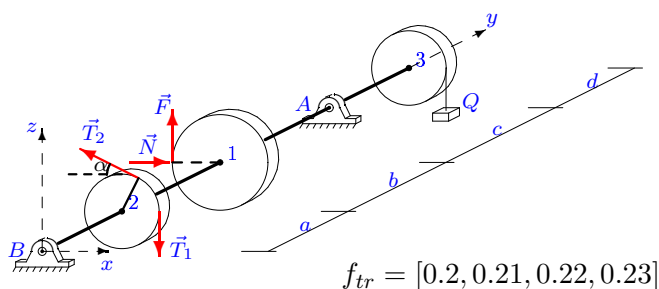


## Вал

Горизонтальный вал весом  $G$  может вращаться в цилиндрических шарнирах  $A$  и  $B$ . К шкиву 1 приложено нормальное давление  $N$  и касательная сила сопротивления  $F$ , пропорциональная  $N$ . На шкив 2 действуют силы натяжения ремней  $T_1$  и  $T_2$ . Груз  $Q$  висит на нити, навитой на шкив 3. Найти математические ожидания реакции шарниров в условии равновесия вала, если коэффициент трения  $f$  задан как случайная величина с рядом распределения  $p = [0.2, 0.3, 0.4, 0.1]$ . Учесть веса шкивов  $P_1, P_2, P_3$ . Все нагрузки действуют в вертикальной плоскости. Силы даны в ньютонах, размеры — в сантиметрах.

Кирсанов М.Н. **Решебник. Теоретическая механика** / Под ред. А. И. Кириллова. — М.: ФИЗМАТЛИТ, 2008. — 384 с. (с.94.)

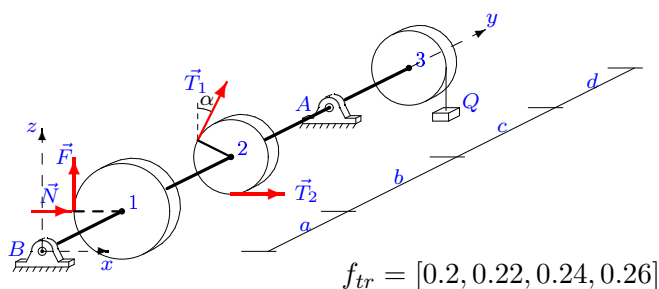
### Задача L-22.1.



$$F = fN, T_1 = 40, \\ T_2 = 77, P_1 = 28, \\ P_2 = 20, P_3 = 24, \\ Q = 18, G = 20, \\ \alpha = 45^\circ, R_1 = 20, \\ R_2 = 10, R_3 = 11, \\ a = 22, b = 25, \\ c = 27, d = 24.$$

1

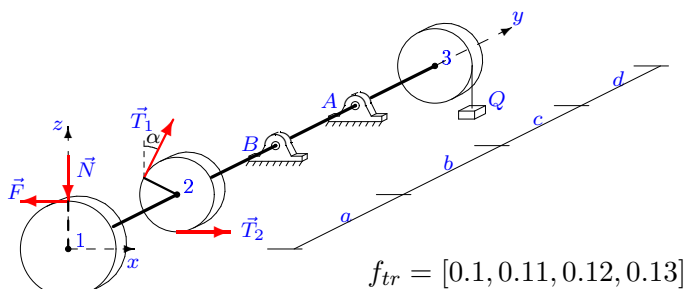
### Задача L-22.2.



$$F = fN, T_1 = 40, \\ T_2 = 77, P_1 = 32, \\ P_2 = 20, P_3 = 24, \\ Q = 18, G = 20, \\ \alpha = 45^\circ, R_1 = 28, \\ R_2 = 10, R_3 = 11, \\ a = 22, b = 25, \\ c = 27, d = 26.$$

1

### Задача L-22.3.

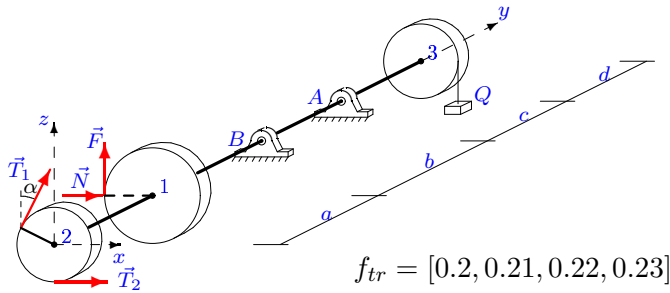


$$F = fN, T_1 = 60, \\ T_2 = 31, P_1 = 30, \\ P_2 = 20, P_3 = 24, \\ Q = 26, G = 30, \\ \alpha = 45^\circ, R_1 = 24, \\ R_2 = 10, R_3 = 11, \\ a = 22, b = 27, \\ c = 29, d = 25.$$

1

Задача L-22.4.

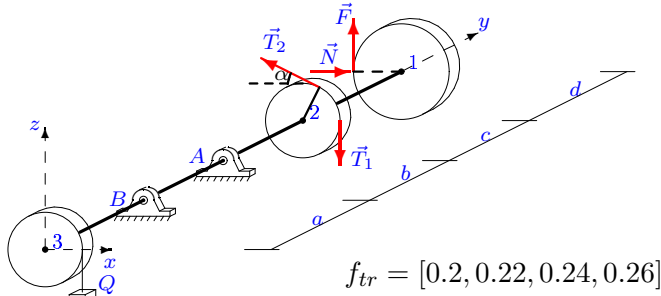
1



$F = fN, T_1 = 50,$   
 $T_2 = 96, P_1 = 32,$   
 $P_2 = 20, P_3 = 24,$   
 $Q = 22, G = 25,$   
 $\alpha = 45^\circ, R_1 = 28,$   
 $R_2 = 10, R_3 = 11,$   
 $a = 22, b = 26,$   
 $c = 28, d = 26.$

Задача L-22.5.

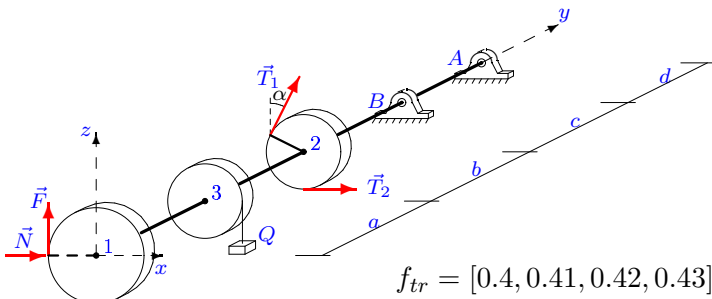
1



$F = fN, T_1 = 70,$   
 $T_2 = 138, P_1 = 18,$   
 $P_2 = 10, P_3 = 14,$   
 $Q = 14, G = 35,$   
 $\alpha = 30^\circ, R_1 = 18,$   
 $R_2 = 8, R_3 = 9,$   
 $a = 22, b = 24,$   
 $c = 25, d = 24.$

Задача L-22.6.

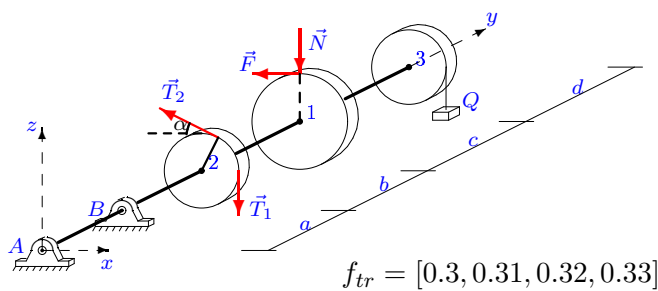
1



$F = fN, T_1 = 60,$   
 $T_2 = 118, P_1 = 46,$   
 $P_2 = 30, P_3 = 38,$   
 $Q = 14, G = 30,$   
 $\alpha = 60^\circ, R_1 = 30,$   
 $R_2 = 12, R_3 = 14,$   
 $a = 24, b = 26,$   
 $c = 29, d = 28.$

Задача L-22.7.

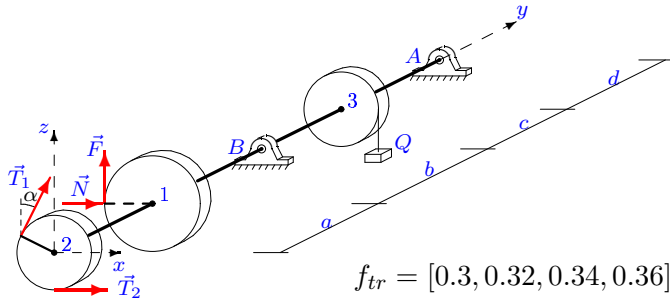
1



$F = fN, T_1 = 30,$   
 $T_2 = 18, P_1 = 42,$   
 $P_2 = 30, P_3 = 38,$   
 $Q = 26, G = 15,$   
 $\alpha = 60^\circ, R_1 = 22,$   
 $R_2 = 12, R_3 = 14,$   
 $a = 24, b = 29,$   
 $c = 32, d = 26.$

Задача L-22.8.

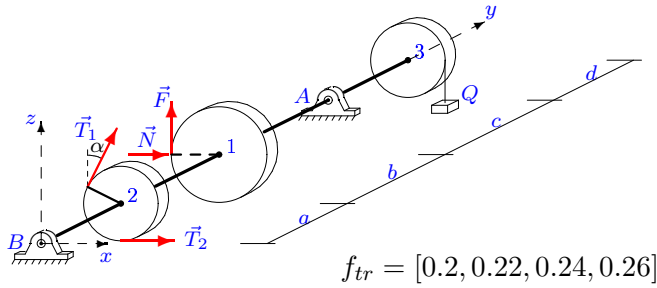
1



$F = fN, T_1 = 50,$   
 $T_2 = 98, P_1 = 34,$   
 $P_2 = 20, P_3 = 28,$   
 $Q = 14, G = 25,$   
 $\alpha = 45^\circ, R_1 = 24,$   
 $R_2 = 10, R_3 = 12,$   
 $a = 24, b = 26,$   
 $c = 28, d = 27.$

Задача L-22.9.

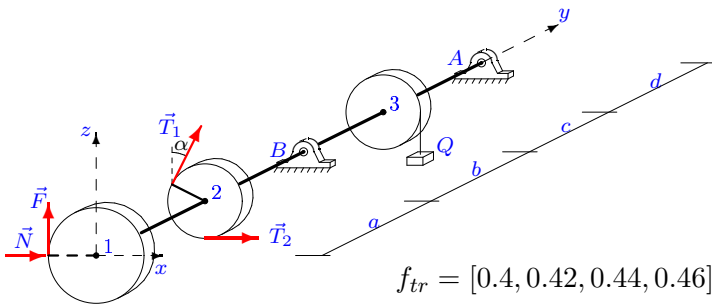
1



$F = fN, T_1 = 40,$   
 $T_2 = 78, P_1 = 40,$   
 $P_2 = 30, P_3 = 34,$   
 $Q = 14, G = 20,$   
 $\alpha = 60^\circ, R_1 = 26,$   
 $R_2 = 12, R_3 = 13,$   
 $a = 22, b = 24,$   
 $c = 27, d = 25.$

Задача L-22.10.

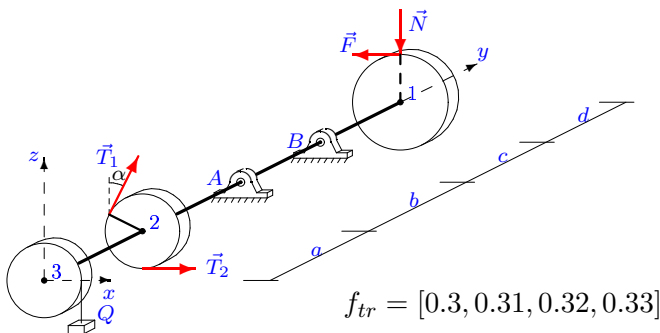
1



$F = fN, T_1 = 60,$   
 $T_2 = 116, P_1 = 34,$   
 $P_2 = 20, P_3 = 28,$   
 $Q = 22, G = 30,$   
 $\alpha = 45^\circ, R_1 = 24,$   
 $R_2 = 10, R_3 = 12,$   
 $a = 24, b = 28,$   
 $c = 30, d = 27.$

Задача L-22.11.

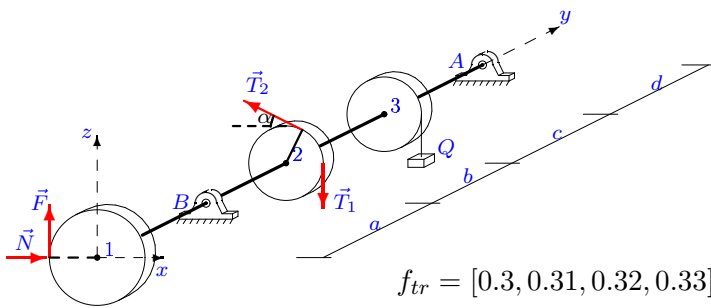
1



$F = fN, T_1 = 70,$   
 $T_2 = 38, P_1 = 24,$   
 $P_2 = 10, P_3 = 18,$   
 $Q = 10, G = 35,$   
 $\alpha = 30^\circ, R_1 = 22,$   
 $R_2 = 8, R_3 = 10,$   
 $a = 24, b = 25,$   
 $c = 26, d = 27.$

Задача L-22.12.

1

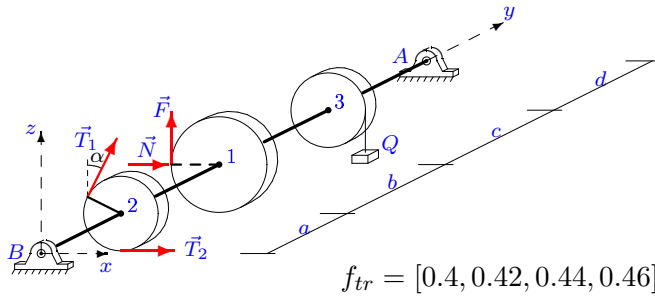


$F = fN, T_1 = 60,$   
 $T_2 = 118, P_1 = 32,$   
 $P_2 = 20, P_3 = 28,$   
 $Q = 14, G = 30,$   
 $\alpha = 45^\circ, R_1 = 20,$   
 $R_2 = 10, R_3 = 12,$   
 $a = 24, b = 26,$   
 $c = 28, d = 26.$

$f_{tr} = [0.3, 0.31, 0.32, 0.33]$

Задача L-22.13.

1

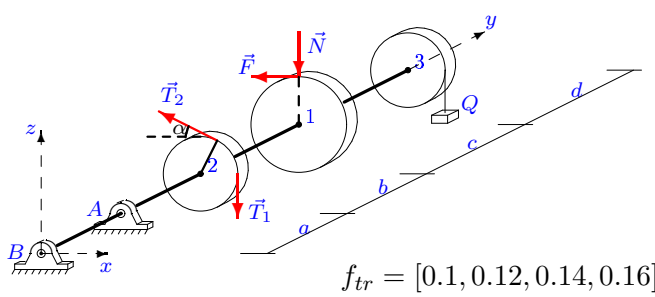


$F = fN, T_1 = 40,$   
 $T_2 = 76, P_1 = 44,$   
 $P_2 = 30, P_3 = 38,$   
 $Q = 22, G = 20,$   
 $\alpha = 60^\circ, R_1 = 26,$   
 $R_2 = 12, R_3 = 14,$   
 $a = 24, b = 28,$   
 $c = 31, d = 27.$

$f_{tr} = [0.4, 0.42, 0.44, 0.46]$

Задача L-22.14.

1

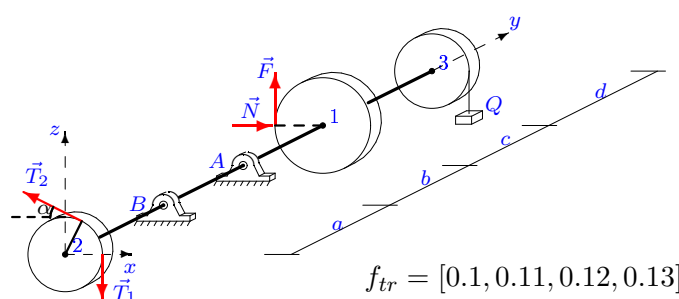


$F = fN, T_1 = 40,$   
 $T_2 = 21, P_1 = 36,$   
 $P_2 = 30, P_3 = 34,$   
 $Q = 26, G = 20,$   
 $\alpha = 60^\circ, R_1 = 18,$   
 $R_2 = 12, R_3 = 13,$   
 $a = 22, b = 27,$   
 $c = 30, d = 23.$

$f_{tr} = [0.1, 0.12, 0.14, 0.16]$

Задача L-22.15.

1

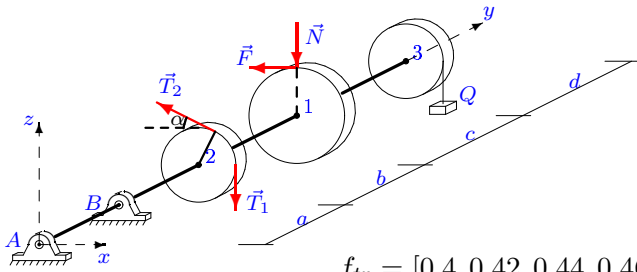


$F = fN, T_1 = 50,$   
 $T_2 = 96, P_1 = 18,$   
 $P_2 = 10, P_3 = 14,$   
 $Q = 22, G = 25,$   
 $\alpha = 30^\circ, R_1 = 18,$   
 $R_2 = 8, R_3 = 9,$   
 $a = 22, b = 26,$   
 $c = 27, d = 24.$

$f_{tr} = [0.1, 0.11, 0.12, 0.13]$

Задача L-22.16.

1

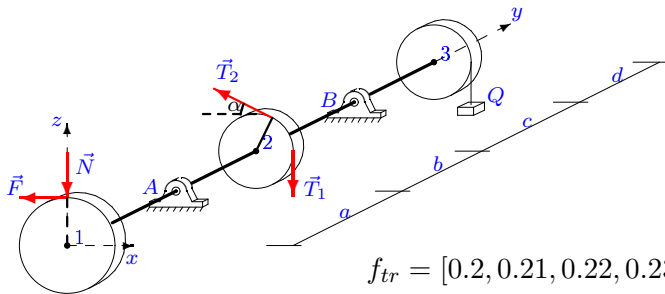


$$f_{tr} = [0.4, 0.42, 0.44, 0.46]$$

$$F = fN, T_1 = 30, \\ T_2 = 19, P_1 = 42, \\ P_2 = 30, P_3 = 38, \\ Q = 10, G = 15, \\ \alpha = 60^\circ, R_1 = 22, \\ R_2 = 12, R_3 = 14, \\ a = 24, b = 25, \\ c = 28, d = 26.$$

Задача L-22.17.

1

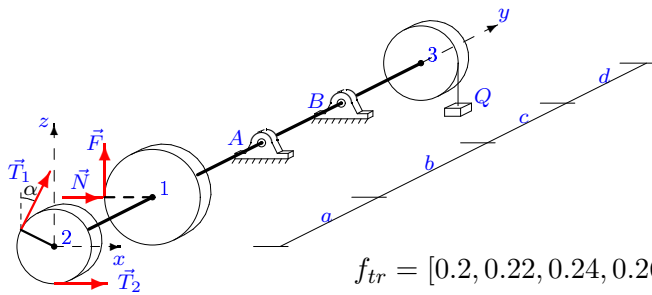


$$f_{tr} = [0.2, 0.21, 0.22, 0.23]$$

$$F = fN, T_1 = 60, \\ T_2 = 32, P_1 = 36, \\ P_2 = 30, P_3 = 34, \\ Q = 26, G = 30, \\ \alpha = 60^\circ, R_1 = 18, \\ R_2 = 12, R_3 = 13, \\ a = 22, b = 27, \\ c = 30, d = 23.$$

Задача L-22.18.

1

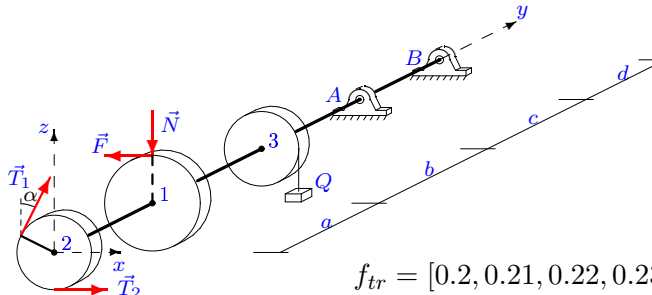


$$f_{tr} = [0.2, 0.22, 0.24, 0.26]$$

$$F = fN, T_1 = 50, \\ T_2 = 96, P_1 = 20, \\ P_2 = 10, P_3 = 14, \\ Q = 22, G = 25, \\ \alpha = 30^\circ, R_1 = 22, \\ R_2 = 8, R_3 = 9, \\ a = 22, b = 26, \\ c = 27, d = 25.$$

Задача L-22.19.

1

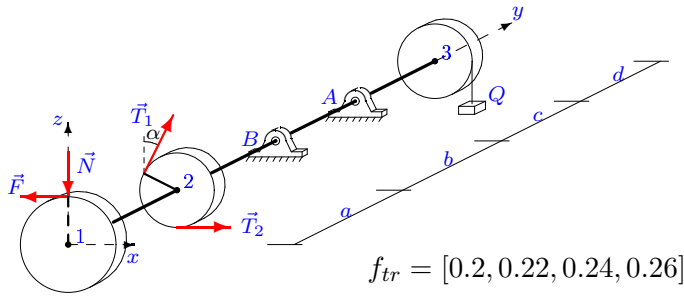


$$f_{tr} = [0.2, 0.21, 0.22, 0.23]$$

$$F = fN, T_1 = 50, \\ T_2 = 27, P_1 = 42, \\ P_2 = 30, P_3 = 34, \\ Q = 10, G = 25, \\ \alpha = 60^\circ, R_1 = 30, \\ R_2 = 12, R_3 = 13, \\ a = 22, b = 23, \\ c = 26, d = 26.$$

Задача L-22.20.

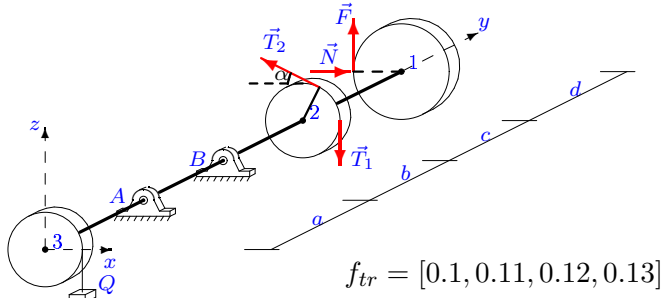
1



$F = fN, T_1 = 60,$   
 $T_2 = 32, P_1 = 30,$   
 $P_2 = 20, P_3 = 24,$   
 $Q = 10, G = 30,$   
 $\alpha = 45^\circ, R_1 = 24,$   
 $R_2 = 10, R_3 = 11,$   
 $a = 22, b = 23,$   
 $c = 25, d = 25.$

Задача L-22.21.

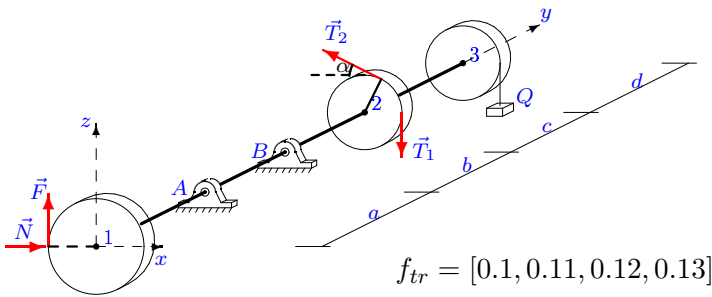
1



$F = fN, T_1 = 70,$   
 $T_2 = 138, P_1 = 26,$   
 $P_2 = 20, P_3 = 24,$   
 $Q = 14, G = 35,$   
 $\alpha = 45^\circ, R_1 = 16,$   
 $R_2 = 10, R_3 = 11,$   
 $a = 22, b = 24,$   
 $c = 26, d = 23.$

Задача L-22.22.

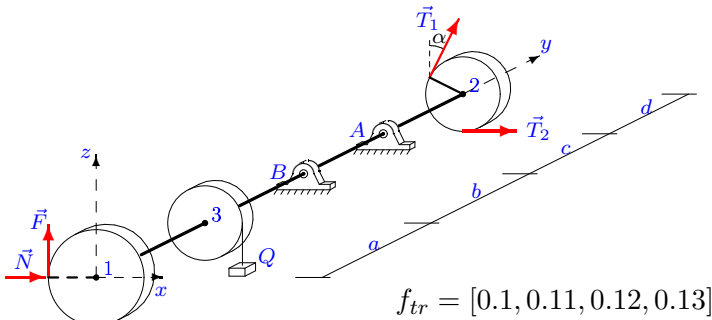
1



$F = fN, T_1 = 60,$   
 $T_2 = 118, P_1 = 16,$   
 $P_2 = 10, P_3 = 14,$   
 $Q = 14, G = 30,$   
 $\alpha = 30^\circ, R_1 = 14,$   
 $R_2 = 8, R_3 = 9,$   
 $a = 22, b = 24,$   
 $c = 25, d = 23.$

Задача L-22.23.

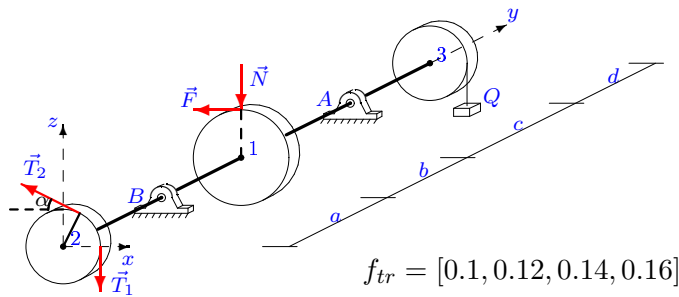
1



$F = fN, T_1 = 60,$   
 $T_2 = 116, P_1 = 32,$   
 $P_2 = 20, P_3 = 24,$   
 $Q = 22, G = 30,$   
 $\alpha = 45^\circ, R_1 = 28,$   
 $R_2 = 10, R_3 = 11,$   
 $a = 22, b = 26,$   
 $c = 28, d = 26.$

Задача L-22.24.

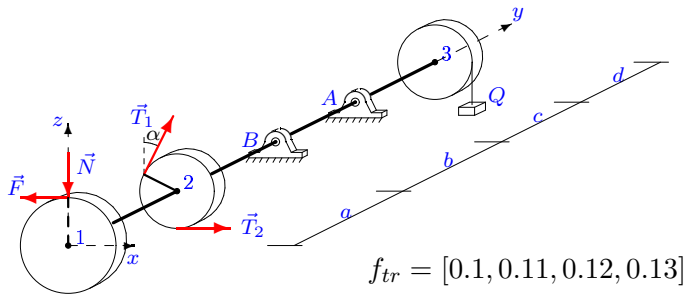
1



$F = fN, T_1 = 50,$   
 $T_2 = 26, P_1 = 28,$   
 $P_2 = 20, P_3 = 24,$   
 $Q = 10, G = 25,$   
 $\alpha = 45^\circ, R_1 = 20,$   
 $R_2 = 10, R_3 = 11,$   
 $a = 22, b = 23,$   
 $c = 25, d = 24.$

Задача L-22.25.

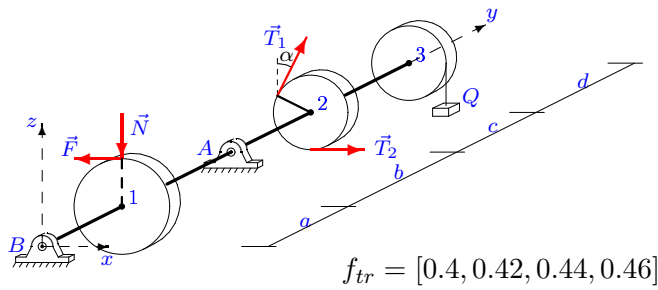
1



$F = fN, T_1 = 60,$   
 $T_2 = 31, P_1 = 30,$   
 $P_2 = 20, P_3 = 24,$   
 $Q = 10, G = 30,$   
 $\alpha = 45^\circ, R_1 = 24,$   
 $R_2 = 10, R_3 = 11,$   
 $a = 22, b = 23,$   
 $c = 25, d = 25.$

Задача L-22.26.

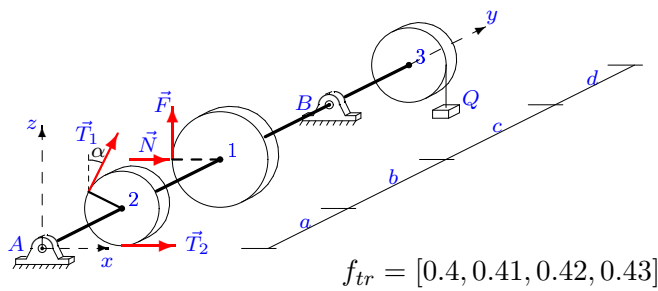
1



$F = fN, T_1 = 40,$   
 $T_2 = 24, P_1 = 26,$   
 $P_2 = 10, P_3 = 18,$   
 $Q = 26, G = 20,$   
 $\alpha = 30^\circ, R_1 = 26,$   
 $R_2 = 8, R_3 = 10,$   
 $a = 24, b = 29,$   
 $c = 30, d = 28.$

Задача L-22.27.

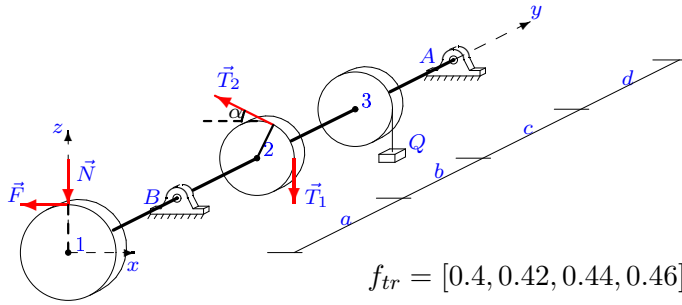
1



$F = fN, T_1 = 30,$   
 $T_2 = 56, P_1 = 44,$   
 $P_2 = 30, P_3 = 38,$   
 $Q = 22, G = 15,$   
 $\alpha = 60^\circ, R_1 = 26,$   
 $R_2 = 12, R_3 = 14,$   
 $a = 24, b = 28,$   
 $c = 31, d = 27.$

Задача L-22.28.

1

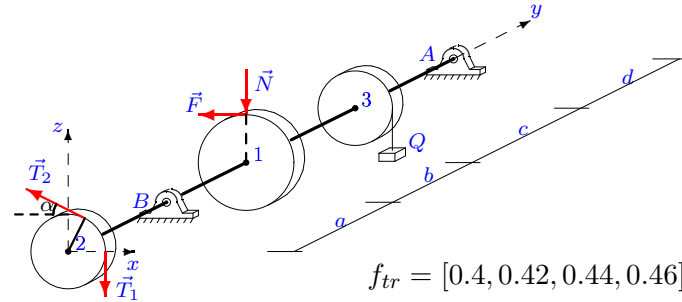


$F = fN$ ,  $T_1 = 60$ ,  
 $T_2 = 34$ ,  $P_1 = 32$ ,  
 $P_2 = 20$ ,  $P_3 = 28$ ,  
 $Q = 26$ ,  $G = 30$ ,  
 $\alpha = 45^\circ$ ,  $R_1 = 20$ ,  
 $R_2 = 10$ ,  $R_3 = 12$ ,  
 $a = 24$ ,  $b = 29$ ,  
 $c = 31$ ,  $d = 26$ .

$f_{tr} = [0.4, 0.42, 0.44, 0.46]$

Задача L-22.29.

1

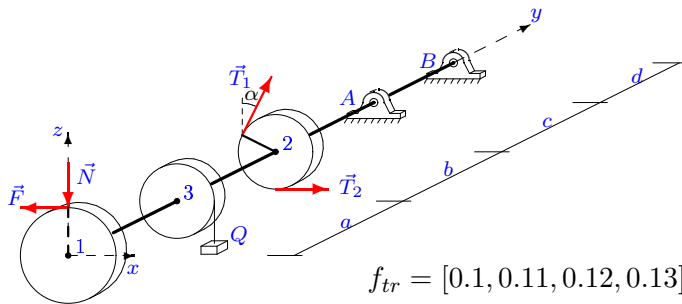


$F = fN$ ,  $T_1 = 50$ ,  
 $T_2 = 29$ ,  $P_1 = 32$ ,  
 $P_2 = 20$ ,  $P_3 = 28$ ,  
 $Q = 10$ ,  $G = 25$ ,  
 $\alpha = 45^\circ$ ,  $R_1 = 20$ ,  
 $R_2 = 10$ ,  $R_3 = 12$ ,  
 $a = 24$ ,  $b = 25$ ,  
 $c = 27$ ,  $d = 26$ .

$f_{tr} = [0.4, 0.42, 0.44, 0.46]$

Задача L-22.30.

1



$F = fN$ ,  $T_1 = 60$ ,  
 $T_2 = 31$ ,  $P_1 = 42$ ,  
 $P_2 = 30$ ,  $P_3 = 34$ ,  
 $Q = 26$ ,  $G = 30$ ,  
 $\alpha = 60^\circ$ ,  $R_1 = 30$ ,  
 $R_2 = 12$ ,  $R_3 = 13$ ,  
 $a = 22$ ,  $b = 27$ ,  
 $c = 30$ ,  $d = 26$ .

$f_{tr} = [0.1, 0.11, 0.12, 0.13]$



	$N$	$X_A$	$Z_A$	$X_B$	$Z_B$	$M(R_A)$	$M(R_B)$
1	37.391	-7.562	82.837	24.617	4.115	83.374	23.927
2	23.626	-73.894	72.696	-55.017	6.877	104.402	57.882
3	184.615	27.811	-246.057	-77.237	518.246	293.519	596.725
4	33.851	256.614	95.232	-421.820	-15.373	275.978	427.107
5	89.316	-27.668	18.095	57.863	50.683	70.570	99.203
6	38.760	285.389	-212.226	-494.110	323.560	359.099	595.487
7	69.972	-69.564	-589.948	101.655	825.332	603.195	844.325
8	36.111	138.303	26.550	-307.769	46.094	142.522	316.517
9	40.533	-59.488	99.442	-93.686	8.020	117.878	96.238
10	26.812	102.283	18.882	-287.521	60.358	105.858	297.641
11	49.036	-159.997	-62.065	103.178	147.479	172.591	184.267
12	62.424	45.845	34.312	-24.830	45.649	58.045	54.143
13	10.368	-29.041	76.000	-91.968	53.231	81.495	106.625
14	196.528	136.301	1274.934	-94.356	-910.593	1476.872	1055.969
15	72.650	-218.441	140.344	228.930	-58.788	278.404	247.185
16	26.877	-37.199	-372.652	59.062	548.075	379.037	557.829
17	162.802	60.318	298.842	-6.873	52.248	321.868	47.922
18	29.720	-394.451	-78.598	243.731	118.569	410.671	274.856
19	58.841	-223.239	444.175	166.471	-269.334	508.804	323.910
20	62.500	39.222	-74.868	-97.399	208.941	99.642	254.295
21	252.885	410.594	92.895	-565.898	-34.350	495.808	680.522
22	185.714	-462.401	-84.315	378.878	145.173	521.923	429.375
23	87.363	-155.772	-118.139	-90.017	192.355	178.610	230.196
24	109.375	-0.041	106.189	35.926	141.801	120.714	161.649
25	128.205	37.552	-193.137	-94.312	392.916	230.371	455.916
26	32.441	-62.148	100.970	33.071	-3.169	119.525	33.131
27	0.358	-58.409	12.581	-23.929	121.265	59.754	123.605
28	62.174	0.126	41.077	52.516	193.055	39.745	205.969
29	35.870	-1.021	40.511	38.027	139.852	41.406	146.736
30	175.897	-86.340	1132.086	26.245	-824.188	1240.150	903.606

L-22 файл o22L1A