#### **Task 4. Symbiosis model. Change of variables**

**Question 1**. Consider the system of differential equations *x*'*=f*(*x*,*y*) and *y*'=*g*(*x*,*y*) with initial conditions *x*(0)=*x*0 and *y*(0)=*y*0, where the functions *f* and *g* are given. It is necessary to change the variables so that the system in the new variables includes as few parameters as possible. The task involves specifying a concrete replacement of variables, as well as a concrete representation of all new parameters through the old ones.

**Question 2**. For the mathematical model of symbiosis in new variables, two of the three parameters are specified. It is necessary to choose the value of the third parameter twice in order to achieve these two effects and describe the evolution of the system. If some effect is impossible with given parameter values, then change one of them to achieve the desired result.

**Variants**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **№** | ***f*** | ***g*** | **Parameters** | **Effect 1** | **Effect 1** |
| 1 | (*ax*2+*by*)*y* +*ky*2 | (*cx*+*dy*)*x* | *m=*2, *u*0=2 | *u* ↑↓, *v* ↓ | *u* ↑, *v* ↑ |
| 2 | (*ax*+*by*)y | (*cx*+*dy*2)*x*2+*kx* | *m=*1/2, *v*0=3 | *u* ↑, *v* ↓↑ | *u* ↓, *v* ↓ |
| 3 | *ax*+*bxy* +*kx*2 | (*cx*2+*dy*)*x* | *u*0=2, *v*0=1/2 | *u* ↓↑, *v* ↑ | *u* ↓, *v* ↑↓ |
| 4 | *ax*2+*by*2*x* | (*cx*+*dy*)(*y*2+*ky*) | *m=*1/3, *u*0=3 | *u* ↑↓, *v* ↓ | *u* ↓, *v* ↓ |
| 5 | (*ax*+*by*)y | *cx*2+*dy* +*kx* | *m=*3, *v*0=1/2 | *u* ↑, *v* ↓↑ | *u* ↓, *v* ↑↓ |
| 6 | *ax*2*y*2+*cx* | *bxy*+*dy*+*ky*2 | *u*0=1/2, *v*0=1/3 | *u* ↑, *v* ↑ | *u* ↓, *v* ↑↓ |
| 7 | (*ax*+*by*+*k*)*y* | (*cx*+*dy*)*x*2 | *m=*1/4, *u*0=3 | *u* ↓, *v* ↓ | *u* ↑↓, *v* ↓ |
| 8 | (*cx*+*dy*)*x* | (*ax*2+*by*)*y* +*ky*2 | *m=*3/2, *v*0=1/2 | *u* ↓, *v* ↑↓ | *u* ↑, *v* ↑ |
| 9 | (*cx*+*dy*2)*x*2+*kx* | (*ax*+*by*)*y* | *u*0=3, *v*0=1/3 | *u* ↑, *v* ↑ | *u* ↑↓, *v* ↓ |
| 10 | (*cx*2+*dy*)*x* | *ax*+*bxy* +*kx*2 | *m=*1/2, *u*0=2 | *u* ↓, *v* ↑↓ | *u* ↑↓, *v* ↓ |
| 11 | (*cx*+*dy*)(*y*2+*ky*) | *ax*2+*by*2*x* | *m=*2, *v*0=2 | *u* ↑, *v* ↑ | *u* ↓↑, *v* ↑ |

Remark. ↑ - the function increases, ↓↑ - the function first decreases and then increases,

↓ - the function decreases, ↑↓ - the function first increases and then decreases.