

Problem 2.1

[Difficulty: 1]

2.1 For the velocity fields given below, determine:

a. whether the flow field is one-, two-, or three-dimensional, and why.

b. whether the flow is steady or unsteady, and why.

(The quantities a and b are constants.)

- (1) $\vec{V} = [(ax + t)e^{by}] \hat{i}$ (2) $\vec{V} = (ax - by) \hat{i}$
 (3) $\vec{V} = ax \hat{i} + [e^{bx}] \hat{j}$ (4) $\vec{V} = ax \hat{i} + bx^2 \hat{j} + ax \hat{k}$
 (5) $\vec{V} = ax \hat{i} + [e^{bx}] \hat{j}$ (6) $\vec{V} = ax \hat{i} + bx^2 \hat{j} + ay \hat{k}$
 (7) $\vec{V} = ax \hat{i} + [e^{bx}] \hat{j} + ay \hat{k}$ (8) $\vec{V} = ax \hat{i} + [e^{by}] \hat{j} + az \hat{k}$

Given: Velocity fields

Find: Whether flows are 1, 2 or 3D, steady or unsteady.

Solution:

(1)	$\vec{V} = \vec{V}(x, y)$	2D	$\vec{V} = \vec{V}(t)$	Unsteady
(2)	$\vec{V} = \vec{V}(x, y)$	2D	$\vec{V} \neq \vec{V}(t)$	Steady
(3)	$\vec{V} = \vec{V}(x)$	1D	$\vec{V} \neq \vec{V}(t)$	Steady
(4)	$\vec{V} = \vec{V}(x)$	1D	$\vec{V} \neq \vec{V}(t)$	Steady
(5)	$\vec{V} = \vec{V}(x)$	1D	$\vec{V} = \vec{V}(t)$	Unsteady
(6)	$\vec{V} = \vec{V}(x, y)$	2D	$\vec{V} \neq \vec{V}(t)$	Steady
(7)	$\vec{V} = \vec{V}(x, y)$	2D	$\vec{V} = \vec{V}(t)$	Unsteady
(8)	$\vec{V} = \vec{V}(x, y, z)$	3D	$\vec{V} \neq \vec{V}(t)$	Steady