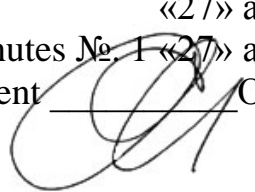


Ministry of Public Health of Ukraine
“Ukrainian Medical Stomatological Academy”

“APPROVED”
at the meeting of the Department
of Medical Informatics, Medical Biophysics
«27» august 2020
Minutes № 1 «27» august 2020
Head of department  O.V.Silkova

METHODICAL GUIDANCE

for students’ self-directed work when preparing and during the practical session

Academic Subject	Medical Information Science
Module No 2	Medical knowledge and decision making in medicine and dentistry
Topic	Formalization and algorithmization of medical problems
Year of study	2
Speciality	Foreign Student Training (Medicine/Stomatology)
Number of academic hours	2

1. Relevance of the topic:

The topic is very important for future doctors in their professional activity, positively influences the students in their attitude to the future profession, and forms professional skills and experience as well as taking as a principle the knowledge of the subject learned.

2. The specific aims:

To have general knowledge of the topic studied;

To understand, to remember and to use the knowledge received;

To form the professional experience by reviewing, training and authorizing it;

To be able to carry out laboratory and experimental work.

3. Basic knowledge and skills necessary to study the topic (inter-disciplinary integration).

Previous (providing disciplines)	Obtainable skills
Informatics bases	To describe principles of algorithm construction ; To draw schematically flowchart basic elements; To use these concepts at tasks decision: flowchart analysis

4. The tasks for students' individual work

4.1. The list of basic term, parameters, characteristics, which student should master while preparin for the class.

Term	Definition
Algorithm	A set of rules which determine effective solution procedure of any problem, which is one of certain class of problems.
Formal algorithms	Algorithms using methods that make a decisions by logic rules from certain hypotheses about research object.
Heuristic algorithms	They bases on intuition reasons, that bases on the previous experience.

4.2 Theoretical questions for the class (to the topic):

1. The algorithm definition.
2. Algorithms types.
3. Algorithmic languages classification.
4. Types of algorithms.
5. Construction of algorithm stages.
6. Stages of medical tasks solution.
7. Main properties of algorithms.
8. Order of construction of algorithms
9. Linear, Branched , Cyclic algorithms.
10. Algorithm structural schemes.
11. Stages of construction of algorithm with structural scheme use.

4.3 Practical tasks pertaining to the topic and to be completed during the class:

Test

1. What is an algorithm?
 - a) a set of rules;
 - b) a list of instructions, which leads to getting results;
 - c) list of actions;
 - d) table of formulas;
 - e) set of narrative sentences.
2. What algorithm's property means that it can be divided into separate steps performed in sequence?
 - a) discrete(discontinuity);
 - b) certainty;

- c) finite-state;
 - d) mass;
 - e) none of above.
3. How does name the algorithm, which consists of commands that can be executed more than once?
- a) linear;
 - b) condition;
 - c) branching;
 - d) cycle;
 - e) array.
4. How does name the algorithm, in which you must decide what actions to perform?
- a) linear;
 - b) cycles;
 - c) shape;
 - d) branching;
 - e) array.
5. How does name the specific recording of algorithm by someone on computer?
- a) algorithm;
 - b) program;
 - c) command;
 - d) scheme;
 - e) performer.
6. How does name the error detection and elimination on computer?
- a) debugging tasks;
 - b) adjusting artist;
 - c) compilation;
 - d) adjusting the algorithm;
 - e) debugging programs.
7. What figure in algorithm designated for inputting?
- a) circle;
 - b) rectangle;
 - c) parallelogram;
 - d) oval;
 - e) diamond.
8. Which form of algorithm has the greatest clarity possess of writing?
- a) Verbal;
 - b) Recursive;
 - c) String;
 - d) Graphics;
 - e) Character.
9. Oval geometric shape used in block diagrams to describe ...
- a) the start of algorithm;
 - b) input or output;
 - c) decision making;
 - d) action;
 - e) none of above.
10. Geometric shape rectangle used in block diagrams to describe:

- a) the start of algorithm;
- b) end algorithm;
- c) input or output;
- d) decision making;
- e) an action.

Practical work:

<p>1. At what initial values of variables the algorithm will finish work?</p> <ul style="list-style-type: none"> 1) A=-2; C=-3 2) A=-3; C=-2 3) A=-3, C=-3 4) A=-2; C=-1 5) A=-4, C=-3 	<pre> graph TD Start([Start]) --> Input[/Input A, C/] Input --> Process[A:=A+1; C:=C+1] Process --> Dec1{A>0} Dec1 -- No --> Process Dec1 -- Yes --> Dec2{C>0} Dec2 -- Yes --> End([End]) Dec2 -- No --> End </pre>
<p>2. Determine target values of variables A and C after execution of algorithm:</p> <ul style="list-style-type: none"> 1) 1, 7 2) 0, -4 3) 1, 3 4) 0, -5 5) Cycling 	<pre> graph TD Start([Start]) --> Init[A:=-3; C:=3;] Init --> Process[A:=A+1; C:=C+1;] Process --> Dec1{A>0} Dec1 -- No --> Process Dec1 -- Yes --> Dec2{C<0} Dec2 -- No --> Stop([Stop]) Dec2 -- Yes --> Process </pre>

Content of the topic:

ALGORITHMS. CONSTRUCTION OF ALGORITHMS

Algorithm (by al-Horezmi, IX century) is set of rules, by which actions for achievement of aim do.

Algorithm is a set of rules which determine effective solution procedure of any problem, which is one of certain class of problems.

There may be rules of calculation for the mathematics task, or rules that determine order of examining of sick human. Algorithm uses for solution perfect class of problems, in which input data can vary but rules of solution are constant.

Algorithm may be described in symbolic shape or in words.

Description of algorithm for the machine's perception is named program. Programming languages (or algorithmic languages) was developed for such descriptions.

Such languages base on the few numbers of elementary rules which permit to do processing information with definite order. They take into account real possibility of computer. Still recently there were particularity of input and output of data, types of memory devices and all. Now such problems were solved by unification of requirements to the control systems of peripheral devices and types of memory.

Construction of algorithm of some process (for example, diagnosis) is consecutive realization of next steps.

1. Preliminary analysis of process determines probability of computer using for the realization of algorithms.
2. Structuring describe researched process.
3. Making or choosing of mathematical equations that describe relations of process parameters.
4. Determination of process characteristic.
5. Making process model and checking conformity of mathematical description to real process.
6. Construction of algorithm of process.

Various methods of evaluation (statistical, for example) apply on 4-th stage for determination of process characteristics. Different mathematical methods are applied in accordance with particularity of certain problem.

Forming algorithms of medical problems

Stages of tasks solution:

- 1) Choosing of solution method; its details, learning;
- 2) formulation of problem and solution method for a programming specialist;
- 3) solution of problem by programming engineering group (with exact rules).

Main properties of algorithms:

discontinuity(discrete): algorithm is sequence of stages which follows one after another; in other words it is sequence of the steps (acts, commands);

certainty: every command of an algorithm has only one sense, one method of execution and is understandable to executor; every command signifies one action with exactly described details;

effectiveness and **finite-state:** algorithm must reach result after finite (limited) quantity of the steps;

mass: every algorithm which formed for one problem of certain class need to be useful for solution of all problems of this class with all possible values of initial data.

Person or computer can works according to an algorithm. If worker is computer then algorithm must be translated to the algorithm language.

3 kinds of algorithm description:

- 1) on natural language;
- 2) by scheme (graph method);
- 3) on an algorithm language.

You can use 3 main types of algorithms:

- 1) linear [successive; serial; consecutive];
- 2) alternative (branching).
- 3) cyclic;

Linear algorithm - it is algorithm with blocks that follow one after one (linearity). Term "block" mean series or combination of instructions. Such algorithm is executed step by step.

Branched algorithm has points of condition checking, after that actions have different ways (branches) in accordance to result of checking. **Alternative algorithm** is special case of branched algorithm with two branches. And, on the contrary, branched algorithm can be divided on the series of alternative sections with checking of own condition in every check point.

Cyclic algorithm – it is algorithm with repeating parts, when sequence of mathematical and logic repeat certain (finished) quantity of times.

Cyclic algorithm is such, in which identical actions (sequence of mathematical and logic actions, other instructions) repeat many times. Quantity of repetitions is certain, finished and can change in dependence on initial values of task. Every new repetition of the cycle must begin (or run out) on check point, in which some condition is checked. For cycle organization it is necessary:

- 1) before entrance into the algorithm body it is need to set initial value of *cycle parameter*;
- 2) Before every new repetition to change value of cycle parameter;
- 3) Then to check condition of cycle ending and in dependence on result to return control into cycle beginning or to exit from cycle..

Cycle parameter is some value, which change (grows or diminishes) at every cycle repetition on certain *step*.

Medicine problems have principle of the construction of algorithm just like written above.

Every process (diagnostic, treatment, and research) is divided onto inner stages, which connect one with another.

Then analysis is carried out. There are distinguished algorithms. i.e. rules of realizing of each stage. After then algorithms are used in the practice or utilized automation of the process, carried out construction of programs and it using in the computers.

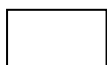
An example of the algorithmic actions is actions of a doctor in reanimation department of clinic during examining of each patient:


- 1) a doctor collects all need data about state of patient;
- 2) a doctor analyzes data and compares they with normal data;
- 3) if any parameter or complex of parameters isn't in accord with limited values, doctor seek complex of action for the achievement of the correct state of patient in the available conditions; if all complex of parameters corresponds to limited values, a doctor assigns a patient to other clinic department in accordance to diagnosis.


Stages of construction of algorithm with structural scheme use


First step of writing of program is generalized description of algorithm. It is block-scheme or structural scheme of problem. Structural scheme (block diagram, flow diagram, skeleton diagram, flowgraph, operations flowchart, flowchart, flowgraph) use conventional signs on this step. Such sign is the shape specific for certain kind of actions.


Most important signs are:

Process.  It corresponds to series of successively executing actions or calculations.

Solution.  It denotes checking of condition. Further actions depend on result of solution.

Completion.  It is start and finish of algorithm.

Input-output (without details). 

Knot.  It is place of merging of two (or more) branches of algorithm.

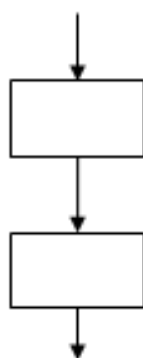
Elements of block-scheme are bound by arrows shows direction of transition.

Basic structures of algorithm in scheme:

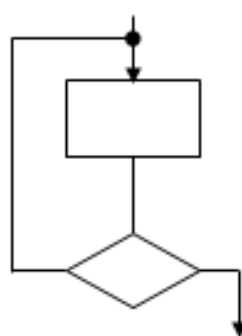
1. successive carrying out;
2. conditional carrying out (alternating);
3. branching, which is succession of conditional carrying out.
4. cycle (repetition, loop, iteration);

There are images of their structures.

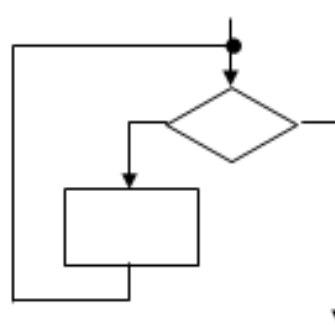
1. Successive carrying out



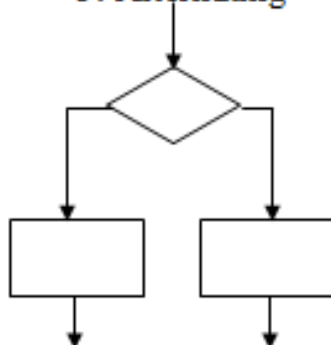
2a. Cycle "after"



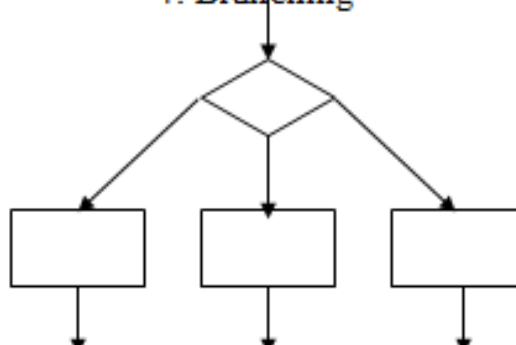
2b. Cycle "before"



3. Alternating



4. Branching



Part of algorithm, whose execution depends on condition, has name "**loop body**". Iteration is one repetition of this part of algorithm.

Cycle "after" is cycle with condition check after one execution of loop body. This cycle has feature: loop body will be in progress as minimum once.

Cycle "before" is cycle with condition check before execution of loop body. In this case it is possible situation without execution of loop body operators.

When general structure is clear, **step** of construction of algorithm is analysis of inner structure of algorithm and its detailing.

Finals description (program) consist of elementary language operators (separate phrases), which are named as code statements or program statements too.

Every algorithm works with information in computer memory, not with real objects. Correspondingly, minimal memory volume with separate certain element of information is marked by special address (for inner computer using) or by name (for human using). This name is **variable**. Word "**variable**" is used as value (contents) of memory can change during algorithm work. Very often we tell about this memory unit as about a memory cell (really it can be block of many separate cells, which are used as a single whole). When we change value of variable, check or send information – we carry out some elementary action – we mark this action by **operator sign**.

Variables in algorithmic languages are marked by names, consisted of letters and figures, at some languages – and selected signs can be used too. Program-translator forms queries to operating system that put into conformity with every name one free memory cell address.

Text like " $A = 3$ " or " $A := 3$ " in shape \square means that number 3 is sended to the memory cell with name A. Sign $:=$ is named **appropriation**.

Sention like " $A := A + 5$ " or " $A = A + 5$ " means: take value written in the memory cell A, ass 5 to this value, than send result into the cell A. After this command execution old value A will be replaced by new.

Text like " $A = 3$ " in shape \diamond is check condition and read as "**Is A equal 3?**" Two possible answers "**Yes**" and "**No**" mark two output arrows – two algorithm branches.

In other commands new value will be used up to next command of information sending to cell

A.

When algorithm includes cycle, for counting of cycle body repetitions very often we must use cycle counter (index counter, loop counter, repetition counter, step counter). It is special temporary integer variable, typically marked as i , j , or k . Loop body is sequence of actions (calculations, information input or output and other) executed between two condition check events.

It is necessary for cycle creation:

- 1) before cycle to set counter start value;
- 2) during every cycle passing to change counter value (typically add or subtract 1 – step value);
- 3) in every cycle repetition to check condition of cycle end; by result of check-up either pass on to cycle beginning, or go out cycle to next stage.

For operators conventional signs are used too.

Tasks for self-check:

Task 1:

1. THE GEOMETRIC FIGURE OF A RECTANGLE IS USED IN BLOCK DIAGRAMS TO DENOTE:

- a) start of the algorithm
- b) the end of the algorithm
- c) input or output data
- d) decision-making
- e) performance of action

2. WHAT FIGURE IN THE BLOCK DIAGRAM REPRESENT THE BEGINNING OR END OF THE ALGORITHM?

- a) trapezium
- b) a rectangle
- c) parallelogram
- d) an oval
- e) diamond

1. THE ALGORITHM CAN BE CONSIDERED AS:

- a) Description of the solution of the quadratic equation
- b) List of class in the journal
- c) School timetable
- d) Vehicle technical passport
- e) None of the listed options

2. WHAT IS THE ALGORITHM?

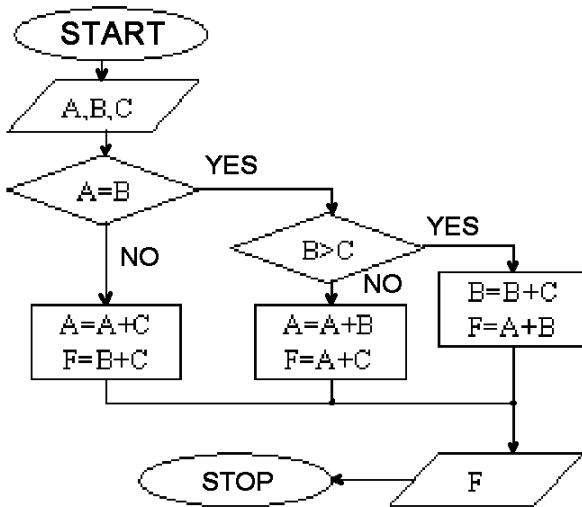
- a) The rules for carrying out certain actions
- b) Oriented graph specifying the order of the execution of commands
- c) The sequence of actions leading to the solved task
- d) A set of commands for a computer
- e) All of the above

3. THE GEOMETRIC FIGURE OF PARALLELOGRAMS IS USED IN BLOCK DIAGRAMS TO DENOTE ...

- a) start of the algorithm
- b) the end of the algorithm
- c) input or output data
- d) decision-making
- e) performance of action

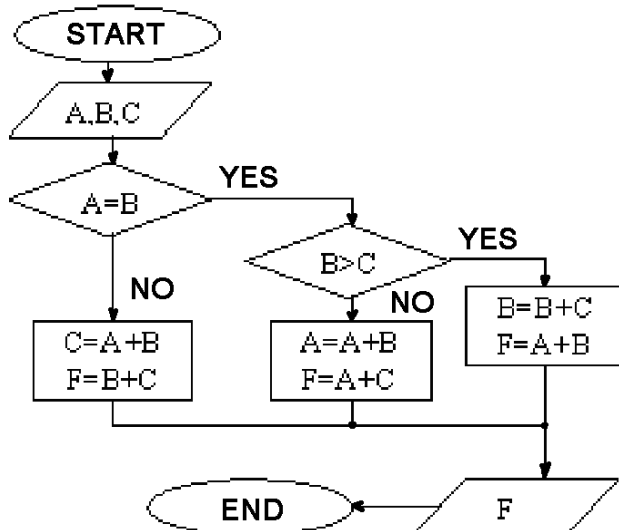
Task 2.

Value of variable F calculated by the block diagram for the entry (entered data) 1, 1, 3 equal to: 1) 7 2) 3 3) 4 4) 5 5) 6



Task 3.

Value of variable F calculated by the block diagram for the entry (entered data) 2,2,3 equal to: 1) 5 2) 6 3) 7 4) 9 5) 8



References:

Basic.

1. Olenets S.Yu. Medical informatics [Text]:Tutorial guide / Olenets S.Yu.: HSEE of Ukraine "UMSA". – Poltava: TOV "ASMP", 2017. – 160 p.:im.
2. Handbook of Medical Informatics. Editors: J.H. van Bommel, M.A. Musen. – <http://www.mieur.nl/mihandbook>; <http://www.mihandbook.stanford.edu>
3. Mark A. Musen B. Handbook of Medical Informatics // Электронний ресурс <ftp://46.101.84.92/pdf12/handbook-of-medical-informatics.pdf>
4. Edward H., Shortliffe J., Cimino J. Biomedical Informatics, 2014 // Электронний ресурс: <http://www.rhc.ac.ir/Files/Download/pdf/nursingbooks/Biomedical%20Informatics%20Computer%20Applications%20in%20Health%20Care%20and%20Biomedicine-2014%20-%20CD.pdf>
5. Коровіна Л.Д. Медична інформатика : навчальний посібник для студентів вищих медичних навчальних закладів / Л. Д. Коровіна - Полтава : РВВ УМСА, 2008. – 144 с. – англ. мовою.

6. Marzeniuk, V.P. Biophysics and medical informatics : Manual for Students of the Higher Medical Schools of the III-IV Degree of Accreditation / V.P. Marzeniuk, V.D. Didukh, D.V. Vakulenko at al. – Ternopil : Ukrmedknyha, 2004. Vol. 1: – 479 с. :

Additional.

1. www.imia.org (Міжнародна Асоціація Медичної Інформатики)
2. www.mihandbook.stanford.edu (Медична інформатика, Стенфордський університет)
3. www.ncbi.nlm.nih.gov (Національна бібліотека медицини США)
4. www.cochrane.ru (Розділ Кохранівського співтовариства)

The methodical guidance has been completed by **S.Y. Olenets**