.pdf	LUIS FERNANDO DA CRUZ ANTUNES CCB_MNC_AA05_AL33_LFCA.pdf
LUIS GUSTAVO WERLE TOZEVICH CCB_MNC_AA05_AL34_LGWT.pdf	LUIS HENRIQUE SILVEIRA POZZEBON CCB_MNC_AA05_AL35_LHSP.pdf	MATHIAS ECKERT RECKTENVALD CCB_MNC_AA05_AL36_MER.pdf
MIGUEL BRONDANI CCB_MNC_AA05_AL37_MB.pdf	MIGUEL MIRON SILVA CCB_MNC_AA05_AL38_MMS.pdf	PEDRO DE ANDRADE SANTOS CCB_MNC_AA05_AL39_PAS.pdf
RAFAELA DA ROSA SOARES CCB_MNC_AA05_AL40_RRS.pdf	TOBIAS VIERO DE OLIVEIRA CCB_MNC_AA05_AL41_TVO.pdf	VIVIANE DILKIN ENDLER CCB_MNC_AA05_AL42_VDE.pdf
WESLEY LOPES DE OLIVEIRA CCB_MNC_AA05_AL43_WLO.pdf		

EXEMPLO DE SOLUÇÃO | QUESTÃO 01

TABELA DE DADOS

k	x_k	y_k	x_k^2	x_k^3	x_k^4	$y_k x_k$	$y_k x_k^2$
1	4.29	17.03	18.4041	78.9536	338.711	73.0587	313.422
2	7.11	30.21	50.5521	359.425	2555.51	214.793	1527.18
3	8.49	33.94	72.0801	611.96	5195.54	288.151	2446.4
4	11.51	43.57	132.48	1524.85	17551.	501.491	5772.16
5	12.73	44.55	162.053	2062.93	26261.1	567.121	7219.46
6	15.68	54.6	245.862	3855.12	60448.3	856.128	13424.1
7	16.2	57.75	262.44	4251.53	68874.8	935.55	15155.9
8	18.45	65.5	340.403	6280.43	115874.	1208.48	22296.4
9	21.76	69.8	473.498	10303.3	224200.	1518.85	33050.1
10	23.26	75.7	541.028	12584.3	292711.	1760.78	40955.8
Σ	139.48	492.65	2298.8	41912.8	814010.	7924.4	142161.

AJUSTE LINEAR

$a_0 = 7.70055$ $a_1 = 2.97996$

AJUSTE QUADRÁTICO

SISTEMA LINEAR

$$10a_0 + 139.48a_1 + 2298.8a_2 = 492.65$$

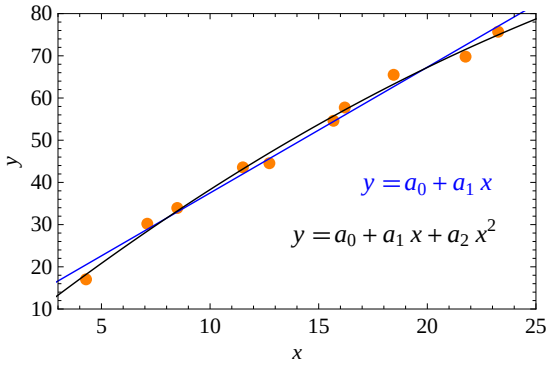
$$139.48a_0 + 2298.8a_1 + 41912.8a_2 = 7924.4$$

$$2298.8a_0 + 41912.8a_1 + 814010.a_2 = 142161.$$

SOLUÇÃO

$a_0 = 1.36031$ $a_1 = 4.09205$ $a_2 = -0.0398956$

GRÁFICO



EXEMPLO DE SOLUÇÃO | QUESTÃO 02 | AJUSTE EXPONENCIAL

TABELA DE DADOS

k	x_k	$\log y_k$	x_k^2	$x_k \log y_k$
1	12.23	1.4956	149.573	18.2912
2	14.82	1.55054	219.632	22.979
3	16.67	1.99511	277.889	33.2585
4	18.49	2.54003	341.88	46.9651
5	20.6	2.83674	424.36	58.4368
6	23.31	3.24415	543.356	75.6212
7	25.59	3.62754	654.848	92.8286
8	27.34	3.83146	747.476	104.752
9	30.02	4.25448	901.2	127.719
10	32.3	4.65491	1043.29	150.354
11	34.61	4.99654	1197.85	172.93
12	35.98	5.22682	1294.56	188.061
13	39.03	5.69944	1523.34	222.449
14	41.04	6.01225	1684.28	246.743
15	43.39	6.37944	1882.69	276.804
Σ	415.42	58.345	12886.2	1838.19

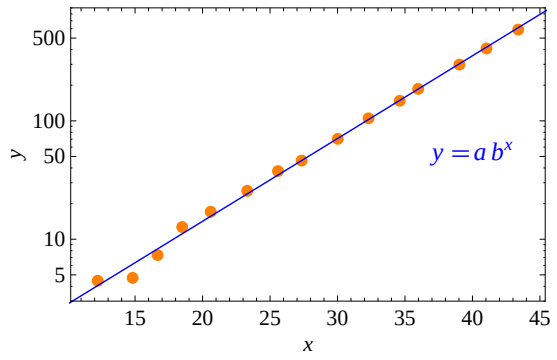
AJUSTE LINEAR

$a_0 = -0.568266$ $a_1 = 0.160967$

AJUSTE EXPONENCIAL

$a = e^{a_0} = 0.566507$ $b = e^{a_1} = 1.17465$

GRÁFICO



EXEMPLO DE SOLUÇÃO | QUESTÃO 02 | AJUSTE POTÊNCIA

TABELA DE DADOS

k	$\log x_k$	$\log y_k$	$\log^2 x_k$	$\log y_k \log x_k$
1	2.39516	3.03975	5.73681	7.2807
2	2.5416	3.18346	6.45974	8.09108
3	2.71204	3.50225	7.35517	9.49825
4	2.82909	3.68009	8.00373	10.4113
5	2.93916	3.81947	8.63867	11.226
6	3.0713	4.11218	9.4329	12.6298
7	3.12676	4.16573	9.77663	13.0253
8	3.22764	4.38726	10.4176	14.1605
9	3.30138	4.51075	10.8991	14.8917
10	3.35794	4.5523	11.2758	15.2863
11	3.44935	4.74145	11.898	16.3549
12	3.51333	4.85281	12.3435	17.0496
13	3.54559	4.88884	12.5712	17.3338
14	3.61092	5.0113	13.0387	18.0954
15	3.67503	5.09987	13.5059	18.7422
Σ	47.2963	63.5475	151.354	204.077

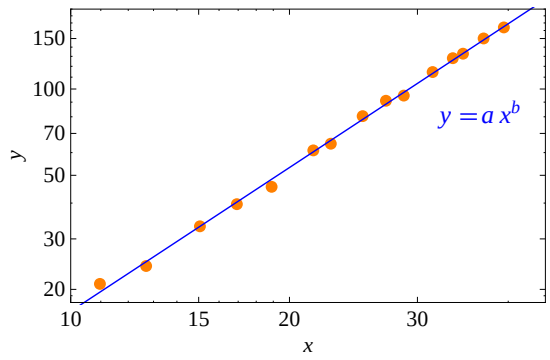
AJUSTE LINEAR

$a_0 = -1.01725$ $a_1 = 1.66622$

AJUSTE POTÊNCIA

$a = e^{a_0} = 0.361588$ $b = a_1 = 1.66622$

GRÁFICO



EXEMPLO DE SOLUÇÃO | QUESTÃO 03

PARÂMETROS DA FUNÇÃO

$c_0 = -1.3777$ $c_1 = -8.5271$ $c_2 = 1.4728$

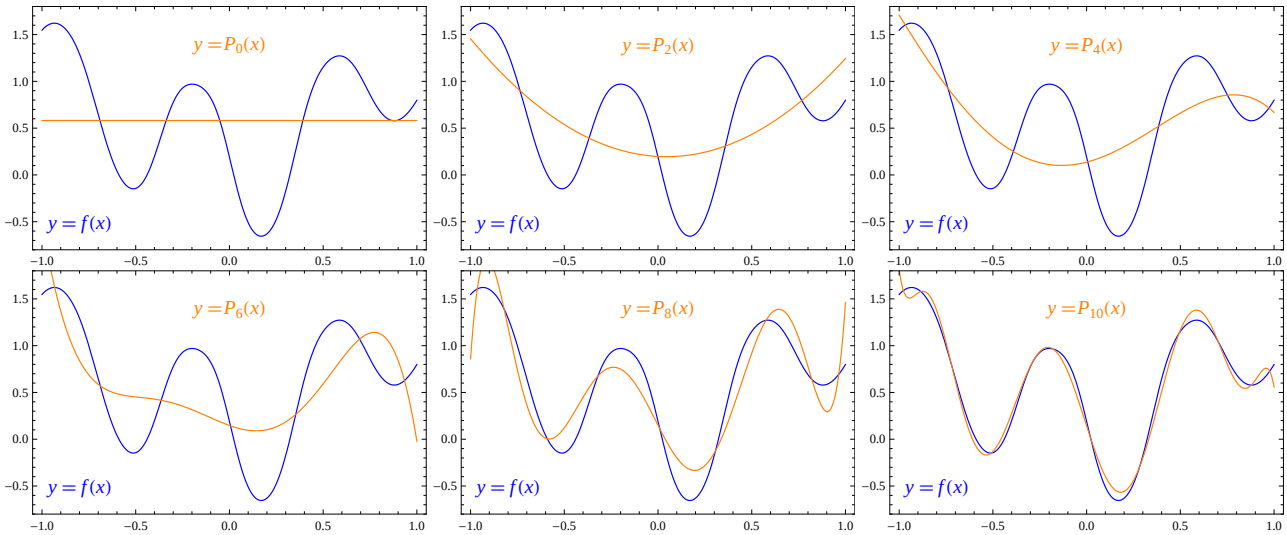
POLINÔMIOS DE LEGENDRE

k	a_k	$EA_k^{(g)}$	$ER_k^{(g)}$
0	0.581737	–	–
1	−0.10546	0.00741455	0.68425
2	0.768064	0.235969	0.920219
3	−0.414666	0.049128	0.969347
4	−0.161803	0.00581786	0.975165
5	−0.65738	0.0785725	1.05374
6	−0.0324208	0.000161709	1.0539
7	1.47812	0.291313	1.34521
8	0.00512236	−63.0868910	1.34522
9	−0.927418	0.0905372	1.43575
10	0.0236829	0.0000534172	1.43581

POLINÔMIOS TRIGONOMÉTRICOS

k	a_k	b_k	$EA_k^{(g)}$	$ER_k^{(g)}$
0	1.16347	0	–	–
1	−0.487538	0.0405286	0.239336	0.414252
2	0.0636513	−0.284046	0.0847335	0.127902
3	−0.0143063	−0.650464	0.423308	0.38986
4	0.00620963	0.0737151	0.00547247	0.00501478
5	0.0202551	−0.0612302	0.00415941	0.00379706
6	0.0216644	0.046566	0.00263774	0.00240217
7	−0.00213828	−0.0441417	0.00195306	0.00177548
8	0.00235285	0.0118204	0.000145259	0.000132034
9	−0.00161166	−0.0388961	0.00151551	0.00137564
10	0.00152681	0.024687	0.000611778	0.000555006

GRÁFICOS | POLINÔMIOS DE LEGENDRE



GRÁFICOS | POLINÔMIOS TRIGONOMÉTRICOS