

Advanced Numerical Techniques -Question Paper [M.Sc Physics Sem IV 2017]

I am posting here the question Paper for the subject: Advanced Numerical Techniques (Theory and Practical) for the IV semester year 2017. The question paper is for the students of M.Sc Physics at the University of Delhi. Future students taking this course might find it helpful.

1. Fit a polynomial $y = Ax^3$ to the following data:

x	1	2	3	4	5
y	0.109	0.834	2.893	6.325	12.47

Estimate the best fit value of constant A and error σ_A in it. Plot the polynomial and superimpose it on the data. Also plot the polynomials for $A \pm \sigma_A$.

2. Find an interpolating polynomial that passes through all the points (x_i, y_i) depicted in the Table below:

x	-1	-0.5	0	0.5	1
y	-1.0000	0.4375	0	-0.4375	1

Plot the interpolating polynomial superimposed on the data. Also fit a cubic polynomial to the above data and compare the two polynomials.

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M.Sc. Physics (Semester IV)
PHY580 : Advanced Numerical Techniques
Final Exam (2017)

Marks : 30

Time : 1.5 hours.

All questions are compulsory.

$$\frac{1}{10}, \frac{1}{3}, \frac{1}{4}$$

1. We generate three sets of random numbers with uniform distribution: first in the range $[0,1]$, second in the range $[1,3]$ and third in the range $[3,4]$. Each set contains N random numbers. The three sets are joined to form a single set. What is the mean value of the combined set? (2)
2. If u is a uniformly distributed random number between 0 and 1, what will be the distribution of the function $-\ln(1-u)$? (3)

3. Consider the following probability distribution function:

$$f(x) = \frac{a}{1+x^2}$$

$$1, \frac{1}{2}, \phi$$

- (a) Find the constant a from the normalization condition $\int_0^\infty f(x)dx = 1$.
(b) Find the cumulative distribution function $F(x) = \int_0^x f(y)dy$.
(c) Solve $F(x) = u$ and express x as a function of u . What is the value of x at $u = 1$? (1+2+2=5)
4. The counts in a radioactive detector are distributed according to Poisson distribution with a mean of 9. What is the probability of getting more than 18 counts in a measurement? (3)
5. A function $y = f(x)$ is tabulated at three points:

x	a	$(b-a)/2$	b
y	$f(a)$	$f((b-a)/2)$	$f(b)$

Obtain an interpolating polynomial $P(x)$ that passes through these three points. Evaluate the derivative $P'(x)$ and $P''(x)$ at $x = (b-a)/2$. (5)

6. A function of the form $y = Ax^3$ has to be fitted to N data points (x_i, y_i) where $i = 1, 2, 3, \dots, N$. Each value y_i has an error of σ_i . Obtain an expression for A using maximum likelihood method. (7)

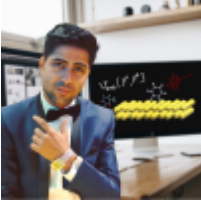
7. Interpolate the following data using cubic spline:

x	0	1	2	3	4
y	0	0	0.5	1	1

Evaluate the interpolated function at $x = 2.5$. (5)

$$A = \frac{\sum x_i^3 y_i}{\sum \frac{x_i^3}{\sigma_i^2}}$$

$$\frac{9^x}{x^1}$$



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I'm a physicist specializing in computational material science with a PhD in Physics from Friedrich-Schiller University Jena, Germany. I write efficient codes for simulating light-matter interactions at atomic scales. I like to develop Physics, DFT, and Machine Learning related apps and software from time to time. Can code in most of the popular languages. I like to share my knowledge in Physics and applications using this Blog and a YouTube channel.

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