**Theme 11. Practical exercises**

A)

1. Open program **Theme11\progs\ECG_pati**

2. Choose patient name, click on phone button to call the patient


   then press "next"

3. Write down the theme of current lesson in your copybook and sketch the plan of electrodes and their designations (all C – on chest, L – on left hand, R – on right hand, F – on left foot, N – on right foot).

4. Press "next" and then press "Schematic" button
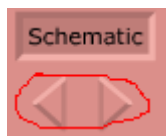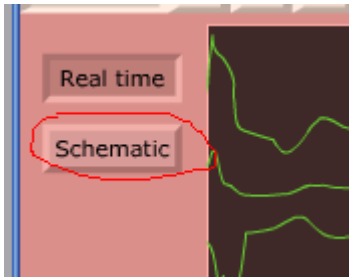
5. Using left-right buttons construct the cardiogram step-by-step and draw it in your copybook.
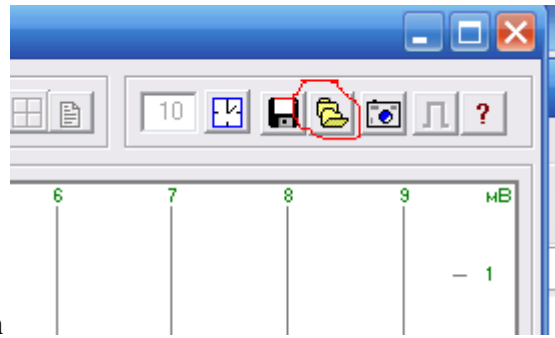
6. Press "next" and click on "Patient's ECG".
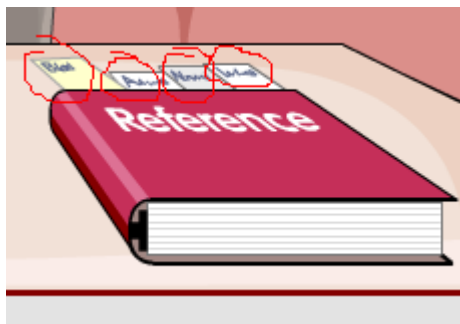
   Clicking on insets of reference choose correct diagnosis for the patient.

7. Call another patient and do same.

B)

Open program **Theme11\ekg\ekg.exe.**

1. Click on open button and choose file **p1.ekg**

2. Increase the scale vertically (using the button) till cardiogram occupies a large portion of the screen.

3. Zoom in the scale on the time axis. To do this, click on and then highlight the peace of screen using left mouse button to change the scale:
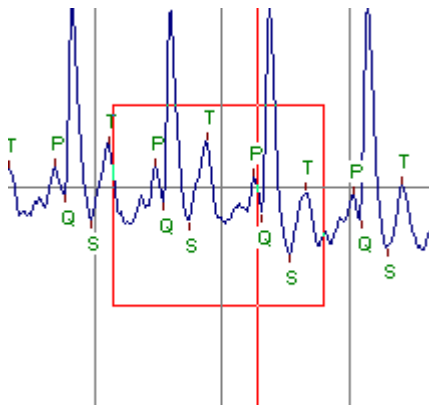
4. Calculate the heart rate by the formula: $heart\ rate = \dfrac{1}{time(\sec onds)} \cdot 60$.

(To measure the time click to R and notice the time in down part of program window (now it is 38.6 seconds). Then click to same character on right side, notice time and calculate difference)
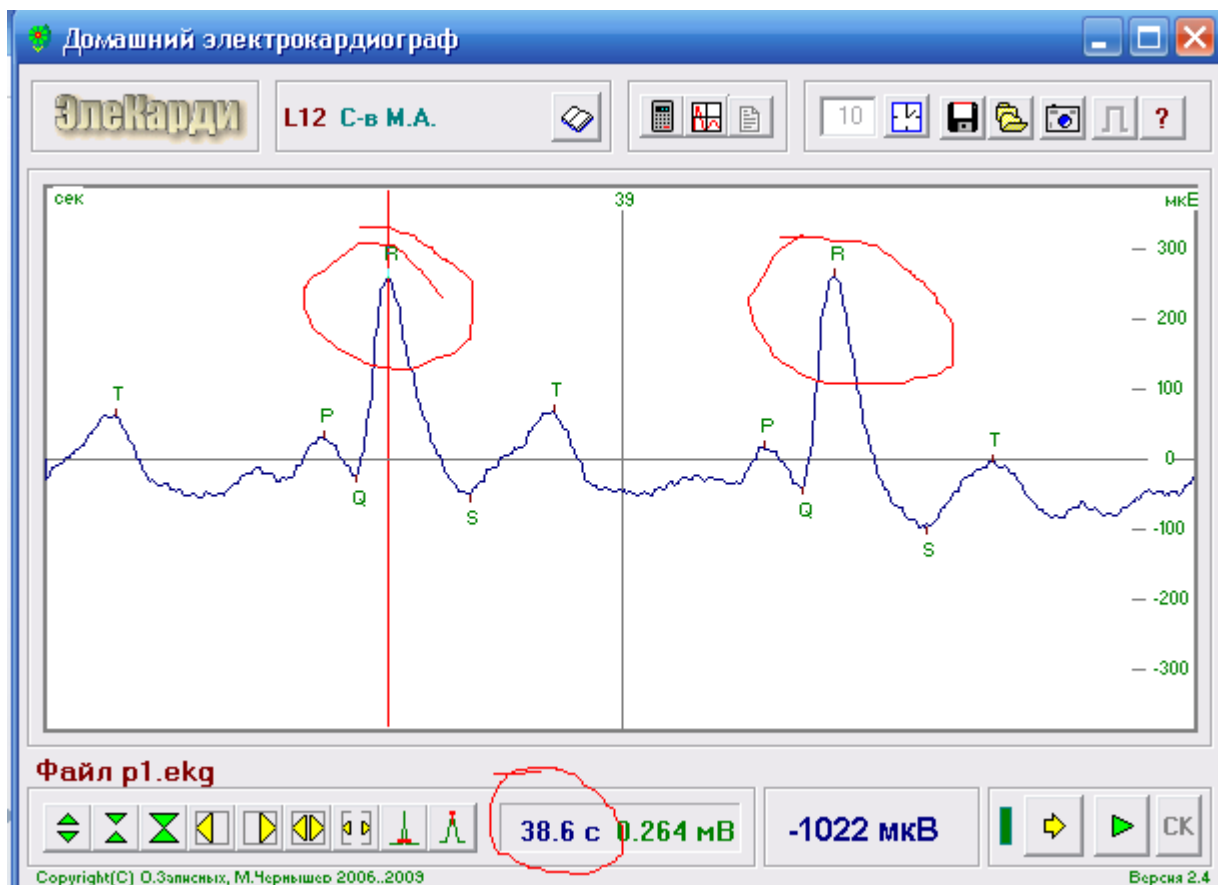
5. Write down levels of waves signal – P, Q, R, S, T, within a period of cardiac contraction (in the mini volts).
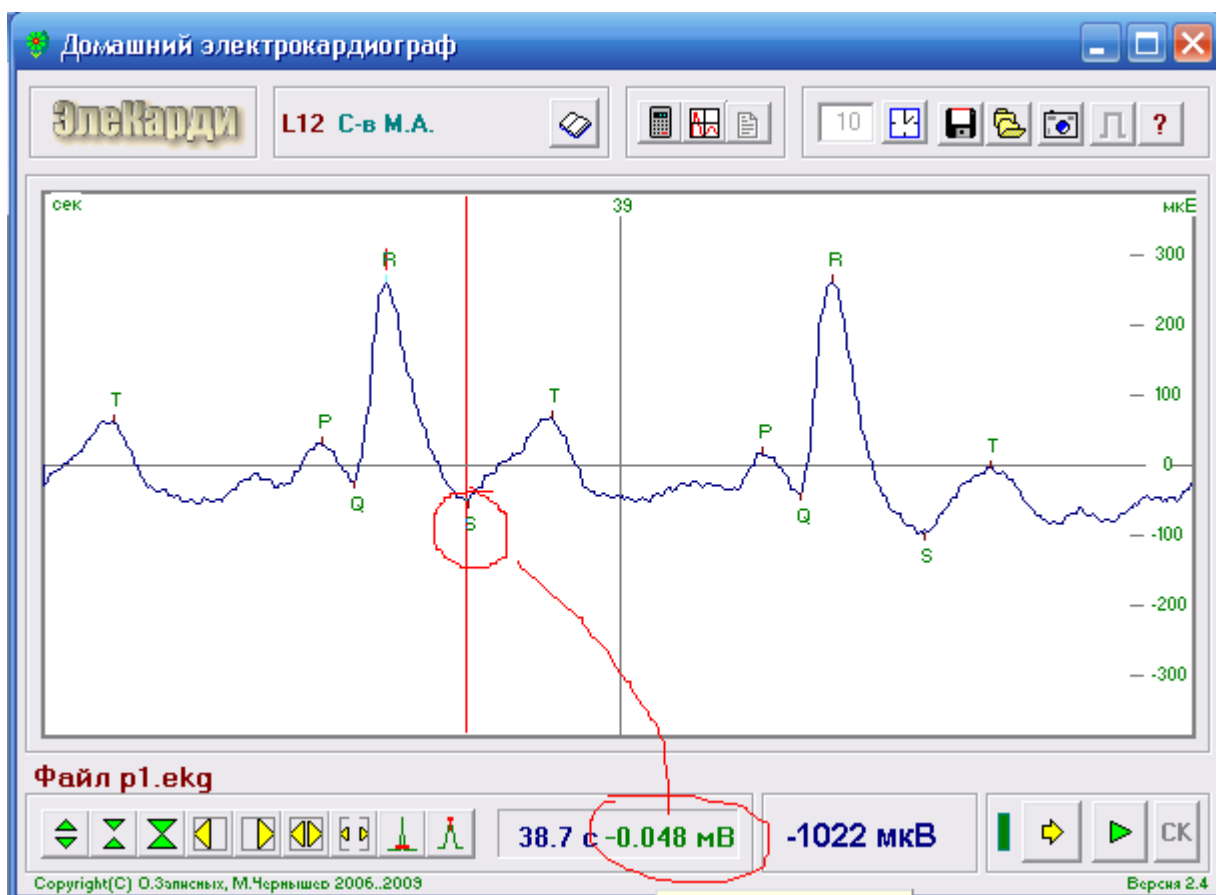
6. Click to button "Analysis of the shape".
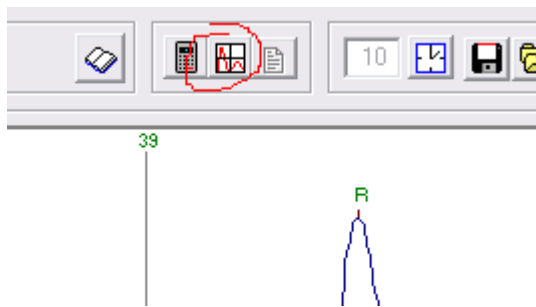
In the resulting window, define the waves for which the variation coefficient is maximum. Write result down in a notebook.
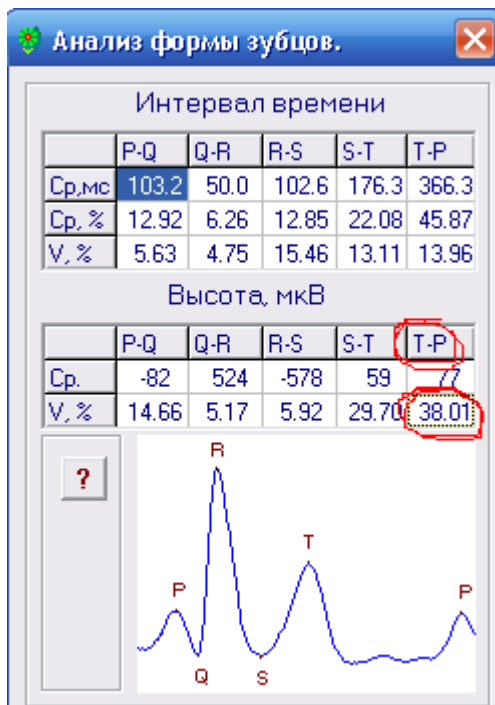
7. Write down the time interval between the wave, which is the longest
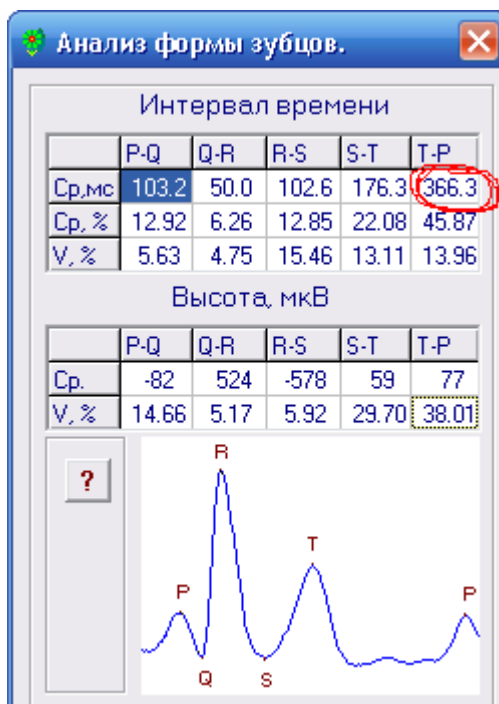
8. Close the window.

9. Click to button "Analysis of the rhythm".
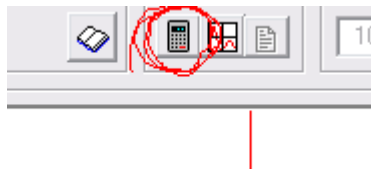
Compare heart rate you have calculated with heart rate program has calculated.
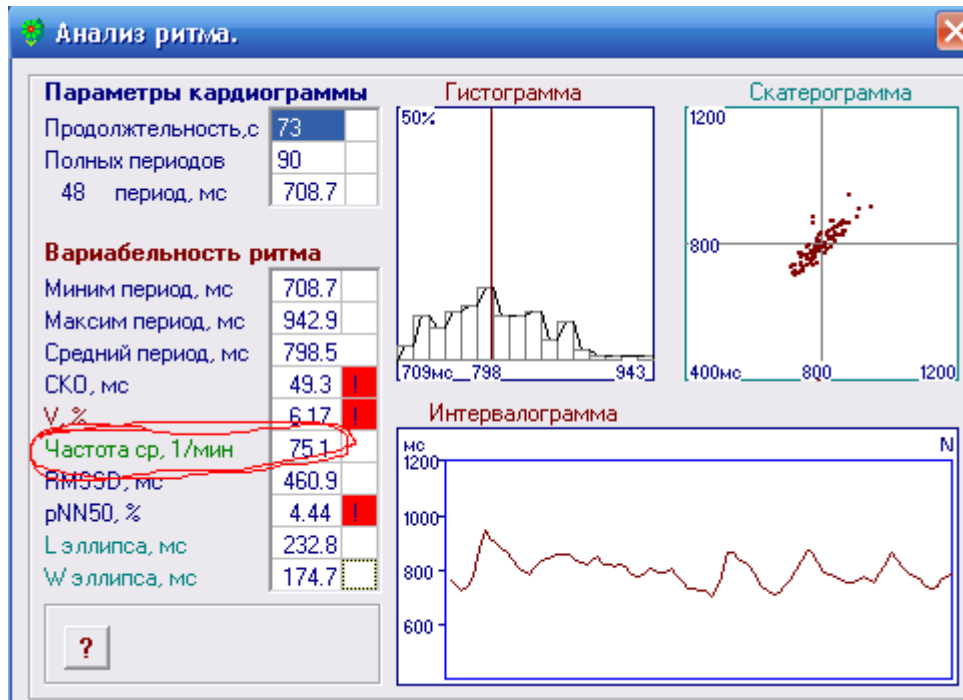
Calculate absolute and relative error of measurement such as

$$absolute\,error = \text{heart rate you have calculated - heart rate program has calculated}$$

$$relative\,error = \frac{absolute\,error}{\text{heart rate program has calculated}}$$

C) Biosignals proccessing

Electrical forces of the body surface of 10 groups of patients were investigated (N/m^2). Samples of scores are given below. Check up statistical hypothesis about differences of independent sample means (2 samples) using Student's t-criteria at the level of statistical significance p=0,05.

| 1	2	3	4	5	6	7	8	9	10
11,07584	10,38422	10,7416	11,70624	11,64977	15,50363	19,23737	17,9596	20,15929	21,06365
10,2699	10,17648	8,354331	11,92321	14,60213	13,61223	19,71451	22,36013	18,25602	19,39045
7,931686	11,3508	8,457366	7,137387	15,03201	16,89968	19,48118	18,74211	18,33591	20,01309
12,73669	10,58217	8,847569	9,437535	15,56062	15,57506	23,66586	20,29372	18,39258	21,78228
10,11382	10,68121	10,23639	9,717449	15,58935	15,28537	18,50704	18,47902	16,24289	19,02903
9,649431	10,57494	10,64595	10,40815	15,81175	13,1602	19,78655	19,51551	20,25677	17,23664
9,367413	10,6966	9,953166	10,25943	15,27683	13,19112	21,73515	18,99508	13,6866	17,33563
9,591819	10,54188	9,739427	9,141288	11,67671	12,8877	14,26206	20,31208	18,50432	23,20873
9,480667	10,38901	10,81984	9,56888	15,61778	15,21507	18,44937	20,71609	16,90905	15,12277
9,495446	8,641086	11,02652	7,860554	15,88901	15,36672	18,36216	17,46646	18,35496	19,06711
10,08971	12,1757	11,41638	10,77614	16,08366	13,76343	19,92796	20,92697	21,50137	19,44547
11,09976	9,537291	9,028646	8,103873	15,37545	13,82453	19,3404	19,77431	18,85681	20,56789

11,40494	11,00107	10,67675	10,90056	13,86993	16,66552	18,54344	18,44698	23,0329	20,414
8,476085	10,69507	9,858024	10,94154	13,90138	15,00561	21,79474	22,05476	21,90019	24,19996
9,87401	9,447699	10,40108	9,077523	16,41565	14,58417	21,72058	20,78336	23,79328	19,46011
8,827264	10,10945	8,338038	10,0173	15,30779	15,65118	21,8559	22,44836	15,82153	21,27515
9,705795	10,29385	11,20857	10,91827	16,50433	14,58098	20,42634	19,99855	24,30122	17,84748
11,00117	9,01262	10,95897	6,337795	15,68219	15,08064	20,14558	18,30491	17,61042	22,23401
10,356	10,64218	11,75332	10,98272	13,50827	13,19794	19,22814	21,53351	19,29999	18,74102
11,80908	9,488245	9,118885	8,381984	14,64418	15,16475	18,56824	19,72078	22,38463	21,43212
9,891351	10,65285	6,799106	11,48117	13,08797	13,57764	19,51984	20,59276	23,29956	16,01446
9,883127	8,452314	10,88373	11,33339	10,9642	12,76191	20,44632	21,18854	16,17727	11,9613
9,228835	11,69886	9,984971	9,701702	15,23373	14,98521	18,93359	17,62738	17,78404	20,49361
10,13216	12,06628	10,26079	9,384022	17,06213	13,27665	17,73516	24,21168	20,29955	18,35014
10,58121	11,33258	8,223863	8,886549	17,2426	16,36978	17,23064	18,7928	18,68863	20,06872
10,37278	9,834359	10,45135	9,3126	13,10735	15,88943	22,71309	20,85247	22,17298	22,19367
10,05996	9,696831	9,825718	9,807737	13,66969	15,25787	20,97923	21,51053	22,2566	19,68624
11,44064	8,152403	12,04183	10,0454	14,89695	15,67931	23,61965	18,59704	16,23353	17,7225
9,397065	10,23775	6,982582	8,950713	16,21084	15,55076	18,59364	20,21432	18,99129	15,55888
11,92793	11,19066	11,39911	8,05093	14,01	13,15719	19,5294	19,76143	19,70793	17,34069
9,867574	9,777872	10,76302	11,61818	17,90041	15,11515	20,87467	19,80228	20,85776	23,50118
10,42818	10,42349	9,788761	11,12148	15,03168	11,7955	20,58121	18,8644	21,78755	19,41715
10,08658	8,468094	8,792866	8,307586	15,40685	12,95446	20,54445	21,42806	22,85586	19,35093
10,04428	10,01982	9,904702	10,43043	14,50682	15,49294	20,70121	22,47779	16,70284	18,92108
10,96096	8,942148	9,947482	9,724556	15,49335	16,72493	18,31643	18,01131	17,82094	18,56273
11,11123	10,20598	8,762623	11,41832	15,51867	15,90289	20,6083	18,55135	21,1064	15,81741
11,52276	9,901524	8,572193	7,908805	16,20377	14,18498	18,76686	19,21334	24,43753	19,59322
10,68964	9,671008	10,5611	7,391552	15,1807	16,5412	20,1219	22,77775	23,2806	18,66719
9,892455	9,744733	13,60644	10,03596	13,53105	16,81016	19,90763	20,5516	16,87022	18,27483
8,17567	10,17591	7,608829	11,75572	17,02856	15,29361	20,59762	19,28106	18,71675	19,58453
9,251102	11,11722	10,37493	9,738475	16,07308	13,4467	21,41997	16,56733	18,51449	19,78095
10,33794	10,90575	9,440295	9,646774	15,41401	15,18619	22,69557	17,60855	20,96278	18,78405
11,43049	9,820254	11,03623	7,58421	14,61097	16,02114	20,31077	20,49033	15,93993	22,39817
9,253617	9,788031	10,29909	9,401924	15,27202	15,88484	21,41521	21,594	19,90074	22,51674
9,111633	9,533523	8,699978	10,83909	15,06534	15,17119	21,92021	20,11019	28,47559	18,76188
11,14128	8,142216	7,603531	9,005318	14,35989	15,77856	17,23243	20,21244	21,85616	24,07502
9,525576	8,105704	10,12992	7,008062	14,70165	14,63309	19,07571	18,74535	17,06349	17,50884
10,97295	11,70134	10,78537	9,461941	18,90699	14,75768	19,49507	19,46931	17,38687	20,73438
8,678257	8,92379	12,51996	6,546929	14,7084	13,23094	21,12883	18,07673	20,58252	19,23111
10,6377	9,72398	11,02011	11,11234	15,69607	14,1568	20,69632	19,24494	20,24148	17,37864
10,77751	10,54374	8,001731	11,82056	15,10989	15,57466	19,28822	19,99922	21,72709	20,10178
10,37378	9,762494	11,52391	10,16509	17,37973	12,56779	20,3299	19,74445	21,87018	17,54816
9,997603	10,43669	11,32571	9,718489	14,35561	14,76756	20,16041	16,86582	18,724	23,21853
7,939773	11,01001	11,15506	10,00105	14,62547	14,36209	21,4251	20,49204	18,43029	17,75781
8,685149	11,36607	8,177691	12,19139	14,39322	14,52499	19,73497	19,3463	20,72179	24,29056
9,95183	9,963676	12,66036	10,12417	15,1351	13,93175	18,46914	21,14483	24,32022	21,45945
9,920994	9,860844	12,62278	10,71406	13,13987	12,63152	21,17249	19,36431	22,93479	16,89612
9,831674	10,45385	12,48251	10,63162	16,42498	17,28114	22,19076	21,65437	15,75862	10,39299
10,32133	9,536474	8,85948	11,23463	14,31062	14,98679	23,14294	19,76108	22,82451	19,75543
11,86361	9,907787	10,69607	8,576836	12,61337	13,11338	20,71517	22,98622	17,86374	22,09217
9,689253	10,49421	11,42524	11,2482	16,6796	16,88767	19,9443	21,23493	19,28363	19,38154
9,875726	9,09664	10,66222	11,26377	18,74031	11,51499	21,1429	18,96055	23,22275	17,98739
10,00816	10,47498	11,93606	9,065802	15,35693	15,47561	17,12246	20,29994	22,15384	19,63985
9,276197	9,474908	11,1611	11,99931	15,61318	14,63253	20,51232	22,76688	18,56659	22,45659
10,92253	12,21558	8,616038	11,30879	12,10406	17,60891	22,43511	19,66968	21,36405	19,24781
10,77338	8,37125	9,305993	8,453519	15,91092	14,50329	18,59604	18,42358	20,5633	20,94777
10,68275	10,57823	11,5009	8,101209	16,61964	14,07007	19,19989	18,86483	18,06994	16,1419
11,95746	8,519111	6,93757	8,772212	14,84317	13,47776	19,86579	22,17867	16,79456	21,08217

9,281227	10,09065	11,11895	9,720077	11,95283	14,93539	18,59966	21,34677	18,7794	16,83889
10,76477	10,02448	10,55223	9,714127	13,77576	14,45082	20,40427	23,30287	18,4059	23,8545
10,74043	9,401462	10,53385	9,462671	17,16688	14,50279	17,04888	19,944	15,98384	22,34762
10,45086	10,78044	10,64053	8,233376	14,31739	16,24592	19,88548	18,73221	20,44064	21,54374
10,53093	11,14646	7,894224	9,068665	15,7955	14,09873	24,0976	20,27713	23,31061	20,29675
8,828319	9,697623	9,843195	12,65466	14,7351	13,73479	19,25765	18,04228	20,61057	20,02023
9,204707	10,58045	10,56269	9,134891	15,78237	14,31156	19,53387	21,44616	19,37542	14,87998
10,16263	10,72522	9,806023	7,640005	14,63068	16,60389	20,17671	21,82707	22,59605	21,48847
10,68474	11,03472	8,892625	10,54143	14,95813	14,5206	22,04155	20,94734	17,22924	22,45144
8,22861	8,138369	8,658207	9,241401	16,60652	15,91311	22,19098	19,06509	24,63004	23,62539
9,485066	9,921576	7,148168	10,03927	18,15775	13,63498	20,85879	21,49286	19,04208	21,95008
9,389466	10,13896	8,712289	9,653222	17,22629	15,99844	20,81093	19,51006	15,78953	19,62804
8,890763	11,21196	8,222773	10,24648	12,44398	16,23719	21,56742	18,56358	19,94835	18,34086
8,849559	10,42367	7,699533	9,846059	14,54672	17,45686	20,30164	20,21044	17,78108	20,82384
8,782223	11,23433	9,727952	11,89651	20,53505	15,95759	20,82836	22,95347	22,9553	19,31145
9,262616	10,70449	7,427611	8,012528	13,57682	16,83558	19,47548	22,24826	19,50975	17,89567

Table of Student's distribution (t$_{st}$).

p / n	0.10	0.05	0.025	0.01
1	1.000000	3.077684	6.313752	12.70620
2	0.816497	1.885618	2.919986	4.30265
3	0.764892	1.637744	2.353363	3.18245
4	0.740697	1.533206	2.131847	2.77645
5	0.726687	1.475884	2.015048	2.57058
6	0.717558	1.439756	1.943180	2.44691
7	0.711142	1.414924	1.894579	2.36462
8	0.706387	1.396815	1.859548	2.30600
9	0.702722	1.383029	1.833113	2.26216
10	0.699812	1.372184	1.812461	2.22814
11	0.697445	1.363430	1.795885	2.20099
12	0.695483	1.356217	1.782288	2.17881
13	0.693829	1.350171	1.770933	2.16037
14	0.692417	1.345030	1.761310	2.14479
15	0.691197	1.340606	1.753050	2.13145
16	0.690132	1.336757	1.745884	2.11991
17	0.689195	1.333379	1.739607	2.10982
18	0.688364	1.330391	1.734064	2.10092
19	0.687621	1.327728	1.729133	2.09302
20	0.686954	1.325341	1.724718	2.08596
21	0.686352	1.323188	1.720743	2.07961
22	0.685805	1.321237	1.717144	2.07387
23	0.685306	1.319460	1.713872	2.06866
24	0.684850	1.317836	1.710882	2.06390
25	0.684430	1.316345	1.708141	2.05954
26	0.684043	1.314972	1.705618	2.05553
27	0.683685	1.313703	1.703288	2.05183
28	0.683353	1.312527	1.701131	2.04841
29	0.683044	1.311434	1.699127	2.04523
30	0.682756	1.310415	1.697261	2.04227
∞	0.674490	1.281552	1.644854	1.95996

$$t = \frac{(\bar{x}_1 - \bar{x}_2) - 0}{SE(\bar{x}_1 - \bar{x}_2)} = \frac{(\bar{x}_1 - \bar{x}_2)}{s\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}}, \text{ where:}$$

X$_1$– means,

X$_2$–number of scores in the samples.

n_1, n_2 – sample sizes

s – standard deviation