

# Unit 4 - Week 2

## Course outline

### How to access the portal?

#### Week-0

#### Week 1

#### Week 2

- Lecture 6: Fourier space representation - Definitions
- Lecture 7: Fourier space representation - Flow equations
- Lecture 8: Fourier space representation - Kinetic energy
- Lecture 9: Fourier space representation - Vorticity, Kinetic Helicity, and Enstrophy
- Lecture 10: Fourier space representation - Examples
- Lecture 11: Fourier space representation - Examples (continued)
- Lecture Slides
- Quiz : Assignment 2**
- Assignment 2 solution
- Feedback For Week 2

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#### Week 4

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## Assignment 2

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

**Due on 2019-08-21, 23:59 IST.**

1) For an incompressible flow,  $\mathbf{u}(1, 1, 2) = (2i, c, -3i)$ . The constant  $c$  is given by

1 point

- $-2i$
- $i$
- $4i$
- None of these

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $4i$

2) Velocity mode corresponding to the vorticity mode  $\omega(1, 1, -1) = (-2i, 3i, i)$  is

1 point

- $\mathbf{u}(1, 1, -1) = (-2i/3, i, i/3)$
- $\mathbf{u}(1, 1, -1) = (-4/3, -1/3, -5/3)$
- $\mathbf{u}(1, 1, -1) = (-3i, 4i, i)$
- Not possible to obtain from the given information

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\mathbf{u}(1, 1, -1) = (-4/3, -1/3, -5/3)$

3) Temperature equation for incompressible fluid flow is  $\partial_t T + (\mathbf{u} \cdot \nabla)T = \alpha \nabla^2 T$ . Corresponding equation in Fourier space would be

1 point

- $d_t T(\mathbf{k}) + i \sum_p \mathbf{k} \cdot \mathbf{u}(\mathbf{k} - \mathbf{p})T(\mathbf{p}) = -\alpha k^2 T(\mathbf{k})$
- $d_t T(\mathbf{k}) + i \sum_k \mathbf{k} \cdot \mathbf{u}(\mathbf{k} - \mathbf{p})T(\mathbf{p}) = \alpha k^2 T(\mathbf{k})$
- $d_t T(\mathbf{k}) + i \sum_p \mathbf{k} \cdot \mathbf{u}(\mathbf{p} - \mathbf{k})T(\mathbf{p}) = i\alpha k^2 T(\mathbf{k})$
- None of these

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $d_t T(\mathbf{k}) + i \sum_p \mathbf{k} \cdot \mathbf{u}(\mathbf{k} - \mathbf{p})T(\mathbf{p}) = -\alpha k^2 T(\mathbf{k})$

4) Which one of the following quantities can also be negative?

1 point

- Energy
- Helicity
- Enstrophy
- None of these

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
Helicity

5) All the active Fourier modes in the velocity field  $\mathbf{u}(x, y) = \hat{x}2A \sin x + \hat{y}2B \sin y + (\hat{x} - \hat{y})4C \cos(x + y)$  are

1 point

- $(1, 0)$  and  $(1, -1)$
- $(\pm 1, 0)$ ,  $(0, \pm 1)$ ,  $(1, 1)$  and  $(-1, -1)$
- $(0, \pm 1)$ , and  $(1, 1)$
- $(\pm 1, 0)$ ,  $(0, \pm 1)$ ,  $(\pm 1, \pm 1)$ , and  $(\mp 1, \pm 1)$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $(\pm 1, 0)$ ,  $(0, \pm 1)$ ,  $(1, 1)$  and  $(-1, -1)$

6) Modal energy and enstrophy corresponding to  $\mathbf{k} = (1, 1)$  for the velocity field  $\mathbf{u}(x, y) = \hat{x}2A \cos y + \hat{y}2A \cos x + (\hat{x} - \hat{y})4A \cos(x + y)$  are

1 point

- $4A^2$  and  $2A^2$
- $A^2$  and  $A^2$
- $4A^2$  and  $8A^2$
- $2A^2$  and 0

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $4A^2$  and  $8A^2$

7) Spectral methods are superior than finite difference, finite element, and finite volume in following aspects:

1 point

- Higher accuracy
- Better way to understand energy distribution and transfer among different scales
- Both first and second options
- None of these

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
Both first and second options

8) How many triads are formed for the velocity field

1 point

$$\mathbf{u} = 4C(\hat{x} \sin x \cos z - \hat{z} \cos x \sin z) + 4B(\hat{y} \sin y \cos z - \hat{z} \cos y \sin z) + 8A(-\hat{x} \sin x \cos y \cos 2z - \hat{y} \cos x \sin y \cos 2z + \hat{z} \cos x \cos y \sin 2z)?$$

- 4
- 5
- 3
- No triads are formed

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
3

9) Evolution equation of  $A$ ,  $B$  and  $C$  for the velocity field  $\mathbf{u} = \hat{x}2B \cos y + \hat{y}2C \cos x + (\hat{x} - \hat{y})2A \sin(x + y)$  (Assuming  $v = 0$ ) are

1 point

- $A = \text{constant}$ ,  $B = c \cos(At)$ , and  $C = c \sin(At)$
- $A = c \exp(-Bt)$ ,  $B = \text{constant}$ , and  $C = c \sin(At)$
- $A = c \sin(At)$ ,  $B = c \cos(At)$ , and  $C = c \sin(At)$
- None of these

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $A = \text{constant}$ ,  $B = c \cos(At)$ , and  $C = c \sin(At)$

10) Velocity field constructed using the Fourier modes  $\mathbf{u}(1, 0) = (0, 1, -i)$ ,  $\mathbf{u}(-1, 0) = (0, 1, i)$ ,  $\mathbf{u}(0, 1) = (-1, 0, -i)$ , and  $\mathbf{u}(0, -1) = (-1, 0, i)$  is

1 point

- $\mathbf{u} = -\hat{x}2 \cos y + \hat{y}2 \cos x + \hat{z}2(\sin x + \sin y)$
- $\mathbf{u} = \hat{x}2 \sin y + \hat{y}2 \sin x + \hat{z}2(\cos x + \sin y)$
- $\mathbf{u} = -\hat{x}2 \cos y + \hat{y}2 \sin x + \hat{z}2(\sin x + \cos y)$
- $\mathbf{u} = -\hat{x} \sin x + \hat{y} \cos y + \hat{z} \sin z$

No, the answer is incorrect.  
Score: 0

Accepted Answers:  
 $\mathbf{u} = -\hat{x}2 \cos y + \hat{y}2 \cos x + \hat{z}2(\sin x + \sin y)$