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Workbook
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The workbook comprises a range of theoretical exercises and practical assignments focused on production process organization and enterprise management. It aims to equip learners with both conceptual knowledge and hands-on experience in managing industrial operations effectively.

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TOPIC 1. THE ESSENCE AND OBJECTIVES OF ORGANIZATION OF PRODUCTION

Practical class No. 1

Task 1. Based on the lecture No. 1 and open sources define the following concepts:

a) enterprise (company)

b) goods and services

c) production

d) production process

e) technology

Task 2. List the main stages of development of production organization.

1) _____

2) _____

3) _____

4) _____

5) _____

Task 3. From your point of view, what is the primary objective of industrial engineering:

a) as a theoretical (academic) discipline?

b) as a practical activity in economics?

What are the main differences between these definitions?

Task 4. Compare the F.W. Taylor and Henry Ford production systems as shown in Table 1

Table 1 – Comparison of the F.W. Taylor and Henry Ford production systems

Criteria	F.W. Taylor	Henry Ford
1. Essence of the system		
2. Basic principles		
3. Advantages		
4. Disadvantages		

Task 5. Name the object and subject of study of the discipline «industrial engineering».

Task 6. What does a systematic approach to studying the discipline involve?

Practical class No. 2

Task 7. List the characteristics of development of light industry enterprises in the digital economy.

- 1) _____
- 2) _____
- 3) _____
- 4) _____
- 5) _____

Task 8. Identify key industrial engineering goals addressed in light industry companies.

- 1) _____
- 2) _____
- 3) _____
- 4) _____
- 5) _____

Task 9. From your point of view, what are the main functions of industrial engineering?

Task 10. Complete the sentences by filling the missing words.

Industry is the largest and leading part of _____ .

It is a system of _____

Task 11. What main methods of organizing production do you know?

- 1) _____
2) _____
3) _____

Task 12. Specify the prevalent production organization method currently adopted by the majority of industrial enterprises.

Task 13. Define the concept of “enterprise” by various authors in Table 2.

Table 2 – Definitions of enterprise

No.	Definition	Authors (sources)
1		
2		
3		
4		
5		

What is the main goal of any commercial enterprise (company)?

Task 14. An industrial enterprise is characterized by production, technical, organizational and economic unity, as well as economic independence.

Production and technical unity means _____

Organizational **and** **economic** **unity** means

TOPIC 2. PRODUCTION STRUCTURE OF THE ENTERPRISE

Practical class No. 3

Task 1. What is the general structure of enterprise?

Task 2. What is the production structure of enterprise?

Task 3. Distinguish between an enterprise's general structure and its production structure, highlighting their differences and shared elements.

Task 4. What factors influence the formation of an enterprise management structure?

Task 5. From your point of view, why enterprise should improve the production structure?

Task 6. The machine-building enterprise includes workshops (departments): *foundry (1), forging (2), model (3), electrical repair (4), bushings (5), chassis (6), motors (7), mechanical (8), thermal (9), metal coating (10), transport (11), container (12), assembly (13), consumer goods (14).*

Classify workshops into main, auxiliary, service and side in Table 3.

Before completing the task, please, read theoretical information below.

Theoretical information

There are main, auxiliary, service and secondary workshops.

In the ***main workshops***, products (or part of them) are manufactured or a certain stage of production is performed, as a result of which a semi-finished product is created, used in this or other enterprises.

Auxiliary workshops contribute to the production of main products and produce auxiliary types of products necessary for the normal operation of the main workshops.

Service workshops transport and store raw materials, semi-finished products, finished products, etc.

Side workshops are engaged in processing waste from the main production.

Table 3 – Classification of workshops

Workshops:			
<i>main</i>	<i>auxiliary</i>	<i>service</i>	<i>side</i>

Task 7. A machine-building enterprise employing 2,500 people has the workshops (departments) listed in Table 4.

Table 4 – Workshops in a machine-building enterprise

No.	Workshops	Number of employees
1	Foundry	300
2	Cutting workshop	80
3	Forge workshop	320
4	Mechanical workshop No. 1	400
5	Mechanical workshop No. 2	300
6	Metal coating workshop	70
7	Thermal workshop	100
8	Assembly and welding workshop	400
9	Pattern workshop	60
10	Energy-mechanical workshop	50
11	Electrical repair workshop	150
12	Mechanical repair workshop	120
13	Container workshop	50
14	Transport workshop	70
15	Printing and binding shop	30

Determine the number of workers employed in the main, auxiliary, service and side industries in Table 5.

Table 5 – Structure of the production departments

Workshops	Number of employees
Main:	
Auxiliary:	
Service:	
Side:	

Practical class No. 4

Task 8. The automobile enterprise includes the following workshops: iron foundry, forge, steel foundry, repair and construction, charge preparation, foundry

equipment repair shop, motor transport, railway, electric transport, spare parts, automated warehouse, assembly, tooling and stamping, production mechanization, mechanical assembly production, car assembly, trailer and bus production, gearbox shop; departments – metal supply, sales, marketing, export and technical, planning and economic management, labor and wages department, chief designer, legal, export, import, personnel management, chief architect, chief technologist. Service organizations: cultural center, children's institutions, hostel, sanatorium.

1. Draw up the general and production structures of the enterprise.

General structure of the enterprise

Production structure of the enterprise

Task 9. What is the general plan of the enterprise?

Task 10. What are the main effectiveness indicators for developing a master plan?

1. _____
2. _____
3. _____

Task 11. What does the production efficiency of an enterprise depend on?

Task 12. What is the optimal size of an enterprise?

Task 13. What factors influence the size of an enterprise?

Task 14. What types of outsourcing do you know?

Task 15. The road machinery enterprise significantly increases output, which entails a change in the production structure: in the main production, the foundry production is to be reconstructed and expanded, and in the auxiliary production, the tool production. However, it is possible to obtain castings and tools from specialized enterprises.

Assess the situation and decide on the advisability of changing the structure. The data for analysis are presented in Table 6.

Economic model for the calculation:

$$\mathbf{RC} = \mathbf{C}_{pr} + \mathbf{I}_c - (\mathbf{C}_t + \mathbf{WP})$$

RC – reduced cost, \$;

C_{pr} – production cost of one unit, \$;

I_c – capital investments, \$;

C_t – transport costs, \$;

WP – wholesale price per unit, \$.

If $RC > 0$, we should choose purchase details from another enterprise, because it is more profitable (minimum reduced cost).

If $RC < 0$, we should choose expansion of production at our enterprise, because it is more profitable (minimum reduced cost).

Table 6 – Technical and economic indicators of the road machinery enterprise

Indicator	Dollars, \$
Specific capital expenditures for expansion and reconstruction:	120
– foundry production	130
– tool production	
Unit cost of production:	
– castings	280
– tools	900
Wholesale price per unit of production:	
– castings	240
– tools	870
Transportation costs per unit of production:	
– castings	290
– tools	50

Solution:

TOPIC 3. PRODUCTION PROCESS. PRINCIPLES OF RATIONAL ORGANIZATION OF THE PRODUCTION PROCESS

Practical class No. 5

Task 1. The enterprise produces 15,000 cars annually. Also, it purchases two types of components for each car through cooperative deliveries – at prices of 2,500\$ and 3,000\$ per piece per year. The cost of one car is 12,000\$. Determine the level of cooperation (L_k).

Methodological explanation for the calculation:

$$L_k = \frac{C_{\text{comp.}}}{C_{\text{prod.}}}$$

$C_{\text{comp.}}$ – the cost of semi-finished products and components (details), obtained through cooperation;

$C_{\text{prod.}}$ – the cost of all enterprise products.

The closer the result is to 1, the higher the level of cooperation of the enterprise.

$$C_{\text{comp.}} = (C_1 + C_2 + \dots + C_n) \times V$$

C_1, C_2, C_n – cost of each component (detail), obtained through cooperation;
 V – volume of production.

$$C_{\text{prod.}} = C_{1\text{prod}} \times V$$

$C_{1\text{prod}}$ – cost of one unit of production.

Solution:

Result: _____

Task 2. Assess the level of concentration of the enterprise by calculating reduced cost. The initial data for calculation are presented in Table 7.

Table 7 – Indicators for calculation

Indicator	Options		
	1	2	3
Production cost of one unit, \$	375	450	350
Production volume (output), un.	2 500	2 000	3 500
Capital investments, \$	10 000	15 000	12 500
Transport costs of one production unit, \$	150	270	200
Standard efficiency coefficient,	0,15	0,15	0,15

coef.			
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Methodological explanation.

Reduced cost (RC) is a calculation category reflecting the amount of current and one-time (capital) costs for production goods and services.

$$RC = C_{pr} + E_c \times I_c - C_t$$

C_{pr} – production cost, \$;

E_c – standard efficiency coefficient, coef.;

I_c – capital investments, \$;

C_t – transport costs, \$.

Solution:

**TOPIC 4. ORGANIZATION OF THE PRODUCTION
PROCESS IN TIME**

A practical class No. 6

Methodological explanation. When producing a batch of identical objects of labor, one of the types of movement of objects of labor through operations can be used: *sequential, parallel, parallel-sequential*.

A sequential type of movement. With a sequential type of movement of objects of labor, the parts for each operation are processed in a whole batch. The transfer of parts to the subsequent operation is carried out after the completion of processing of all parts of a given batch.

With a sequential type of movement, the technological cycle ($T_{seq.}$) for processing a batch of parts in operations is equal to:

$$T_{seq.} = n \times \sum_{i=1}^m t_i$$

t_i – is the processing time of one detail in the i -th operation, min;
 n – number of details in the batch.
 i – number of technical operations ($i=1, \dots, m$)

If in one or several operations work is carried out simultaneously at several (WP) workplaces, then:

$$T_{\text{seq.}} = n \times \sum_{i=1}^m \frac{t_i}{WP_i}$$

WP_i – number of workplaces at i -th operation.

Example. Batch of 3 details is processed in five operations lasting $t_1 = 20$, $t_2 = 10$, $t_3 = 120$, $t_4 = 10$, $t_5 = 20$ minutes. The third operation has three workplaces. The sum of the processing time for the entire batch is:

$$3 \times (20 + 10 + 120/3 + 10 + 20) = 300 \text{ min.}$$

Task 1. The number of details in the batch is 12. Type of movement of details in production is sequential. The technological process consists of six operations: $t_1 = 4$, $t_2 = 6$, $t_3 = 6$, $t_4 = 2$, $t_5 = 5$, $t_6 = 6$ minutes. Each operation is producing on one machine. Determine the duration of the technological cycle.

Solution:

Task 2. The number of details in the batch is 15. Type of movement of details in production is sequential. The technological process consists of ten operations: $t_1 = 3$, $t_2 = 12$, $t_3 = 5$, $t_4 = 9$, $t_5 = 14$, $t_6 = 7$, $t_7 = 2$, $t_8 = 6$, $t_9 = 8$, $t_{10} = 6$ minutes. The second operation is producing on three machines, the fifth operation on two machines. Determine the duration of the technological cycle.

Solution:

A parallel type of movement is an order of transfer of objects of labor in which a specific part (or transport batch) is transferred to the next operation immediately after the completion of processing of the previous operation. Thus, the processing of batch parts is carried out simultaneously in many operations.

The total duration of the technological part of the production cycle (T_{par}) is determined by the formula:

$$T_{par.} = p \sum_{i=1}^m \frac{t_i}{WP_i} + (n - p) \sum_{i=1}^{m-1} \left(\frac{t}{WP} \right) max.$$

$\left(\frac{t}{WP} \right) max$ – is the time of the longest operation (main, maximum), min;
p – transport batch of details (usually in production p=1).

For our example:

$$T_{par} = 100 + (3-1) \times (120/3) = 180 \text{ min.}$$

Task 3. The number of details in the batch is 10. Type of movement of details in production is parallel. The technological process consists of five operations: $t_1 = 7$, $t_2 = 4$, $t_3 = 8$, $t_4 = 2$, $t_5 = 6$ minutes. Each operation is producing on one machine. Transport batch of details is 1. Determine the duration of the technological cycle.

Solution:

Task 4. The number of details in the batch is 10. Type of movement of details in production is parallel. The technological process consists of eight operations: $t_1 = 2$, $t_2 = 9$, $t_3 = 5$, $t_4 = 8$, $t_5 = 3$, $t_6 = 4$, $t_7 = 7$, $t_8 = 10$ minutes. The second operation is producing on three machines, the eighth operation on five machines. Transport batch of details is 1. Determine the duration of the technological cycle.

Solution:

A parallel-sequential type of movement is such an order of transfer of objects of labor in which the execution of the subsequent operation begins before the end of processing of the entire batch in the previous operation, i.e. there is parallelism in the execution of operations.

$$T_{\text{par.}=p} = \sum_{i=1}^m \frac{t_i}{WP_i} - (n-p) \sum_{i=1}^{m-1} \left(\frac{t}{WP} \right)_{\min}$$

$\left(\frac{t}{WP} \right)_{\max}$ – is the time of the shortest (minimum) operation, min;

Task 5. The number of details in the batch is 10. Type of movement of details in production is parallel-sequential. The technological process consists of eight operations: $t_1 = 2$, $t_2 = 4$, $t_3 = 3$, $t_4 = 6$, $t_5 = 5$ minutes. Each operation is producing on one machine. Transport batch of details is 1. Determine the duration of the technological cycle.

Solution:

Practical class No. 7

Task 1. Duration of the operations: $t_1 = 10$, $t_2 = 5$, $t_3 = 6$, $t_4 = 1$, $t_5 = 2$, $t_6 = 4$ min. Determine the duration of the production cycle depending on the change in the number of details in a batch from 5 to 10 with a parallel type of movement of objects of labor.

Solution:

Task 2. A batch of details is processed using a parallel-sequential type of movement in eight operations of the production process. Duration of the operations: $t_1 = 4$, $t_2 = 5$, $t_3 = 2$, $t_4 = 6$, $t_5 = 1$, $t_6 = 2$, $t_7 = 3$, $t_8 = 7$ min. The number of parts in a batch is 10. The size of the transfer batch is 4 details.

1. Determine the duration of production process.

Solution:

2. How will change the duration of the production cycle with:

a) a decrease in the duration of the fourth operation by 2 minutes;

Solution:

b) combining the third and fifth operations into one without changing the duration of each separately;

Solution:

c) an increase in the seventh and eighth operations by 1 minute.

Solution:

Task 3. A batch of 300 details is processed using a parallel-sequential type of movement. The technological process consists of six operations, the duration of which is: $t_1 = 4$, $t_2 = 5$, $t_3 = 7$, $t_4 = 3$, $t_5 = 5$, $t_6 = 6$ min. Each operation is performed on one machine. The transport batch consists of 30 details. As a result of improving the production technology, the duration of the third operation will be reduced by 3 min, the seventh – by 2 min. Determine how the duration of the technological cycle of processing a batch of parts will change.

Solution:

Practical class No. 8

Task 4. A batch of parts is processed sequentially in seven operations. The average interoperational time is 15 min. The technological process is given in Table 8. Transport batch of details is 2. Determine the duration of the technological cycle.

Table 8 – Time of the operations and number of machines

Indicator	Operations						
	1st	2nd	3rd	4th	5th	6th	7th
Time, min.	3	7	5	6	2	3	8
Number of machines	1	2	1	2	1	1	2

Determine how the following will change:

- 1) the technological cycle if the batch size is doubled;
- 2) the duration of the production cycle if operation 2 is divided into three- and four-minute operations and each of them is performed on one machine.

Solution:

Task 5. The number of details in the batch is 10. The technological process consists of 4 operations: $t_1 = 5$, $t_2 = 8$, $t_3 = 6$, $t_4 = 7$ minutes. Each operation is producing on one machine. Transport batch of details is 1. Determine the duration of the technological cycle, using the different types of movement of details in production.

Solution:

Task 6. The number of details in the batch is 8. The technological process consists of 4 operations: $t_1 = 3$, $t_2 = 4$, $t_3 = 9$, $t_4 = 6$ minutes. The second operation is producing on 2 machines, the third – on 3 machines. Transport batch of details is 3. Determine the duration of the technological cycle, using the different types of movement of details in production.

Solution:

Task 7. The number of details in the batch is 5. The technological process consists of 10 operations: $t_1 = 2$, $t_2 = 9$, $t_3 = 8$, $t_4 = 3$, $t_5 = 2$, $t_6 = 7$, $t_7 = 4$, $t_8 = 10$, $t_9 = 6$, $t_{10} = 3$ minutes. The second operation is producing on 6 machines, the fifth operation – on 4 machines, the eighth operation – on 5 machines. Transport batch of details is 10. Determine the duration of the technological cycle, using the different types of movement of details in production.

You need to:

- 1) determine the changes in duration of the technological cycle, using the different types of movement of details in production;
- 2) calculate the monetary savings if the cost of production is \$2 per minute and 15 batches of details are producing per day.

Solution:

TOPIC 5. TYPES AND METHODS OF PRODUCTION

Practical class No. 9

Theoretical information. There are three main types of production organization: mass, serial and individual. In turn, mass production is divided into large-, medium- and small-scale.

Methodological explanation. The main indicator for determining the type of production is the specialization coefficient (K_{sp}), which is determined by model 1:

$$K_{sp} = \frac{n_i}{WP_i}$$

n_i – number of technological operations performed in a certain workshop;

WP_i – number of workplaces in a certain workshop.

In practice, the following K_{sp} values are accepted: mass production – 1–2, large-scale production – 3–5, medium-scale production – 5–20, small-scale production – 20–40, single production – over 40.

Task 1. In the car assembly shop 125 technological operations are performed, which require 32 workplaces. Determine the type of production organization.

Solution:

Methodological explanation. The mass coefficient (K_m) is determined by model 2:

$$K_m = \frac{\sum_{i=1}^m t_i}{n \times r}$$

t_i – standard time for the i -th operation, minutes;

n – number of operations for a technological process;

r – product release cycle, minutes.

If $K_m \geq 1$, there is a mass type of production, because of each operation of the technological process fully loads at least one workstation throughout the entire period.

Task 2. The technological process consists of five operations: $t_1 = 12$, $t_2 = 18$, $t_3 = 15$, $t_4 = 21$, $t_5 = 9$ minutes. Product release cycle – 5 minutes. Determine the type of production organization, using the mass coefficient.

Solution:

Methodological explanation:

The main indicators of a production line in mass production are:

- line beat (product release cycle) (r);
- number of workplaces (WP);
- job load factor (JLF);
- speed of movement of the conveyor belt (V);
- conveyor length (l_c);
- the duration of the technological cycle (TC_d).

The line beat (r) is determined by model 3:

$$r = \frac{F_{WT} \times 60}{N}$$

F_{WT} – working time fund, hours;

N – volume of production.

Working time fund (F_{WT}) is determined by model 4:

$$F_{WT} = (S_d - B_d) \times WS$$

S_d – shift duration, min.;

B_d – duration of regulated rest breaks per shift, min.;

WS – number of work shifts per day.

The estimated number of workplaces (WP) in the technological process according to the model 5:

$$WP = \frac{t_i}{r}$$

t_i – standard time for the i -th operation, min.;

The accepted number of workplaces (WP_a) is determined by rounding the calculated number up.

The job load factor (JLF) is determined by model 6:

$$JLF = \frac{WP}{WP_a}$$

The speed of the conveyor belt (V) is calculated according to the production line cycle (model 7):

$$V = \frac{l}{r}$$

l – conveyor pitch (distance between the axes of adjacent objects), meters.

The length of the conveyor (l_c) is determined by model 8:

$$l_c = l \times WP_a$$

The duration of the technological cycle (TC_d) is determined by model 9:

$$TC_d = \frac{l_c}{V}$$

Task 3. The unit is assembled on a continuous working conveyor. The technological cycle for assembling a unit on a conveyor is 85 minutes. Product release cycle – 5 minutes. The conveyor pitch is 1.5 meters. Determine the speed and length of the conveyor.

Solution:

Task 4. The product is assembled on a production line equipped with a continuous working conveyor. Conveyor speed – 0.5 m/min. The conveyor pitch is 1.5 meters. The length of the conveyor is 30 meters. The line operates in two shifts of 8 hours. Regulated rest breaks are 30 minutes per shift. Determine the duration of the technological cycle and the volume of production.

Solution:

Task 5. The production line, equipped with a continuous working conveyor, has the following parameters: conveyor pitch – 1,5 m, closed belt length – 61,256 meters; the radius of the drive and tension drums is 0,2 meters. The conveyor operates in two shifts of 8 hours. Regulated rest breaks – 30 minutes per shift. Production program – 180 pcs per day.

Determine the production release cycle; conveyor speed; number of workplaces on the line; the duration of the technological cycle.

Solution:

TOPIC 6. FLOW METHOD OF ORGANIZING PRODUCTION

Practical class No. 10

Task 1. List the main indicators of production lines:

– line tact

–

–

–

–

Task 2. Write a formula for determining the line beat, provide an explanation of the formula.



Task 3. Write a formula for determining the actual time fund in continuous flow production with an explanation.



Task 4. Write a formula for determining the number of workstations in a production line operation with a breakdown.



Task 5. The question needs to be answered: How is the accepted number of jobs determined in comparison with the calculated number?



Task 6. Write a formula for the workstation occupancy rate for technological cycle operations.



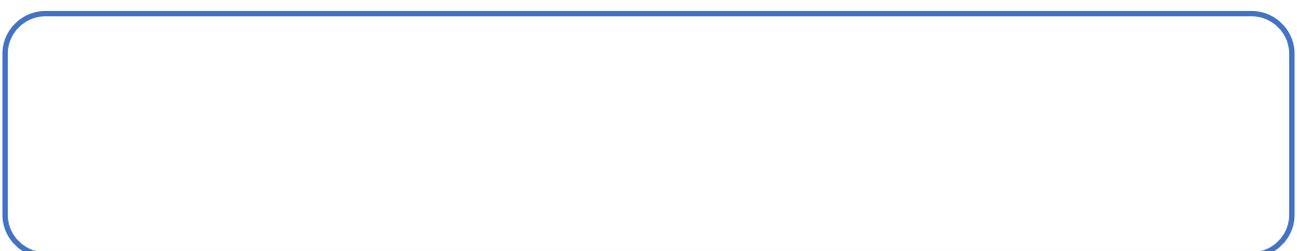
Task 7. Write a formula for determining the speed of a conveyor belt with an explanation.



Task 8 Write a formula for determining the length of a conveyor with explanations.



Task 9. Write a formula to determine the duration of the assembly cycle of a product on a conveyor.



Task 10. Using the formulas presented in tasks 2 – 9, solve the problem. The answer corresponds to the last digit of the student's class number.

The assembly of small-sized products is carried out on a continuous production line equipped with a continuous conveyor. The daily production schedule for each variant is presented in the table.

The assembly process consists of 10 operations, the standard time for which (including the time it takes for the worker to return to his or her previous position) is (see Table 9 for the options). Products are assembled on platforms specially secured to the conveyor belt in transport lots, each consisting of 5 items. The length of the platform along the conveyor travel is 800 mm, the distance between adjacent platforms is 700 mm. The diameter of the drive and tension drum is 0.6 m. The operating mode of the production line is two shifts of 8 hours each. Regulated rest breaks are 30 minutes per shift. Determine the flow rate and rhythm, the number of workstations in the operations and on the entire production line, the conveyor speed, the length of the working section of the conveyor, the length of the closed conveyor belt, and the duration of the technological cycle for producing a transport lot on the conveyor.

Table 9 – Initial data

Operation number	Standard time for operations, min									
	Options									
	1	2	3	4	5	6	7	8	9	10
1st operation	1.9	3.6	4.8	4.5	2.4	3	4	4	4	2
2nd operation	3.9	7.2	2.4	3	4.8	5	5	5	6	3
3rd operation	2	5.4	4.8	6	3.6	2	6.5	7	12	1
4th operation	5.9	9	9.6	4.5	3.6	5	5	3	6	5
5th operation	6	1.8	2.4	6	2.4	4	6	4	4	4.7
6th operation	2	5.4	4.8	1.5	4.8	6	7.5	5	4	2
7th operation	3.9	3.6	2.5	1	2.4	5	2.5	6	6	4
8th operation	2	7.2	7.2	3.8	3.6	2	2	3	2.4	8
9th operation	5.8	2	2.4	5	2	6.5	4	2	3.6	2.5
10th operation	4	3.9	5	2.7	4.9	2.5	3.5	2.5	4	3.7
Daily release program Ncday, (pcs)										
Ncute, pcs.	450	550	375	500	470	300	650	274	360	575

Solution:

Task 11. The block is assembled on a flow line equipped with a working pulsating conveyor. The daily output is 600 units. The duration of the technological cycle is 24 minutes. The time to move a block from one workplace to another is 0,3 minutes. The conveyor pitch is 1,2 m. The line operates in two shifts of 8 hours. Scheduled rest breaks are 30 minutes per shift. Determine the line beat; conveyor speed; number of workplaces on the line; length of the conveyor.

Solution:

Task 12. There are 14 workplaces on the flow line equipped with a working pulsating conveyor. The duration of each operation at the workplace is 5 minutes. The conveyor speed is 4 m/min. The conveyor pitch is 1,6 m. The diameter of the

drive and tension drums is 0,4 m. The line operates in two shifts of 8 hours. Regulated rest breaks are 30 minutes per shift. Determine the line beat; the length of the working section of the conveyor; the length of the closed belt length; the duration of the technological; daily output of products.

Solution:

Practical class No. 11

Task 1. Calculate the annual volume of repair work. According to the schedule, the following repairs are performed this year (see Table 10). Select the option from the list in the log.

Table 10 – Types of repairs

Indicators	Options									
	1	2	3	4	5	6	7	8	9	10
Repair complexity categories	7	8	10	7	11	9	12	11	9	10
Inspection	20	10	20	20	25	24	10	10	14	20
Repair:										
minor	10	5	10	5	12	10	5	3	7	3
medium	2	2	4	3	6	4	2	2	3	3
major	2	1	2	2	1	2	2	1	1	2

Time standards for one repair unit are presented in Table 11.

Table 11 – Time standards for one repair unit, hours

Types of work	Inspection	Repair		
		minor	medium	major
Locksmiths	0,75	4	16	23
Machine tools	0,1	2	7	10
Other	–	0,1	0,5	2
Total	0,85	6,1	23,5	35

The workshop has 20 machines. The workshop operates in a one shift. The shift duration is 8 hours. The annual effective working time is 1840 hours per one person. The service standards per worker per shift for inter-repair maintenance are: N1=1650 repair units; N2=500 repair units; N3=3000 repair units. Determine the duration of the inter-repair cycle, the inter-repair and inter-inspection periods, the labor intensity of repair and inter-repair works, and the staffing by category required to perform repair works and inter-repair maintenance.

Solution:

Practical class No. 12

Task 2. Determine the annual power demand for a section of the mechanical shop based on the following data (Table 12):

Table 12 – Initial data

Machines	Power of installed electric motors, kW	Cos electric motors	Machine operating time coefficient of equipment
Lathing	36	0,8	0,7
Milling	30	0,7	0,8
Drilling	6	0,6	0,4
Gear cutting	18	0,7	0,6
Grinding	28	0,8	0,8

The operation mode of the section is two shifts of 8 hours. The number of working days per year is 260. Time losses due to overhaul amount to 5%.

Solution:

Task 3. Determine the power energy consumption for a section of a mechanical shop over a month, if the total installed capacity of electric motors is 160 kW. The utilization factor of the installed motors is 0,9. The machine time coefficient for the equipment in the section is 0,7. The operation mode of the section is two shifts of 8 hours each. The number of working days in the month is 22. Time losses for scheduled equipment maintenance amount to 4%.

Solution:

Task 4. The total power of electric motors of the metal-cutting machines in the mechanical shop is 180 kW. The demand factor, accounting for underloading and non-simultaneous operation of the shop's electric motors, is set at 0,5. The shop operates in two shifts of 8 hours each. Time losses for scheduled maintenance amount to 4%. Determine the monthly power energy consumption (for 22 working days) for this shop.

Solution:

Task 5. Determine the lighting energy requirement for the mechanical shop over a month, if there are 40 fluorescent lamps, with an average power of 100 W each. The average daily burning time of the lamps is 15 hours. The coefficient of simultaneous operation of the lamps is 0,8. The number of working days in the month is 22.

Solution:

Task 6. Determine the annual water consumption for preparing the cooling emulsion for metal-cutting tools in the mechanical shop. Water is used on 50 machines, with an average hourly consumption of 1.2 liters per machine. The average utilization factor of the machines is 0.8. The shop operates in two shifts of 8 hours. The number of working days in the year is 260. Time losses for scheduled maintenance amount to 5%.

Solution:

Practical class No. 13

Task 7. Parts are supplied for assembly using floor conveyors. The daily load flow reaches 60 tons, with the average weight of one part being 2 kg. The distance between adjacent parts is 0,75 m. The conveyors move at a speed of 0,25 m/s. The assembly shop operates in two shifts. The conveyor operating time fund is utilized at 95%. Determine the required number of conveyors and the hourly throughput of each conveyor.

Solution:

Task 8. The electric overhead crane in the mechanical assembly shop transports 28 items per shift. Loading and unloading one item takes 10 minutes. The crane moves at a speed of 30 m/min. The crane's route length is 80 meters. The utilization factor of the crane's working time is 0,9. The duration of the work shift is 8 hours.

Solution:

Task 9. A suspended conveyor equipped with 16 load hooks delivers 1000 parts per day (two shifts of 8 hours each). One part is hung on each hook. The length

of the working branch of the conveyor is 70 meters. The conveyor operating time fund is utilized at 90%. Determine the conveyor's travel speed.

Solution:

Task 10. The daily output of parts in the mechanical section is 80 units. Each part is transported by an overhead crane over a distance of 75 meters. The crane's speed is 40 m/min. For each part weighing 35 kg, four operations are performed during loading and unloading, each lasting 3 minutes. The shop operates in two shifts. The duration of each shift is 8 hours. Scheduled maintenance for the crane accounts for 15% of the time. Determine the time spent on one crane trip, the number of electric cranes needed, and their hourly throughput.

Solution:

Task 11. Parts are supplied for assembly using a conveyor. The daily load flow is 38 grams, with an average weight of one part being 2 kg. The conveyor step (pitch) is 0,85 meters. The conveyor speed is 0,3 m/s. The shop operates in two shifts. The duration of the working shift is 8 hours. Time losses for maintenance amount to 5%. Determine the required number of conveyors and their capacity (throughput).

Solution:

TOPIC 8. PLANNING THE PRODUCTION PROGRAM AND PRODUCTION CAPACITY OF THE ENTERPRISE

Practical class No. 14

Task 1. *Please, give short answers to the questions below.*

1. What is the production planning?

2. What is the operational planning?

3. What are the main elements operational planning should include?

- 1) _____
- 2) _____
- 3) _____
- 4) _____
- 5) _____

4. What is the inter-shop operational planning?

5. What is the intra-shop operational planning?

6. What are the main stages of forming production tasks for workshops?

- 1) _____
- 2) _____
- 3) _____
- 4) _____

7. What does the rhythmic work of an enterprise mean?

Task 2. Please, give short answers to the questions below.

1. What are the main functions of operational regulation of production?

- 1) _____
- 2) _____
- 3) _____
- 4) _____

2. What are the main directions operational control should include?

- 1) _____
- 2) _____
- 3) _____

3. What types of technical equipment are used in dispatching practice at enterprises?

- 1) _____
- 2) _____

3) _____

4. What does an automated assembly production control system provide?

1) _____

2) _____

3) _____

4) _____

5) _____

6) _____

Task 3. At the mechanical shop production area, 25,000 parts “D” must be manufactured during a quarter (62 working days). The technological process of manufacturing the parts is given in Table 13. The working mode of the area is two shifts. Planned downtime for major repairs is 10%. Determine the required number of machines of each type and their workload.

Table 13 – Technological process for manufacturing part “D”

Operation	Standart time, hours	Fulfillment of the norm, %
Turning	0,6	125
Milling	0,78	HO
Drilling	0,24	120

Solution:

Task 4. Using the initial data provided in Table 14, determine the assembly shop's production capacity utilization rate.

Table 14 – Data for determining assembly shop capacity

Product	Release plan, units	The area required to assemble one product, meters	Assembly time, hours
A	35	15	700
B	5	20	600
C	8	35	550
D	60	10	600

Solution:

Task 5. Determine the number of parts that can be processed on milling machines during the quarter in excess of the plan. There are 12 milling machines on the site, working two 8-hour shifts. The quarter has 65 working days. Time lost due to repairs is 6%. Planned workload is 8 400 norm-hours. Performance factor at the site is 1,2. Standard time to produce one part is 2 hours.

Solution:

TOPIC 9. PLANNING OF THE ORGANIZATION'S LOGISTICS

Practical class No. 15

Task 1. Gears are machined on a continuous-flow (straight-through) line. The machining process consists of the following operations (Table 15):

Table 15 – Initial data

No.	Operations	Standard time for operation, min.
1	Face milling	12,5
2	Rough turning	7,5
3	Taper turning	1,25
4	Finish turning	8,75
5	Gear tooth cutting	2,0
6	Journal grinding	3,0

Daily output program – 192 units. Line operation mode – two shifts of 8 hours each. Period for replenishing inter-operational buffer stocks – 8 hours. Determine the line takt time, the number of workstations and workers at operations and their workload. Prepare the work schedule-regulation for workstations (equipment) and operator-workers on the line, calculate the size of inter-operational buffer stocks, and build a graph of their variation.

Procedure for completing the task:

1. Construct the work schedule-regulation of operator-workers and workstations on the line (Table 16).

Table 16 – Work schedule-regulation of workers and workstations on the flow line

No.	Standard time for operation, min.	Number of work places per operation		Workplace number	Loading of workstations	Working time, hours	Period of completing interoperational stockpiles, hours.							
		Cp.	Cпр.				1	2	3	4	5	6	7	8
1	12,5	2,5	3	1	100	8								
				2	100	8								
				3	50	4								
2	7,5													
3	1,25													
4	8,75													
5	2,0													
6	3,0													

2. Calculate the takt time of the flow line.

3. Determine the number of workstations. The accepted number is rounded to the nearest whole number, allowing for a possible overload of up to 10–12 %.

4. Calculate the workload (in %) of the workstations and operator-workers on the line. When doing this, take into account the possibility of multi-machine operation and combining operations.

5. Show on the graph the periods of product manufacturing (replenishment of inter-operational buffer stocks). When calculating the sizes of inter-operational buffer stocks, consider that the size of inter-operational buffer stocks is calculated based on the phases of change in parallel work time on adjacent operations. Inter-operational (buffer) stocks on a flow line can only exist between adjacent operations that have different processing times, and are determined based on the work schedule-regulation graph of the flow line.

Solution:

Task 2. The weight of a manufactured part is 930 kg. Waste according to the current technological process is 18 %. As a result of changing the method of obtaining the blank, the waste was reduced by 7,5 %. Determine the amount of material saved if 280 parts were manufactured in the shop.

Solution:

Task 3. Determine the quantity of main materials to be procured for the plant based on the following data: annual production program – 2 500 units; material consumption norm per unit: steel – 100 kg, cast iron – 75 kg; actual material stocks at the beginning of the planned year: steel – 5 tons, cast iron – 3 tons; planned material stocks at the end of the planned year: steel – 7 tons, cast iron – 5 tons.

Solution:

Task 4. Determine the total quarterly material requirement, total maximum current and safety stock, and total maximum warehouse stock based on the following data: production program for the quarter – 1 000 units; material consumption norm per unit: steel – 70 kg, copper – 6 kg, bronze – 10 kg; steel is delivered every 20 days; copper and bronze once a month; average delivery delay time: steel – 5 days; copper and bronze – 10 days; number of days in a month – 30, in a quarter – 90.

Solution:

Task 5. Determine the size of the safety stock, maximum stock, and normative current stock of rolled metal if the workshop consumes 6 tons of steel rolled stock per day for manufacturing parts, and the supply of rolled metal is delivered once every 30 days. The safety stock is 7 days.

Solution:

Educational publication

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