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NPTEL

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Courses » Mathematical Methods and Techniques in Signal Processing

Announcements **Course** Ask a Question Progress FAQ

Week 11 - Fourier Series - I

Register for Certification exam

Course outline

How to access the portal

Week 0 - Background and Prerequisites

Week 1 - Introduction to Signal Processing, State Space Representation and Vector Spaces - I

Week 2 - Vector Spaces - II

Week 3 - Vector Spaces - III and Signal Geometry

Week 4 - Probability and Random Processes

Week 5 - Sampling Theorem and Multirate Systems - I

Assignment 11

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2019-04-17, 23:59 IST.

Instructions:

1. **Attempt all questions.**
2. **Submission deadline**: 17th April 2019 23:59 IST
3. **Solutions to be posted**: 18th April 2019
4. Older browsers might show **unnecessary vertical bars** at the end of math equations

1) Given the sequence *1.5 points*

$$f_n = \begin{cases} -\frac{1}{n^2}(t-n) & 0 < t \leq n \\ 0 & t > n \end{cases}$$

and $f(t) = 0 \; \forall \; t \in (0, \infty)$.

Choose the correct options of convergence of f_n to f.

- Pointwise but not uniform.
- Pointwise and uniform.
- Neither pointwise nor uniform.
- Uniform but not pointwise.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Pointwise and uniform.

2) (True/False): Let $\{a_n\}$ be a sequence of real numbers defined as *2 points*

$$a_n = \frac{n^2+n+1}{3n^2+3}$$

Then a_n converges to $\frac{1}{3}$.

- True

Week 8 - Multirate Systems - IV

Week 9 - Wavelets - I

Week 10 - Wavelets - II and Continuity of Functions

Week 11 - Fourier Series - I

- Basic Analysis : Convergence of sequence of functions
- Fourier series and notions of convergence
- Convergence of Fourier series at a point of continuity
- Convergence of Fourier series for piecewise differentiable periodic functions
- Uniform convergence of Fourier series of piecewise smooth periodic function
- Quiz : Assignment 11
- Assignment 11 - Solutions

Week 12 - Fourier Series - II and KL Transform

Interaction Session

3) (True/False): If $\{a_n\}_{n\geq 1}$ is a bounded sequence of real numbers, then it converges. *1 point*

- True
- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
False

4) (True/False): If $\{a_n\}_{n\geq 1},\ \{b_n\}_{n\geq 1}$ are sequences of real numbers and converge to $a,\ b$ respectively, then $\{a_n + b_n\}_{n\geq 1}$ converges to $a+b$. *2 points*

- True
- False

No, the answer is incorrect.
Score: 0

Accepted Answers:
True

5) Let $f(t) = a_0 + \sum_{k=1}^{\infty} a_k \cos\left(2\pi k \frac{t}{T}\right) + \sum_{k=1}^{\infty} b_k \sin\left(2\pi k \frac{t}{T}\right)$ be the Fourier series expansion of a function with period T. We can easily see that $f(t)$ is also periodic with period $T_1 = 3T$. Therefore, an alternative Fourier series expansion of the function is $f(t) = \hat{a}_0 + \sum_{k=1}^{\infty} \hat{a}_k \cos\left(2\pi k \frac{t}{T_1}\right) + \sum_{k=1}^{\infty} \hat{b}_k \sin\left(2\pi k \frac{t}{T_1}\right)$. If we define $A(z) = \sum_{i=0}^{\infty} a_i z^{-i},\ B(z) = \sum_{i=1}^{\infty} b_i z^{-i},\ \hat{A}(z) = \sum_{i=0}^{\infty} \hat{a}_i z^{-i}$ and $\hat{B}(z) = \sum_{i=1}^{\infty} \hat{b}_i z^{-i}$, which of the following options are true? *3 points*

- $\hat{A}(z) = A(z^3)$
- $\hat{A}(z) = A(z)$
- $\hat{B}(z) = B(z^3)$
- $\hat{B}(z) = z^{-1} B(z^3)$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\hat{A}(z) = A(z^3)$
$\hat{B}(z) = B(z^3)$

6) Let $f(t)$ be a 2π periodic function defined as $f(t) = t$ for $t \in [0, 2\pi]$, the value of Fourier series for the function at $t = 0$ is *2 points*

- 0
- $\frac{-\pi^2}{2}$
- π
-

$\frac{\pi}{2}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
π

7) For the 2π periodic function $f(t) = e^t$ the Fourier coefficient a_0 is given by *1 point*

0

$\frac{e^{2\pi}}{2\pi}$

$\frac{e^{2\pi}-1}{2\pi}$

e^{π}

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{e^{2\pi}-1}{2\pi}$

8) (True/False): The sequence of functions $f_n(x) = \frac{\sin(nx)}{n+1}$ where $f_n : \mathbb{R} \to \mathbb{R}$ converges uniformly to zero. *1.5 points*

True

False

No, the answer is incorrect.
Score: 0

Accepted Answers:
True

9) Let $f(t)$ be a 2π periodic function defined as *2 points*

$$f(t) = \begin{cases} k & 0 \leq t \leq \pi \\ -k & \pi < t < 2\pi \end{cases}$$

where k is a real constant.
Choose the correct option showing the Fourier series expansion of $f(t)$.

$\frac{k}{\pi} \sum_{n=1}^{\infty} \frac{1}{n} \sin(nt)$

$\frac{4k}{\pi} \sum_{n=0}^{\infty} \frac{1}{2n+1} \sin((2n+1)t)$

$\frac{4k}{\pi} \sum_{n=1}^{\infty} \frac{1}{n+1} \sin((n+1)t)$

$\frac{2k}{\pi} \sum_{n=0}^{\infty} \frac{1}{2n+1} \sin((2n+1)t)$

No, the answer is incorrect.
Score: 0

Accepted Answers:

$\frac{4k}{\pi} \sum_{n=0}^{\infty} \frac{1}{2n+1} \sin((2n+1)t)$

10) In question 9, at the point $t = 0$, the Fourier series converges to

No, the answer is incorrect.
Score: 0

Accepted Answers:
(Type: Numeric) 0

1 point

11) Let the functions $f_n : [0,1] \to \mathbb{R}$ and $f : [0,1] \to \mathbb{R}$ are defined as follows. *2 points*

$$f_n(x) = \left(x - \frac{1}{n}\right)^2 \quad \text{and} \quad f(x) = x^2$$

Choose the correct options of convergence of f_n to f.

- Pointwise and uniform.
- Pointwise but not uniform.
- Neither pointwise nor uniform.
- Uniform but not pointwise.

No, the answer is incorrect.
Score: 0

Accepted Answers:
Pointwise and uniform.

12) Consider a 2π periodic function defined as *1 point*

$$f(t) = \begin{cases} t^2 & 0 \leq t < \pi \\ \frac{(2\pi - t)^2}{2} & \pi \leq t < 2\pi \end{cases}$$

At the point $t = \frac{25\pi}{2}$, the Fourier series of this function converges to

- $\frac{\pi^2}{2}$
- $\frac{\pi^2}{4}$
- $\frac{\pi^2}{8}$
- $\frac{625\pi^2}{4}$

No, the answer is incorrect.
Score: 0

Accepted Answers:
$\frac{\pi^2}{4}$

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