Question 2

(a) Consider a game with two players **A** and **B**. Player **A** has strategies A_1 and A_2, while player **B** has strategies B_1 and B_2. The payoffs are shown in the table below.

	B_1	B_2
A_1	$(a, \tilde{a})$	$(b, \tilde{b})$
A_2	$(c, \tilde{c})$	$(d, \tilde{d})$

In the above, the first number x in

$$(x, y)$$

refers to the payoff for **A**, while the second number y is the payoff for **B**. Here $a, \tilde{a}, b, \tilde{b}, c, \tilde{c}, d$ and $\tilde{d}$ are fixed numbers. Assume that

$$a > \tilde{d} \quad \text{and} \quad \tilde{c} \geq c .$$

Is it possible that BOTH

$$(A_1, B_1) \quad \text{and} \quad (A_2, B_2)$$

are Nash equilibria? Justify your answer.

(b) In a hypothetical pandemic, two countries **C** and **D** are in discussion for opening up their boundaries for mutual tourism (so call *travel bubbles*). The factors to be considered are shown in the following ($*_1 - *_3$):

$*_1$ V_C – the number of percentage (%) of the population in country **C** that have received the vaccine. In particular,

$$0 \leq \frac{V_C}{100} \leq 1 .$$

Likewise, V_D – the number of % of the population in country **D** that have received the vaccine.

$*_2$ N_C – the average number (for last 7 days) of local infected cases per day, in country **C**. It is assumed that $N_C \leq 10$, so that

$$0 \leq \frac{N_C}{10} \leq 1 .$$

Likewise, N_D – the average number (for last 7 days) of local infected cases per day, in country **D**. It is also assumed that $N_D \leq 10$,

$*_3$ Q_C – the number of day(s) for required quarantine for visitors (from country **D**) entering country **C**. It is assumed that $Q_C \leq 7$, so that

$$0 \leq \frac{Q_C}{7} \leq 1 .$$

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Likewise, Q_D – the number of day(s) for required quarantine for visitors (from country **C**) entering country **D**. It is also assumed that $Q_D \leq 7$.

(There is NO required quarantine for people returning to their home country from the travel bubbles.)

Each one of the countries **C** and **D** has two strategies at its disposal, namely,

EITHER

(I & O) - opening up for incoming and outgoing tourists (between countries **C** and **D**),

OR

(O no I) - allowing outgoing tourists only, and banning incoming tourists (between countries **C** and **D**).

Consider the following payoffs.

$\bullet_1$ Both countries **C** and **D** apply the **(I & O)** strategy:

$$\text{Payoff } \mathbf{C} = 1 + \frac{V_D}{100} - \frac{N_D}{10} - \frac{Q_D}{7} ,$$

$$\text{Payoff } \mathbf{D} = 1 + \frac{V_C}{100} - \frac{N_C}{10} - \frac{Q_C}{7} .$$

$\bullet_2$ Only country **C** applies the **(I & O)** strategy, and country **D** applies the **(O no I)** strategy:

$$\text{Payoff } \mathbf{C} = 1 + \frac{V_D}{100} - \frac{N_D}{10} - \frac{Q_D}{7} ,$$

$$\text{Payoff } \mathbf{D} = \frac{1}{4} + \frac{V_C}{100} - \frac{N_C}{10} .$$

$\bullet_3$ Only country **D** applies the **(I & O)** strategy, and **(O no I)** strategy:

$$\text{Payoff } \mathbf{C} = \frac{1}{4} + \frac{V_D}{100} - \frac{N_D}{10} ,$$

$$\text{Payoff } \mathbf{D} = 1 + \frac{V_C}{100} - \frac{N_C}{10} - \frac{Q_C}{7} .$$

$\bullet_4$ Both countries **C** and **D** apply the **(O no I)** strategy:

$$\text{Payoff } \mathbf{C} = \text{Payoff } \mathbf{D} = 0 .$$

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Q. 2 *continues ....*

(i) Under the conditions that

$$\frac{V_D}{100} \geq \frac{N_D}{10}, \qquad Q_C \leq 5 \quad \text{and} \quad Q_D \leq 5,$$

determined all the Nash equilibria (um) (if any) of the game. Justify your answer.

(ii) Find the conditions on V_C, N_C, Q_C, V_D, N_D and Q_D, so that the situation described in $\bullet_4$ is a Nash equilibrium of the game. Your answer should be in its simplest form. Justify your answer.