Ministry of Public Health of Ukraine
"Ukrainian Medical Stomatological Academy"

"APPROVED"
at the meeting of the Department
of Medical Informatics, Medical Biophysics
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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	Logic as a science. Logical operations, their properties. Building a truth table
Year of study	2
Speciality	Foreign Student Training (Medcine/Stomatology)
Number of academic hours	2

Poltava – 2020

1. Relevance of the topic:

Work of the doctor is connected with any formulation of logic statements: diagnosis statement, the forecast of a course of diseases, continuation according to conclusions of medical measures, etc. the Doctor uses methods of mathematical logic for reception of the well-founded information on value of parametres which are investigated. It first of all logic of statements where logic offers have the algebraic form. Research of the validity or an inaccuracy of some statement is reduced thanking To D.Bulja's algebra to a number of simple operations.

2. The specific aims:

To Treat concept of the statement, to explain stages of process of diagnostics, to make logic expressions by means of the statement, to build validity tables;

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**
1. Previous: 1) mathematics	The basic concepts of probability theory; - To give definitions by the basic concept of probability theory; - The nobility of appointment of statistical methods; To apply knowledge to the decision of medical problems.

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**
Diagnostics	It is process of stage-by-stage processing of the information in system "the doctor-patient" which purpose are creations of the most adequate model of a condition of an organism of the patient.
Diagnostic algorithm	It is logic sequence of rules in which the information on signs of a condition of the patient is compared with a complex of signs which characterise typical illnesses.
The information-likelihood logic	It is a diagnostic method with which help the probability of this or that diagnosis for certain a set of symptoms pays off
Conjunction of statements And and In	Such statement, which true in only case when, when to true of the statement And i is called In
Objection of the statement And	The statement if it true, when And - false and false, when And - true.
Disjunction of statements And and In	Such statement, which false in only case when, when erroneous statements And i is called In
Implication of statements And and In	Such statement which is false only is called when антецедент (the first part of implication - the statement) is true, and the second part of implication - the statement In - false, in all other cases of statement A→B is the true
Equivalence (double implication) statements And i In	Such statement which is true in only case when, when the statement And and In simultaneously true or erroneous is called

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

1. Bases of logic of statements.
2. Logic operations and validity tables. Properties of logic operations.
3. Logic operators and functions.
4. The logic approach to diagnostics and a disease course.

5. Logic operations over statements.

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

Test

1. Let A = 0, B = 0. The result of logical operation (A ↔ B) will be:

a) 1;

b) 10;

c) 11;

d) 2;

e) 0.

2. The statement, which is true, when one of two initial expressions is true, and which result is false, when both are false.

a) the conjunction;

b) the disjunction;

c) the implication;

d) the negation;

e) the equivalence.

3. The «logical multiplication» calls:

a) the conjunction;

b) the disjunction;

c) the implication;

d) equivalence.

4. Find the value of the expression **A and False**:

a) 0; 1

b) 1;

c) 0;

d) 1; 0

5. Which variant is equivalent to logical expression ¬ (¬A /\ B)

a) B;

b) ¬A \/ B;

c) A ^ ⌐B;

d) ⌐B \/ A;

e) A.

Practical work:

Construct the table of the validity for logic functions:

$(A \leftrightarrow B) \vee (\neg B \wedge A) \rightarrow B$

A	B	A ↔ B	¬B	¬B /\ A	(A ↔ B) \/ (¬B /\ A)	F
1	1					
1	0					
0	1					
0	0					

Content of the topic:

<u>Formal logic. Algebra of logic</u>

The science permitting to analyse reasoning, distracting from their content, paying attention only on the shape, selecting their structure, is termed as **formal logic**.

Logic is a **formalization of reasoning**.

Logic is a formal language for **deducing** knowledge from a small number of explicitly, in detail stated **premises** (preconditions or hypotheses, axioms, facts).

Logic provides a formal framework, formal structure for **knowledge representing.** Logic differentiates between the **structure** and **content** of an argument.

Some types of logic: propositional logic, predicate logic (extension of propositional logic), probability logic**.**

Propositional logic – the formal system that uses propositional well-formed formulas; also known as statement logic, propositional calculus.

Probability logic - the logic researching the expressions, which values are made in an interval between true and false. **Probability** is a degree of possibility of appearance of any specific event in a chain of various events in defined conditions, able to repeat many times.

Elements of propositional logic.

A predicate is a sentence which contains a finite number of variables and becomes a statement if particular values are substituted for the variables. Objects in a domain have specific properties.

Before transition to consideration of objects and rules, it is necessary to define some ideas:

Premise – precondition, presupposition, prerequisite.

Deduction. If the conclusion is justified, based solely on the premises, the process of reasoning is called **deduction.**

Inference. If the validity of the conclusion is based on *generalisation* from the premises, based on strong but inconclusive evidence, the process is called **inference** (sometimes called **induction**).

Simple types of statements, called propositions, are treated as atomic building blocks for more complex statements.

Basic conceptions and terms of logical algebra

Logic treats expressions [statements, propositions, sentences, pronouncements] only from point of view their **verity** or **falsehood**; meaning, sense of expression is not significant.

Logic is peculiar formal language. Within that formal language **knowledge** can be stated concisely and precisely and the process of **reasoning** from that knowledge can be made rigorous.

An **argument** is just a **sequence of statements. Statement** – a sentence that is either true or false.

Reasoning are named as **logical proposition** in logic.

Some of these statements, the **premises**, are assumed to be true and serve as a basis for accepting another statement of the argument, called the **conclusion**.

The truth or falsehood assigned to the proposition is termed as its truth value.

Truth value of that or diverse proposition mean by capital letters: **T (true)**, if the proposition is true, and **F (false)**, if it is false.

Equally for designation of true proposition sign 1 is used; for designation of false proposition sign 0 is used. Thus, **True≡"T"≡1; False≡"F"≡0.**

Logical algebra (Boolean algebra) is rules of operating with propositions.

Logical operation (Boolean operation) is construction of new proposition of one or more old propositions.

Operator (operation sign, logical connective, structural constant) is sign of logical operation.

Logical operations are described by tables of validity (truth tables).

Propositional variable is variable that values are propositions.

Basic signs of logical algebra are:

1) propositional variables: p_1, p_2, A, B,…;
2) operators: $\sim \Lambda, V \rightarrow \supseteq \equiv \leftrightarrow$;
3) brakets: ( ).

Logical connectives can be unary (one-placed) or binary (two-placed). Unary connective is negation – "not A". Binary connectives examples are conjunction (A Λ B) or disjunction (A V B).

In implication (A → B) we distinguish antecedent (A) and consequent (B).

Tautology in general use is combination or repetition identical or close by implication words; in logics it is logically true statement.

Truth tables

A truth table is a way to represent a boolean function, useful for optimizing and sometime for designing functions. It is written as a two dimensional array with column for each input variable, row for all possible input values, last column for resulting function value.

BASIC TERMS OF LOGICAL ALGEBRA

Expression is language of expressions which can be or true or false. Correspondingly always expressions have logical value T (true) or F (false).

Number 1 as T and number 0 as F use often.

Main symbols of algebra of expressions are:

a) propositional variables p_1, p_2, p_3, … ;
b) propositional binds: one-placed bind $\neg$ and two-placed binds $\wedge \vee \leftarrow \rightarrow \leftrightarrow$;
c) brackets ( );

THE NEGATION

If you use a particle «not» for any expression, the outcome of the circumscribed linguistic handling is named as negation of the initial expression.

The negation of any expression names such statement, which one is false, when the initial expression is true, and which one is true, when the initial expression is false.

Table for operation «not».

A	Not A
T	F
F	T

In the left column of the table the possible values of truth of the initial expression are presented. Possibilities are only two: each expression can be either true or false. In a right column values of truth of negation of the initial expression signs .

THE CONJUNCTION

The definition of a conjunction. Logic operation «AND» hase a name of a conjunction. With its help from two expressions it obteins third, which one is true in only case when, when are true both initial expressions.

The new expression obtained by application of this operation to initial expressions is named their conjunction.

«Tomorrow our patient will be healthy and cheerful»

After verbal definition we show **table** again.

A (rain)	B (cold)	**A and B**
T	T	T
T	F	F
F	T	F
F	F	F

In a truth table for a conjunction of two expressions three columns present. In first two columns the truth values of the initial expressions are marked, in third column are marked value of their conjunction . The analysis of a meteorological message has shown, that among combinations of the initial expressions such are possible three, at which one their conjunction is false, and only one combination is those, that their conjunction is true. Total, four possibilities. As much and rows in the table.

The logic operation of a conjunction allows to relate not only two, but also any final number of the expressions. Their conjunction is true in only case when, when each of them is true, she is false then, when one of them is false even.

THE DISJUNCTION

Logic operation «or», with which one we can bind two expression, is named a disjunction. With its help third expression will be derivated from two expressions, which result (third expression) is true, when one of two initial expressions is true even, and which result is false, when both are false.

Certainly, if is true both first and second, that all folded of them the expression as a whole

will be true also. If even first of themis true, that even if second is false, it is necessary to recognize all composite expression as a whole as true.

Same there will be it and then, when the second expression is true, and first is false. And only in that case, when both are false, the expression derivated from them by means of union "OR" will be false also.

A	B	**A or B**
T	T	T
T	F	T
F	T	T
F	F	F

THE IMPLICATION

The implication of two expressions is false in that and only in the event that the premise is true, and the conclusion is false.

The composite expression of such structure names as an implication of those two partial expressions, from which one it is derived. From them first, the supplied word «if», is named as premise, or foundation, second, begin with a word that, — corollary, or conclusion.

A truth table for strict definition of the relevant logic operation also called as an implication.

A	B	**If A then B**
T	T	T
T	F	F
F	T	T
F	F	T

It is example: “if every of two values divides on three without residual, then sum of this values divides on three without residual too”. Let’s show to the variants.

It is possible that both basis and consequence are true. 6 and 9 divide on 3, and sum 6+9=15 too. It is possible that both basis and consequence are false. 2 and 5 don’t divide on 3, and it’s sum 2+5=7 don’t divide on 3. It is possible that basis is false, but consequence is true. 4 and 8 don’t divide on3, but it’s sum 12 divides. But it is impossible us to find example that two values divides on three, but it’s sum don’t divides.

A	B	**If A then B**
T	T	T
T	F	F
F	T	T
F	F	T

Result implication of two expressions is false when and only when, when basis is true and conclusion is false. To negation an implication of two expressions A and B (it is wrong, that from A that follows B) is what to state: A and not B.

This construction from two expressions is constructed with the help of previous logic operations conjunction and negation, and consequently it is uneasy to establish, what truth values accepts this composite expression depending on that, the true’s or are false its partial components. Let's construct relevant implications.

All conclusions to output one statement from other and components an essence of any logic reasoning are based on properties of implication.

EQUIVALENTION (IS NECESSARY AND ENOUGH)

The composite expression derived from two initial with the help of this operation, is named them equivalention; as this operation is named also.

A	B	**A or B**

T	T	T
T	F	F
F	T	F
F	F	T

Equivalention of two expressions is true in only case when, when both they are true or both are false, that is the truth values that and other coincide.

STRICT DIJUNCTION

In similar cases speak, that the union «OR» has separating sense and expresses a so-called strict disjunction. Strict disjunction is true in only case when, when one of they is true and second is false, that is the truth values that and other coincide.

A	B	**or A or B**
T	T	F
T	F	T
F	T	T
F	F	F

n logic formula signs of logic operations are so appreciable, as characters symbolizing partial expressions. The logic structure of the composite expression thus is visible clearly, and the possible double meanings are eliminated by application of brackets.

The true and lie — there is all multitude, can accept which one statement variable.

If two characters, which coherent with signs of a conjunction or disjunction, implication or equivalention, be considered as statement variables, each such pair will define by itself two-place function of a propositional calculus.

Tasks for self-check:

Task 1:

1. The binary operators are:

a) AND;

b) NOT;

c) OR;

d) all of these variants;

e) none of above.

2. The statement, which is true only when both initial expressions are true or false:

a) the conjunction;

b) the disjunction;

c) the implication;

d) equivalence;

e) none of above.

3. Logic operation “not” is:

a) Conjunction.

b) Disjunction.

c) Negation.

d) Implication.

e) Equivalence

4. Logic operation “and” is:

a) Negation.

b) Conjunction

c) Disjunction.

d) Implication.

e) Equivalence

5. Let A = 0, B = 1. Then as a result of performance of logic operation (A /\ B) we will receive:

a) 1.
b) 10.
c) 11.
d) 0
e) 5

Task 2.

Construct the table of the validity for logic functions:

$A \leftrightarrow (A \rightarrow \neg B) \vee (A /\backslash \neg B)$

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Additional.

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