

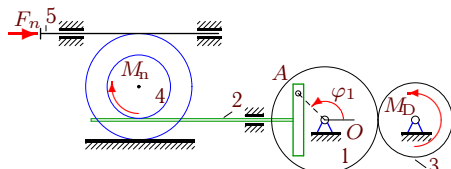
## Кулиса. Уравнение Лагранжа

Кулисный механизм расположен в вертикальной плоскости и состоит из однородных цилиндров, блоков (радиус инерции  $i_k$ ), штока и груза<sup>1</sup>. Используя уравнение Лагранжа 2-го рода, получить уравнение движения механизма. Найти значение углового ускорения  $\ddot{\varphi}_1$  при  $t = 0$ . Кинетическую энергию представить в форме  $T = (\dot{\varphi}^2/2)(A + B \sin^2 \varphi)$  или  $T = (\dot{\varphi}^2/2)(A + B \cos^2 \varphi)$  (варианты помечены \*)

Кирсанов М.Н. **Решебник. Теоретическая механика**/Под ред. А. И. Кириллова.– М.: ФИЗМАТЛИТ, 2008. — 384 с. (с.307.)

### Задача D31.1.

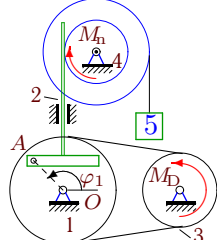
7



$$\begin{aligned} M_{Dz} &= M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z}, \\ F_{nx} &= -\nu v_{5x}, \varphi_{1,0} = 1.2, \omega_{1z,0} = 0.3 \frac{1}{c}, \\ M_0 &= 8 \text{ Нм}, k = 13 \text{ Нмс}, \\ \nu &= 25 \text{ Нс/м}, \mu = 14 \text{ Нмс}, \\ I_1 &= 5 \text{ кгм}^2, m_2 = 15 \text{ кг}, m_3 = 33 \text{ кг}, \\ m_4 &= 25 \text{ кг}, R_1 = 36 \text{ см}, r_1 = 25 \text{ см}, \\ R_3 &= 26 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 14 \text{ см}. \end{aligned}$$

### Задача D31.2.

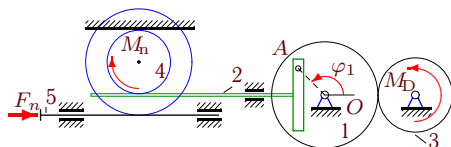
7



$$\begin{aligned} M_{Dz} &= M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z}, \\ M_0 &= 9 \text{ Нм}, k = 11 \text{ Нмс}, \\ \varphi_{1,0} &= 1.2, \omega_{1z,0} = 0.1 \frac{1}{c}, \\ \mu &= 13 \text{ Нмс}, I_1 = 7 \text{ кгм}^2, \\ m_2 &= 15 \text{ кг}, m_3 = 33 \text{ кг}, m_4 = 25 \text{ кг}, \\ m_5 &= 3 \text{ кг}, R_1 = 34 \text{ см}, r_1 = 23 \text{ см}, \\ R_3 &= 24 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 14 \text{ см}. \end{aligned}$$

### Задача D31.3.

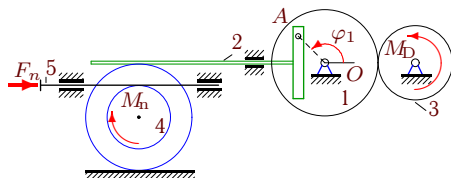
7



$$\begin{aligned} M_{Dz} &= M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z}, \\ F_{nx} &= -\nu v_{5x}, \varphi_{1,0} = 1.2, \omega_{1z,0} = 0.4 \frac{1}{c}, \\ M_0 &= 8 \text{ Нм}, k = 14 \text{ Нмс}, \\ \nu &= 35 \text{ Нс/м}, \mu = 13 \text{ Нмс}, \\ I_1 &= 5 \text{ кгм}^2, m_2 = 15 \text{ кг}, m_3 = 33 \text{ кг}, \\ m_4 &= 25 \text{ кг}, R_1 = 37 \text{ см}, r_1 = 26 \text{ см}, \\ R_3 &= 27 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 14 \text{ см}. \end{aligned}$$

### Задача D31.4.

7

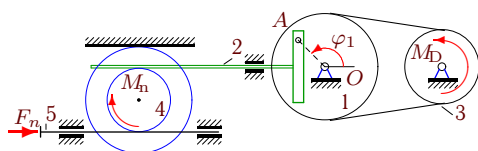


$$\begin{aligned} M_{Dz} &= M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z}, \\ F_{nx} &= -\nu v_{5x}, \varphi_{1,0} = 1.2, \omega_{1z,0} = 0.1 \frac{1}{c}, \\ M_0 &= 8 \text{ Нм}, k = 11 \text{ Нмс}, \\ \nu &= 35 \text{ Нс/м}, \mu = 14 \text{ Нмс}, \\ I_1 &= 5 \text{ кгм}^2, m_2 = 15 \text{ кг}, m_3 = 33 \text{ кг}, \\ m_4 &= 25 \text{ кг}, R_1 = 34 \text{ см}, r_1 = 23 \text{ см}, \\ R_3 &= 24 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 14 \text{ см}. \end{aligned}$$

<sup>1</sup>В некоторых вариантах содержатся не все элементы.

### Задача D31.5.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.1, \omega_{1z,0} = 0.3 \frac{1}{c},$$

$$M_0 = 8 \text{ Нм}, k = 13 \text{ Нмс},$$

$$\nu = 40 \text{ Нс/м}, \mu = 14 \text{ Нмс},$$

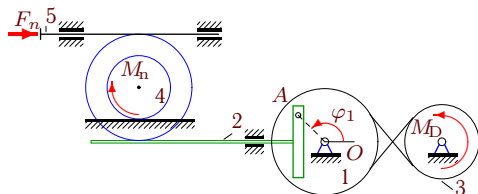
$$I_1 = 5 \text{ кгм}^2, m_2 = 14 \text{ кг}, m_3 = 32 \text{ кг},$$

$$m_4 = 24 \text{ кг}, R_1 = 36 \text{ см}, r_1 = 25 \text{ см},$$

$$R_3 = 26 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 13 \text{ см}.$$

### Задача D31.6.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.4, \omega_{1z,0} = 0.3 \frac{1}{c},$$

$$M_0 = 12 \text{ Нм}, k = 13 \text{ Нмс},$$

$$\nu = 25 \text{ Нс/м}, \mu = 12 \text{ Нмс},$$

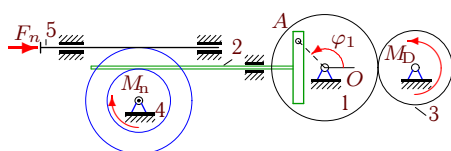
$$I_1 = 15 \text{ кгм}^2, m_2 = 17 \text{ кг}, m_3 = 35 \text{ кг},$$

$$m_4 = 27 \text{ кг}, R_1 = 36 \text{ см}, r_1 = 25 \text{ см},$$

$$R_3 = 26 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 16 \text{ см}.$$

### Задача D31.7.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.4, \omega_{1z,0} = 0.2 \frac{1}{c},$$

$$M_0 = 10 \text{ Нм}, k = 12 \text{ Нмс},$$

$$\nu = 25 \text{ Нс/м}, \mu = 12 \text{ Нмс},$$

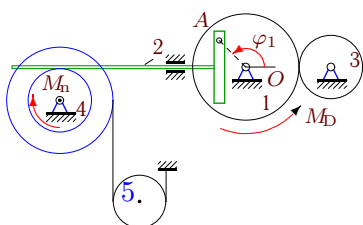
$$I_1 = 7 \text{ кгм}^2, m_2 = 17 \text{ кг}, m_3 = 35 \text{ кг},$$

$$m_4 = 27 \text{ кг}, R_1 = 35 \text{ см}, r_1 = 24 \text{ см},$$

$$R_3 = 25 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 16 \text{ см}.$$

### Задача D31.8.

7



$$M_{Dz} = M_0 - k\omega_{1z}, M_{nz} = -\mu\omega_{4z},$$

$$M_0 = 13 \text{ Нм}, k = 12 \text{ Нмс},$$

$$\varphi_{1,0} = 1.4, \omega_{1z,0} = 0.2 \frac{1}{c},$$

$$\mu = 11 \text{ Нмс}, I_1 = 19 \text{ кгм}^2,$$

$$m_2 = 17 \text{ кг}, m_3 = 35 \text{ кг}, m_4 = 27 \text{ кг},$$

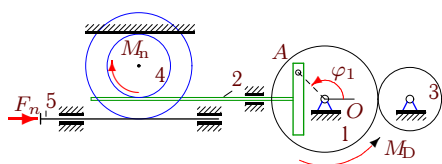
$$m_5 = 7 \text{ кг}, R_1 = 35 \text{ см}, r_1 = 24 \text{ см},$$

$$R_3 = 25 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 16 \text{ см},$$

$$r_5 = 13 \text{ см}.$$

### Задача D31.9.

7



$$M_{Dz} = M_0 - k\omega_{1z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.5, \omega_{1z,0} = 0.2 \frac{1}{c},$$

$$M_0 = 14 \text{ Нм}, k = 12 \text{ Нмс},$$

$$\nu = 20 \text{ Нс/м}, \mu = 10 \text{ Нмс},$$

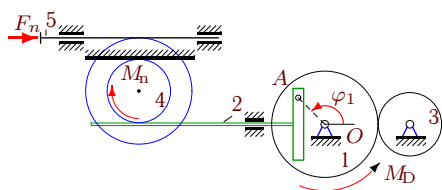
$$I_1 = 23 \text{ кгм}^2, m_2 = 18 \text{ кг}, m_3 = 36 \text{ кг},$$

$$m_4 = 28 \text{ кг}, R_1 = 35 \text{ см}, r_1 = 24 \text{ см},$$

$$R_3 = 25 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 17 \text{ см}.$$

### Задача D31.10.

7



$$M_{Dz} = M_0 - k\omega_{1z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.3, \omega_{1z,0} = 0.5 \frac{1}{c},$$

$$M_0 = 12 \text{ Нм}, k = 15 \text{ Нмс},$$

$$\nu = 8 \text{ Нс/м}, \mu = 12 \text{ Нмс},$$

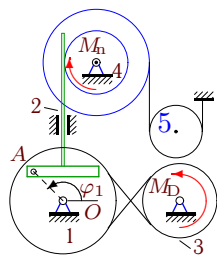
$$I_1 = 15 \text{ кгм}^2, m_2 = 16 \text{ кг}, m_3 = 34 \text{ кг},$$

$$m_4 = 26 \text{ кг}, R_1 = 38 \text{ см}, r_1 = 27 \text{ см},$$

$$R_3 = 28 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 15 \text{ см}.$$

### Задача D31.11.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$M_0 = 13 \text{ Нм}, k = 14 \text{ Нмс},$$

$$\varphi_{1,0} = 1.5, \omega_{1z,0} = 0.4 \frac{1}{c},$$

$$\mu = 10 \text{ Нмс}, I_1 = 18 \text{ кгм}^2,$$

$$m_2 = 18 \text{ кг}, m_3 = 36 \text{ кг}, m_4 = 28 \text{ кг},$$

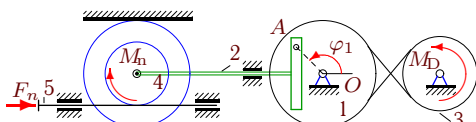
$$m_5 = 7 \text{ кг}, R_1 = 37 \text{ см}, r_1 = 26 \text{ см},$$

$$R_3 = 27 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 17 \text{ см},$$

$$r_5 = 12 \text{ см}.$$

### Задача D31.12.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.5, \omega_{1z,0} = 0.4 \frac{1}{c},$$

$$M_0 = 13 \text{ Нм}, k = 14 \text{ Нмс},$$

$$\nu = 20 \text{ Нс/м}, \mu = 10 \text{ Нмс},$$

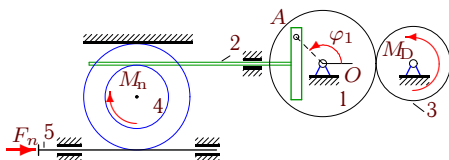
$$I_1 = 18 \text{ кгм}^2, m_2 = 18 \text{ кг}, m_3 = 36 \text{ кг},$$

$$m_4 = 28 \text{ кг}, R_1 = 37 \text{ см}, r_1 = 26 \text{ см},$$

$$R_3 = 27 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 17 \text{ см}.$$

### Задача D31.13.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.5, \omega_{1z,0} = 0.5 \frac{1}{c},$$

$$M_0 = 11 \text{ Нм}, k = 15 \text{ Нмс},$$

$$\nu = 10 \text{ Нс/м}, \mu = 10 \text{ Нмс},$$

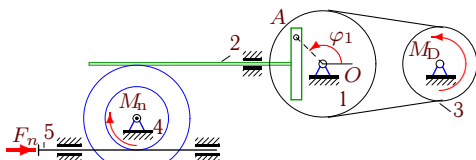
$$I_1 = 8 \text{ кгм}^2, m_2 = 18 \text{ кг}, m_3 = 36 \text{ кг},$$

$$m_4 = 28 \text{ кг}, R_1 = 38 \text{ см}, r_1 = 27 \text{ см},$$

$$R_3 = 28 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 17 \text{ см}.$$

### Задача D31.14.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.4, \omega_{1z,0} = 0.5 \frac{1}{c},$$

$$M_0 = 11 \text{ Нм}, k = 15 \text{ Нмс},$$

$$\nu = 8 \text{ Нс/м}, \mu = 11 \text{ Нмс},$$

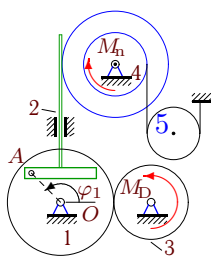
$$I_1 = 11 \text{ кгм}^2, m_2 = 17 \text{ кг}, m_3 = 35 \text{ кг},$$

$$m_4 = 27 \text{ кг}, R_1 = 38 \text{ см}, r_1 = 27 \text{ см},$$

$$R_3 = 28 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 16 \text{ см}.$$

### Задача D31.15.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$M_0 = 11 \text{ Нм}, k = 12 \text{ Нмс},$$

$$\varphi_{1,0} = 1.5, \omega_{1z,0} = 0.2 \frac{1}{c},$$

$$\mu = 11 \text{ Нмс}, I_1 = 8 \text{ кгм}^2,$$

$$m_2 = 18 \text{ кг}, m_3 = 36 \text{ кг}, m_4 = 28 \text{ кг},$$

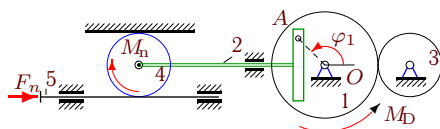
$$m_5 = 6 \text{ кг}, R_1 = 35 \text{ см}, r_1 = 24 \text{ см},$$

$$R_3 = 25 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 17 \text{ см},$$

$$r_5 = 10 \text{ см}.$$

### Задача D31.16.

7



$$M_{Dz} = M_0 - k\omega_{1z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.1, \omega_{1z,0} = 0.4 \frac{1}{c},$$

$$M_0 = 10 \text{ Нм}, k = 14 \text{ Нмс},$$

$$\nu = 55 \text{ Нс/м}, \mu = 14 \text{ Нмс},$$

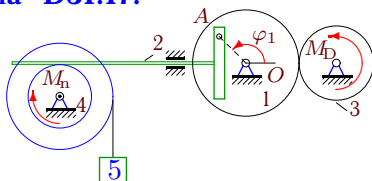
$$I_1 = 7 \text{ кгм}^2, m_2 = 14 \text{ кг}, m_3 = 32 \text{ кг},$$

$$m_4 = 24 \text{ кг}, R_1 = 37 \text{ см}, r_1 = 26 \text{ см},$$

$$R_3 = 27 \text{ см}, R_4 = 12 \text{ см}.$$

### Задача D31.17.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$M_0 = 10 \text{ Нм}, k = 15 \text{ Нмс},$$

$$\varphi_{1,0} = 1.4, \omega_{1z,0} = 0.5 \frac{1}{c},$$

$$\mu = 11 \text{ Нмс}, I_1 = 7 \text{ кгм}^2,$$

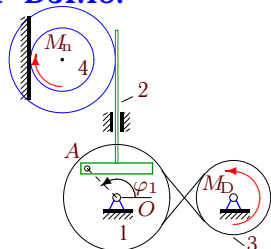
$$m_2 = 17 \text{ кг}, m_3 = 35 \text{ кг}, m_4 = 27 \text{ кг},$$

$$m_5 = 4 \text{ кг}, R_1 = 38 \text{ см}, r_1 = 27 \text{ см},$$

$$R_3 = 28 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 16 \text{ см}.$$

### Задача D31.18.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$\varphi_{1,0} = 1.2, \omega_{1z,0} = 0.5 \frac{1}{c},$$

$$M_0 = 10 \text{ Нм}, k = 15 \text{ Нмс},$$

$$\mu = 14 \text{ Нмс},$$

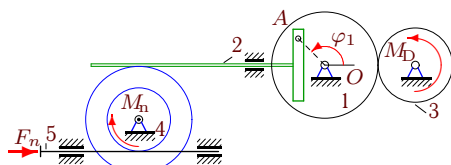
$$I_1 = 9 \text{ кгм}^2, m_2 = 15 \text{ кг}, m_3 = 33 \text{ кг},$$

$$m_4 = 25 \text{ кг}, R_1 = 38 \text{ см}, r_1 = 27 \text{ см},$$

$$R_3 = 28 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 14 \text{ см}.$$

### Задача D31.19.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.3, \omega_{1z,0} = 0.5 \frac{1}{c},$$

$$M_0 = 9 \text{ Нм}, k = 15 \text{ Нмс},$$

$$\nu = 8 \text{ Нс/м}, \mu = 12 \text{ Нмс},$$

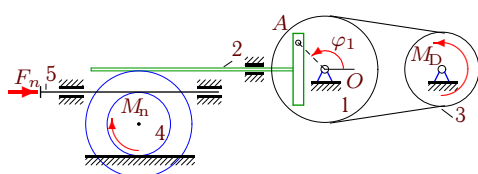
$$I_1 = 6 \text{ кгм}^2, m_2 = 16 \text{ кг}, m_3 = 34 \text{ кг},$$

$$m_4 = 26 \text{ кг}, R_1 = 38 \text{ см}, r_1 = 27 \text{ см},$$

$$R_3 = 28 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 15 \text{ см}.$$

### Задача D31.20.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.5, \omega_{1z,0} = 0.1 \frac{1}{c},$$

$$M_0 = 12 \text{ Нм}, k = 11 \text{ Нмс},$$

$$\nu = 35 \text{ Нс/м}, \mu = 11 \text{ Нмс},$$

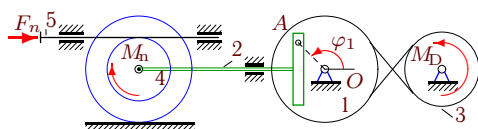
$$I_1 = 13 \text{ кгм}^2, m_2 = 18 \text{ кг}, m_3 = 36 \text{ кг},$$

$$m_4 = 28 \text{ кг}, R_1 = 34 \text{ см}, r_1 = 23 \text{ см},$$

$$R_3 = 24 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 17 \text{ см}.$$

### Задача D31.21.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.2, \omega_{1z,0} = 0.2 \frac{1}{c},$$

$$M_0 = 10 \text{ Нм}, k = 12 \text{ Нмс},$$

$$\nu = 35 \text{ Нс/м}, \mu = 14 \text{ Нмс},$$

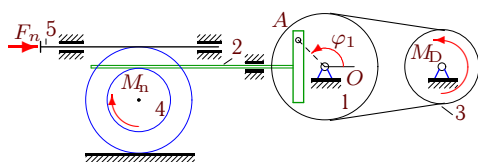
$$I_1 = 9 \text{ кгм}^2, m_2 = 15 \text{ кг}, m_3 = 33 \text{ кг},$$

$$m_4 = 25 \text{ кг}, R_1 = 35 \text{ см}, r_1 = 24 \text{ см},$$

$$R_3 = 25 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 14 \text{ см}.$$

### Задача D31.22.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.4, \omega_{1z,0} = 0.4 \frac{1}{c},$$

$$M_0 = 11 \text{ Нм}, k = 14 \text{ Нмс},$$

$$\nu = 15 \text{ Нс/м}, \mu = 12 \text{ Нмс},$$

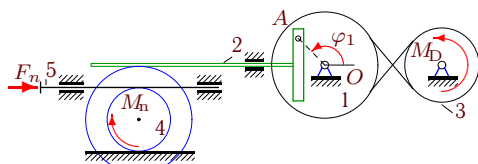
$$I_1 = 11 \text{ кгм}^2, m_2 = 17 \text{ кг}, m_3 = 35 \text{ кг},$$

$$m_4 = 27 \text{ кг}, R_1 = 37 \text{ см}, r_1 = 26 \text{ см},$$

$$R_3 = 27 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 16 \text{ см}.$$

### Задача D31.23.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.1, \omega_{1z,0} = 0.5 \frac{1}{c},$$

$$M_0 = 9 \text{ Нм}, k = 15 \text{ Нмс},$$

$$\nu = 55 \text{ Нс/м}, \mu = 15 \text{ Нмс},$$

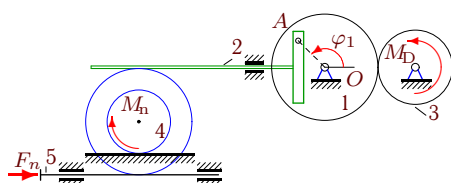
$$I_1 = 6 \text{ кгм}^2, m_2 = 14 \text{ кг}, m_3 = 32 \text{ кг},$$

$$m_4 = 24 \text{ кг}, R_1 = 38 \text{ см}, r_1 = 27 \text{ см},$$

$$R_3 = 28 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 13 \text{ см}.$$

### Задача D31.24.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.5, \omega_{1z,0} = 0.4 \frac{1}{c},$$

$$M_0 = 11 \text{ Нм}, k = 14 \text{ Нмс},$$

$$\nu = 8 \text{ Нс/м}, \mu = 10 \text{ Нмс},$$

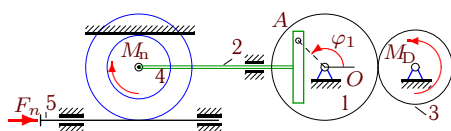
$$I_1 = 8 \text{ кгм}^2, m_2 = 18 \text{ кг}, m_3 = 36 \text{ кг},$$

$$m_4 = 28 \text{ кг}, R_1 = 37 \text{ см}, r_1 = 26 \text{ см},$$

$$R_3 = 27 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 17 \text{ см}.$$

### Задача D31.25.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.1, \omega_{1z,0} = 0.5 \frac{1}{c},$$

$$M_0 = 7 \text{ Нм}, k = 15 \text{ Нмс},$$

$$\nu = 40 \text{ Нс/м}, \mu = 14 \text{ Нмс},$$

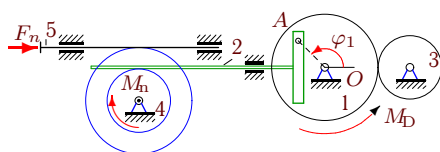
$$I_1 = 4 \text{ кгм}^2, m_2 = 14 \text{ кг}, m_3 = 32 \text{ кг},$$

$$m_4 = 24 \text{ кг}, R_1 = 38 \text{ см}, r_1 = 27 \text{ см},$$

$$R_3 = 28 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 13 \text{ см}.$$

### Задача D31.26.

7



$$M_{Dz} = M_0 - k\omega_{1z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.3, \omega_{1z,0} = 0.1 \frac{1}{c},$$

$$M_0 = 12 \text{ Нм}, k = 11 \text{ Нмс},$$

$$\nu = 30 \text{ Нс/м}, \mu = 13 \text{ Нмс},$$

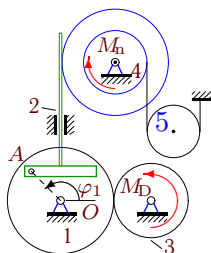
$$I_1 = 15 \text{ кгм}^2, m_2 = 16 \text{ кг}, m_3 = 34 \text{ кг},$$

$$m_4 = 26 \text{ кг}, R_1 = 34 \text{ см}, r_1 = 23 \text{ см},$$

$$R_3 = 24 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 15 \text{ см}.$$

### Задача D31.27.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$M_0 = 7 \text{ Нм}, k = 15 \text{ Нмс},$$

$$\varphi_{1,0} = 1.1, \omega_{1z,0} = 0.5 \frac{1}{c},$$

$$\mu = 15 \text{ Нмс}, I_1 = 4 \text{ кгм}^2,$$

$$m_2 = 14 \text{ кг}, m_3 = 32 \text{ кг}, m_4 = 24 \text{ кг},$$

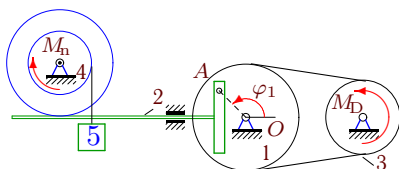
$$m_5 = 2 \text{ кг}, R_1 = 38 \text{ см}, r_1 = 27 \text{ см},$$

$$R_3 = 28 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 13 \text{ см},$$

$$r_5 = 10 \text{ см}.$$

### Задача D31.28.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$M_0 = 10 \text{ Нм}, k = 12 \text{ Нмс},$$

$$\varphi_{1,0} = 1.3, \omega_{1z,0} = 0.2 \frac{1}{\text{с}},$$

$$\mu = 13 \text{ Нмс}, I_1 = 9 \text{ кгм}^2,$$

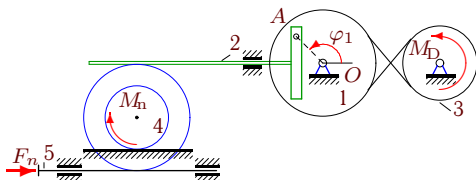
$$m_2 = 16 \text{ кг}, m_3 = 34 \text{ кг}, m_4 = 26 \text{ кг},$$

$$m_5 = 5 \text{ кг}, R_1 = 35 \text{ см}, r_1 = 24 \text{ см},$$

$$R_3 = 25 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 15 \text{ см}.$$

### Задача D31.29.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.5, \omega_{1z,0} = 0.1 \frac{1}{\text{с}},$$

$$M_0 = 13 \text{ Нм}, k = 11 \text{ Нмс},$$

$$\nu = 8 \text{ кНс/м}, \mu = 10 \text{ Нмс},$$

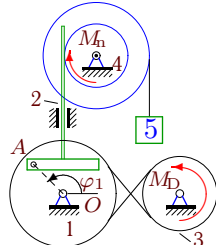
$$I_1 = 18 \text{ кгм}^2, m_2 = 18 \text{ кг}, m_3 = 36 \text{ кг},$$

$$m_4 = 28 \text{ кг}, R_1 = 34 \text{ см}, r_1 = 23 \text{ см},$$

$$R_3 = 24 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 17 \text{ см}.$$

### Задача D31.30.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$M_0 = 12 \text{ Нм}, k = 11 \text{ Нмс},$$

$$\varphi_{1,0} = 1.4, \omega_{1z,0} = 0.1 \frac{1}{\text{с}},$$

$$\mu = 11 \text{ Нмс}, I_1 = 15 \text{ кгм}^2,$$

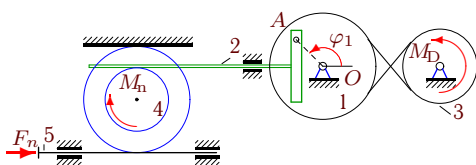
$$m_2 = 17 \text{ кг}, m_3 = 35 \text{ кг}, m_4 = 27 \text{ кг},$$

$$m_5 = 6 \text{ кг}, R_1 = 34 \text{ см}, r_1 = 23 \text{ см},$$

$$R_3 = 24 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 16 \text{ см}.$$

### Задача D31.31.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.4, \omega_{1z,0} = 0.1 \frac{1}{\text{с}},$$

$$M_0 = 12 \text{ Нм}, k = 11 \text{ Нмс},$$

$$\nu = 15 \text{ Нс/м}, \mu = 11 \text{ Нмс},$$

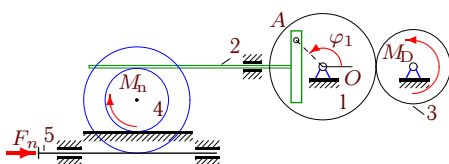
$$I_1 = 15 \text{ кгм}^2, m_2 = 17 \text{ кг}, m_3 = 35 \text{ кг},$$

$$m_4 = 27 \text{ кг}, R_1 = 34 \text{ см}, r_1 = 23 \text{ см},$$

$$R_3 = 24 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 16 \text{ см}.$$

### Задача D31.32.

7



$$M_{Dz} = M_0 - k\omega_{3z}, M_{nz} = -\mu\omega_{4z},$$

$$F_{nx} = -\nu v_{5x}, \varphi_{1,0} = 1.4, \omega_{1z,0} = 0.1 \frac{1}{\text{с}},$$

$$M_0 = 10 \text{ Нм}, k = 11 \text{ Нмс},$$

$$\nu = 8 \text{ кНс/м}, \mu = 11 \text{ Нмс},$$

$$I_1 = 7 \text{ кгм}^2, m_2 = 17 \text{ кг}, m_3 = 35 \text{ кг},$$

$$m_4 = 27 \text{ кг}, R_1 = 34 \text{ см}, r_1 = 23 \text{ см},$$

$$R_3 = 24 \text{ см}, R_4 = 20 \text{ см}, r_4 = 12 \text{ см}, i_4 = 16 \text{ см}.$$

**D31 Ответы.**  
**Кулиса. Уравнение Лагранжа**

23.03.2012

|     | $A$    | $B$    | $Q$      | $\varepsilon$ | $B_2$ | $B_4$ | $B_5$ | $Q_F$   | $Q_M$  | $Q_D$  | $Q_T$  |
|-----|--------|--------|----------|---------------|-------|-------|-------|---------|--------|--------|--------|
| 1   | 7.138  | 15.488 | -64.364  | -3.148        | 0.94  | 14.55 | 0.00  | -10.18  | -35.63 | -18.55 | 0.00   |
| 2*  | 8.907  | 3.034  | 1.739    | 0.188         | 0.79  | 1.80  | 0.44  | 0.00    | -0.63  | 10.54  | -8.18  |
| 3   | 7.259  | 2.012  | -28.242  | -3.148        | 1.01  | 1.00  | 0.00  | -1.46   | -5.30  | -21.48 | 0.00   |
| 4   | 6.907  | 1.286  | -14.046  | -1.751        | 0.79  | 0.49  | 0.00  | -0.10   | -0.40  | -13.54 | 0.00   |
| 5   | 7.074  | 14.211 | -38.508  | -2.125        | 0.88  | 13.34 | 0.00  | -9.53   | -32.58 | 3.60   | 0.00   |
| 6   | 17.268 | 11.609 | -65.516  | -2.302        | 1.06  | 10.55 | 0.00  | -7.28   | -34.14 | -24.09 | 0.00   |
| 7   | 9.144  | 3.744  | -28.804  | -2.256        | 0.98  | 2.76  | 0.00  | -0.78   | -9.32  | -18.70 | 0.00   |
| 8   | 21.144 | 4.164  | -11.480  | -0.457        | 0.98  | 2.76  | 0.42  | 0.00    | -8.55  | 10.60  | -13.53 |
| 9   | 25.205 | 2.249  | 9.202    | 0.335         | 1.04  | 1.21  | 0.00  | -0.41   | -1.99  | 11.60  | 0.00   |
| 10  | 17.455 | 2.381  | -32.632  | -1.667        | 1.17  | 1.21  | 0.00  | -30.08  | -7.05  | 4.50   | 0.00   |
| 11* | 20.464 | 5.508  | -30.620  | -1.491        | 1.22  | 3.80  | 0.49  | 0.00    | -0.09  | -28.33 | -2.20  |
| 12  | 20.464 | 4.477  | -36.435  | -1.464        | 1.22  | 3.26  | 0.00  | -1.38   | -6.73  | -28.33 | 0.00   |
| 13  | 10.599 | 23.287 | -94.477  | -2.810        | 1.31  | 21.97 | 0.00  | -9.07   | -56.67 | -28.74 | 0.00   |
| 14  | 13.527 | 2.499  | -110.563 | -6.937        | 1.24  | 1.26  | 0.00  | -101.94 | -9.73  | 1.11   | 0.00   |
| 15* | 10.205 | 2.249  | -22.818  | -2.233        | 1.04  | 1.17  | 0.05  | 0.00    | -0.02  | -20.10 | -2.70  |
| 16  | 9.190  | 3.380  | -21.205  | -1.804        | 0.95  | 2.43  | 0.00  | -4.72   | -20.88 | 4.40   | 0.00   |
| 17  | 9.527  | 5.548  | -71.826  | -4.831        | 1.24  | 3.50  | 0.81  | 0.00    | -27.04 | -27.39 | -17.40 |
| 18* | 11.383 | 1.699  | -51.434  | -4.419        | 1.09  | 0.61  | 0.00  | 0.00    | -0.65  | -27.39 | -23.39 |
| 19  | 8.455  | 2.233  | -133.645 | -12.708       | 1.17  | 1.07  | 0.00  | -97.46  | -10.15 | -26.03 | 0.00   |
| 20  | 15.081 | 1.579  | 14.123   | 0.848         | 0.95  | 0.63  | 0.00  | -0.10   | -0.57  | 14.79  | 0.00   |
| 21  | 11.021 | 3.010  | -23.103  | -1.697        | 0.86  | 2.15  | 0.00  | -0.90   | -3.50  | -18.70 | 0.00   |
| 22  | 13.396 | 2.318  | 0.865    | 0.051         | 1.15  | 1.17  | 0.00  | -0.62   | -3.08  | 4.56   | 0.00   |
| 23  | 8.310  | 1.555  | -31.165  | -3.281        | 1.02  | 0.53  | 0.00  | -0.90   | -4.24  | -26.03 | 0.00   |
| 24  | 10.464 | 2.017  | -41.670  | -3.343        | 1.22  | 0.80  | 0.00  | -13.45  | -2.63  | -25.59 | 0.00   |
| 25  | 6.310  | 4.824  | -59.695  | -5.934        | 1.02  | 3.80  | 0.00  | -8.23   | -28.15 | -23.31 | 0.00   |
| 26  | 16.965 | 2.995  | 6.057    | 0.306         | 0.85  | 2.15  | 0.00  | -0.41   | -4.43  | 10.90  | 0.00   |
| 27* | 6.310  | 1.779  | -42.225  | -6.298        | 1.02  | 0.74  | 0.02  | 0.00    | -2.81  | -23.31 | -16.10 |
| 28  | 11.083 | 1.868  | 12.626   | 0.984         | 0.92  | 0.84  | 0.10  | 0.00    | -3.48  | 9.30   | 6.81   |
| 29  | 20.081 | 1.579  | -23.770  | -1.098        | 0.95  | 0.63  | 0.00  | -2.63   | -0.51  | -20.62 | 0.00   |
| 30* | 17.023 | 4.320  | -22.009  | -1.283        | 0.90  | 2.54  | 0.88  | 0.00    | -0.12  | -19.21 | -2.68  |
| 31  | 17.023 | 15.539 | -29.964  | -0.934        | 0.90  | 14.64 | 0.00  | -1.93   | -8.83  | -19.21 | 0.00   |
| 32  | 9.023  | 1.891  | -21.922  | -2.019        | 0.90  | 0.99  | 0.00  | -4.57   | -0.98  | -16.37 | 0.00   |

D31 файл o31d7A