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دفتر :

أتمتة

Automation

للطالبة : حلا

للدكتور : مهند

اللجنة الأكاديمية لقسم الهندسة الصناعية

2023

Subject Automation and control system. **Day** _____ **Date** _____

Keywords:

Automation: mechanism for systems that move by itself, defined set of technologies, results in operation of machine without human intervention, achive performance superior to manual operation in terms of power, precision and speed of operation.

why does an automated system achieve superior performance compared to manual one?

1- more precision

2- more energy and more speed of operation.

control: set of technologes achieves patterns of variations of operational parameters and sequences by providing the input signals

Automation system: include control system but the reverse is not true [control system parts of auto].

Main function of control system: ensure that outputs follow set points.

Functionality of Automation system: computing set points for control system, monitoring system performance plant start-up or shut down, job and equipment.

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Automation system are essential for most of modern industries. (المصانع الحديثة)

example of an automated system contains a control system as a part of is: Robot. (الروبوتات)

- we have Five major of Industrial IT context of industrial Automation:

Industrial Automation involves:

1- significant amount of hardware technologies related to instrumentation and sensing (الاستشعار والمحركات), Actuation and drives, electronics (الالكترونيات) for signal conditioning (الاتصالات والعرض), communication and display

Industrial Automation system grow more sophisticated interm of knoledge and algorithms why?

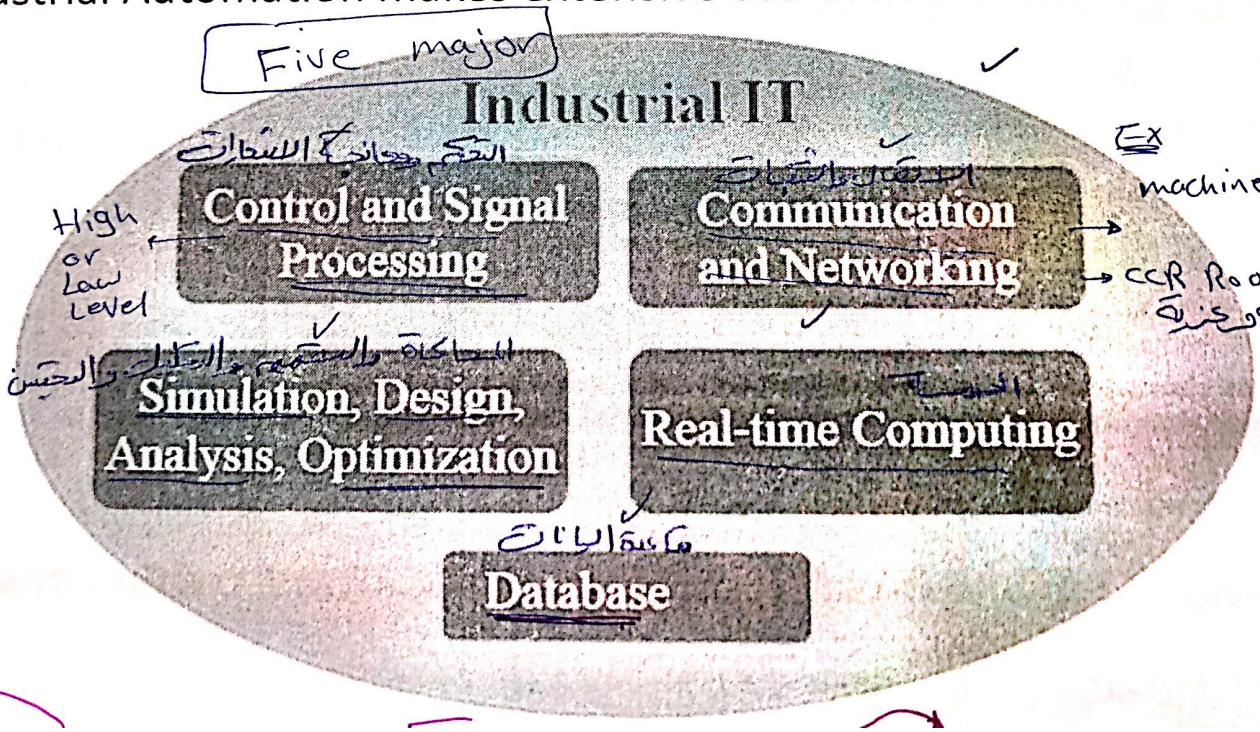
because they encompass (تشمل) larger areas (مناطق تشغيل كبيرة) of operation comprising several units.

notes: IT التحكم ↑ industrial automation في التحكم ↑ ١- كلما

IT الحاجة لنظام ↑ machine التحكم في ال ↑ ٢- كلما زاد

Industrial Automation vs. Industrial Information Technology

✓ Industrial Automation makes extensive use of Information Technology



Role of automation in industry:

عمليات التصنيع

Manufacturing process: produce finished product from raw/unfinished material using energy, manpower and equipment and infrastructure.

بمساعدة

الهدف

↳ raw material → finished material —energy / equipment→ result

نشاط اقتصادي

industry is essentially [systematic economic activity]

الهدف الأساسي

the Fundamental objective of any industry is to make it profit.

الربح

معادلة تحقيق الأرباح

profit = (Price/unit − cost/unit) x production volume

↳ good quality ↑ less cost ↓ less time ↓

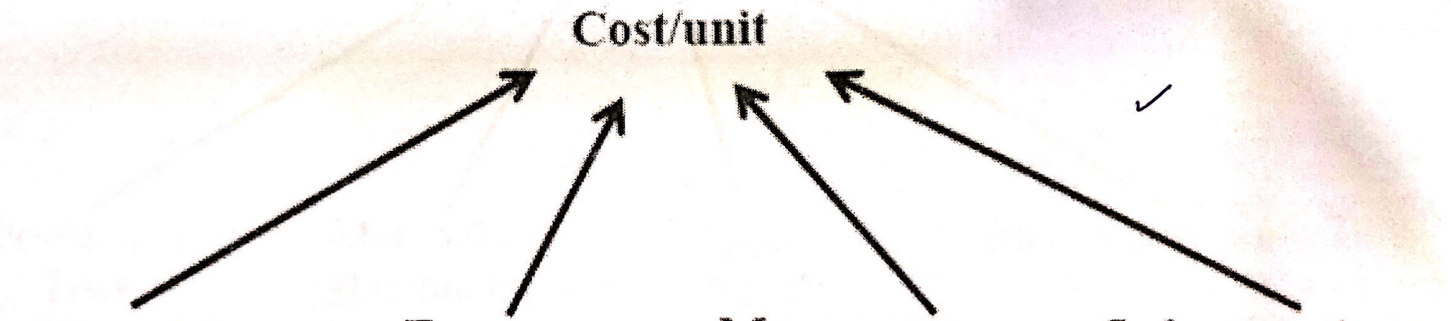
Major parametrs that affect cost/unit of a mass manufactured industrial product.

notes: في حال قدرت اعمل controller لك م ط لل major

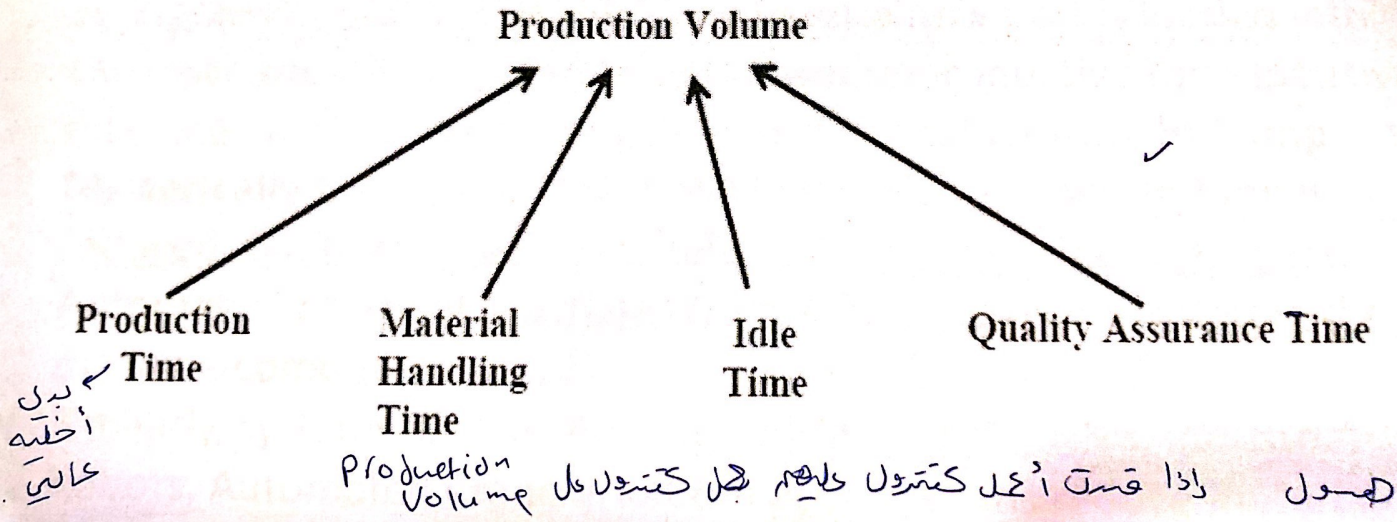
بقدر اعمل controller لل cost.

نفس الكلام

- The major factors that contribute to overall production time.



The major parameters that affect the cost/unit of a mass-manufactured industrial product.



The major factors that contribute to Overall Production Time

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Automated machine have significantly lower production times. اقل وقت لتشغيل

Numerically controlled (CNC): machining centers setup time is reduced signifially with the help of automated tool changers. مساعدة الادوات الالية

Robots, Automated Crane and Conveyor systems reduce material handling time. الرافعات الالية تقلل الحمل التعامل مع الوقت

Automation reduces cost of production signifially by efficient usage of energy, manpower and material.

The product quality that can be achived with automated precision machine and process cannot be achived with manual operations. جودة المنتج حتم تحقيقها باستخدام الالات والعمليات الدقيقة المؤتمتة من خلال العمليات اليدوية

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Economy of scale: reduction in cost per unit resulting from increased production realized through operational efficiencies.

Automation facilites economy of scale it enable efficient large-scale production.

Economy of scope: The situation that arises when the cost of being able manufacture multiple products simultaneously proves more efficient than of being able manufacture single product at a time.

rapid programmability and reconfigurability of machines and process becomes a key requirement for commercial success.

Flexible Manfacturing: producing various products with the same machine.

Same machine to predice diffrent product.

Economy of scope: most largely in electronic product manufacturing.

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Types of production system:

1- Continuous flow process: manfactured product it is in continuous quantities [The product not discrete object]. The volume of production is very high while the product variation is relatively low.
example: oil refineries, Iron and steel plant Cement and chemical plant.

2- Mass manufacturing of discrete product: products are discrete objects and manufactured in large volume. product variaton is limited.
example: Appliances, Automobiles.

3- Batch production: The product is either discrete or continuous, the variation in product types is larger than in continuous flow process.
example: pharmaceuticals, Casting foundries, plastic modeling, printing

4- Job shop production: designed for manufacturing small quantites of discrete products which are custom bulit. example: machine shop, Prototyping facilites.

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Types of Automation systems:

Based on
- Flexibility (المرونة)
- level of integration (التكامل)

in manufacturing process

Automation system can be classified as:

1- Fixed Automation (الأتمتة الثابتة): used in high volume production with dedicated equipment with have a fixed set of operation and designed to be efficient.

Continuos flow + mass production use fixed Automation

example: Conveyors (أحزمة النقل), paint shop (ورشة الدهان), transfer lines (خطوط النقل)

A process using mechanized machineny to perform fixed and repetitive operations to produce a high volume of similar parts.

(عمليات ميكانيكية ومتكررة لإنتاج حجم كبير من أجزاء متشابهة)

2- programmable Automation: changeable sequence of operation and configuration of machines using electronic control.

(تسلسل العمليات والتكوين القابل للتغيير للآلات باستخدام وحدات التحكم الإلكترونية)

Programmable Automation → Batch process job variety low and mass production product volume is medum to high

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3- Flexible Automation: used in Flexible manufacturing systems (FMS) which invariably computer Controlled.

Flexible Automation → job shops, batch process

product varieties are high and job volumes are medium to low.

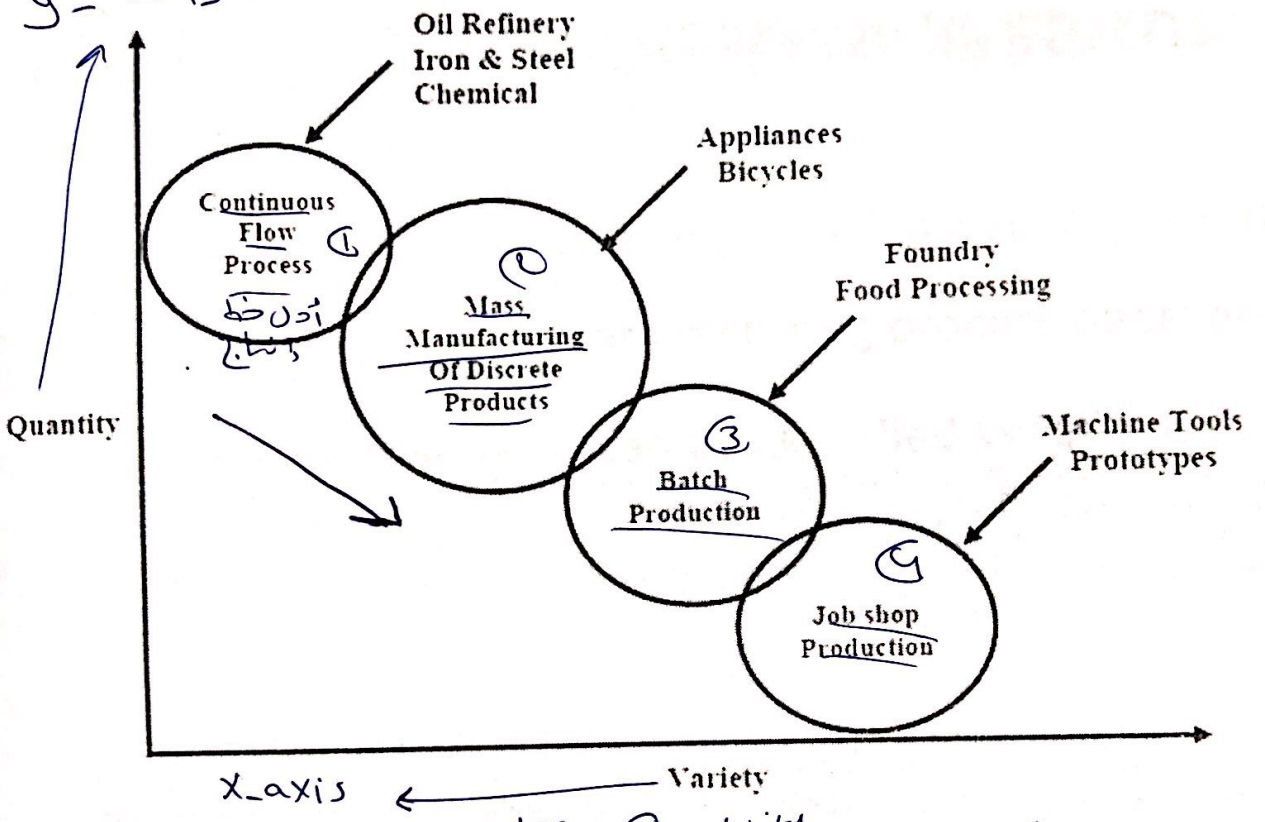
Flexible Automatin (job shop and batch) use multi purpose CNC machines, Automated Guided Vehicles (AGV).

4- Integrated Automation: Complete Automation of manufactring plant with all process functions under computer control and under coordination through digital information processing

Integrated Automation: Include technologies such as computer-aided design and manufacturing computer-aided process planing, computer numerical control machine tools, flexible maching system.

Integrated Automation: it's full integration of process and mangment operation using information and communication technologies.

y- axis.



بتقل Quantity و Variety بتزيد

Types of Production Systems

كل ما زادت ال Variety زادت ال Quantity.

- Continuous Flow process
- Mass Manufacturing of Discrete products
- Batch production.
- Job shop production.

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Example Integrated Automation: CIM [compuler Integrated manufacturing]

Basic element of an automated system:
1- power [to accomplish the process and operate the automated system]
2- program of instructions
3- control system

Two Type of power to Accomplish the Automated system process:
↳ power for process
1- to drive the process itself
2- to load and unload the work unit
3- transport between operations.

power for Automation
1- controller unit
2- power to acuate the control signals
3- Data and information processing.

* The principle power source.
1- widely available at modrate cost.
2- can be readily converted to alternative forms, mechanical, thermal, light
3- low level power, can be stored in long life batteries

There are 6 examples of automated work cycles in which decision making is:

1- Operator intraction
2- Automated teller machine.
3- Different part or product styles processed by system.
4- Robot welding cycle for two doors Vs four door car models.
5- Variations in the starting work unit.
6- Addional machining pass for oversized sand casting.

Two types of control system:

1- closed loop system: operats with the feedback loop.
2- open loop system: operatis without feedback loop.

open loop system:
- Simpler and less expensive.
- Risk that the actuator will not have intended effect.

When to use an open loop control system?

1- Actions performed by control system are simple.

2- Actuating function is very reliable.

3- Any reation forces opposing the actution are small enough to have no effect.

- Advanced Automation function:

1- Safety monitoring

2- maintenance and repair diagnostic

3- Error detection and recovery.

* Reasons for safety monitoring:

1- to protect workers and equipment.

* possible responses to hazards:

1- Complete stoppage of the system.

2- Sound an alarm.

3- reduce operating speed of process

4- Take corrective action to recover from safety violation.

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Maintenance and repair diagnostics:

1- Status monitoring: monitors and records status of key sensors and parametrs during system operation.

2- Failure diagnostics: Invoked when a malfunction occurs.
purpose: analyze recorded value so the cause of the malfunction can be identified.

PSCIM 4e

Error Detection and Recovery

كشف الخطأ والاسترداد

1. Error detection – functions: وظائف كشف الخطأ
   - Use the system's available sensors to determine when a deviation or malfunction has occurred استخدام مستشعرات النظام لتحديد وقت حدوث الانحراف او العطل
   - Correctly interpret the sensor signal
   - Classify the error تصنيف الخطأ
2. Error recovery – possible strategies: استراتيجيات استعادة الخطأ
   - Make adjustments at end of work cycle
   - Make adjustments during current work cycle
   - Stop the process to invoke corrective action
   - Stop the process and call for help

١- اجراء تعديلات في نهاية دورة العمل
٢- اجراء تعديلات اثناء دورة العمل
٣- توقف العملية لاستدعاء اجراء تصحيحي
٤- وقف العملية, طلب المساعدة.

APSCIM 4e

Levels of Automation

مستويات الأتمتة

1. Device level – actuators, sensors, and other hardware components to form individual control loops for the next level
2. Machine level – CNC machine tools and similar production equipment, industrial robots, material handling equipment
3. Cell or system level – manufacturing cell or system
4. Plant level – factory or production systems level
5. Enterprise level – corporate information system

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Management decisions can be either "instinctive or structured"

1- Instinctive decisions :

pros / ايجابيات

rapidity and flexibility

Cons / السلبيات

→ no quantitative model

- limited number of alternatives
- limited understanding of decision cirteria.

Drawbacks can be extremely critical if decisions are complex.

2- structured decisions :

"based on quantitive model"

pros / ايجابيات

Better understanding of the problem.

- Consideration of all possible alternatives.
- precise decision criteria

* optimal decisions can be taken even for complex problems.

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Cons: العمليات

- getting a mathemetical model of a decition problem might be time and resource consuming.
- trade-off between time / recources for decision-making and benifits of optimaly.

4

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PLC

A programmable logic controller: is unit of hardware used to control and automate an industrial process.

- They were initially designed to replace hardwired relay-based control.

- plc are used to solve control problems from [simple to complex].

- essental components in PLC is:

1- input (push button)

2- output (the voltage applied to machine)

- picture 4,p

Three main aspect of programmable logic controller (PLC) is:

1- Input → connected sensor device that inform plc about environment.

2- output → connected to equipment need to be controlled.

3- Control diagram → uses set of logical instruction that drives the output based in input.

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picture 5 p. input and output device.

A relay : device that responds to voltage change by activiting a switch.

- The contactor is used for high current.

- Two common types of programmable logic controller or PLCs.

1- single box type

2- modular or rack type.

- The box type is smaller and used for simpler control situations.

- The modular type consists of central rack that house various models such as power supply processor, analog or digital input and output and communications, and special function moduls

- I/O modules can be much more specialized than that of box type, used for larger and more complex operation.

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Typical plc Application & ip

- example of popular use for plc: carwashes. why? because it involves intricate use sensor and motors, also has need of complex logic. -

- Industrial equipment use three phase power for various reasons such as cost, size, durability

The converter has three contacts:

1- Two are connected to 220 VAC source.

2- other connected to a starting capacitor and a push button

- The Three phase converter has a motor that needs to be started via a starting capacitor.

- The Pressure sensor would feed information in a 1- Timer 2- Counter.

hardware

- relay logic → start relay
→ Timer relay

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How we control without plc? التحكم بدون plc

The switch and momentry push button have been replaced with start and stop button.

- A Solenoid is powered to keep valve shut.
- A solenoid another type of relay.

The pressure sensor would feed information in a Timer and counter.

Instead of large amount of devices and the resulting complicated wiring one piece of hardware plc can take place of all 20 timers and counters. يحل الـ plc محل جميع أجهزة توقيت الوقت والعدادات

plc replace all wiring and invidual pieces of hardware like counters, timers and relays.

plc is a special microprocessor based controller It has programmable memory that is used to store programe that instructs plc to how control machine or process

Input —| |— normaly open "I"

—|/|— normaly close

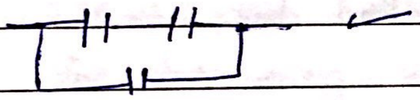
output —( )— "Q"

* مثلاً هاد الصليب —||— بشوف اللون الاحمر ومررنا قطعة حمرا عليه فبتوقف —||—
لـ —|/|— عشان يمر لل output.

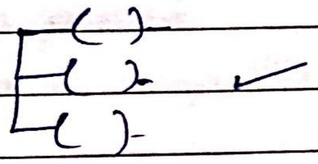
1] —| |—( )— X

2] —|/|—( )— ✓

Input can be parallel and series.



output just parallel.

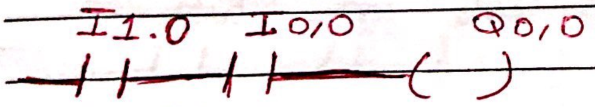


examples:

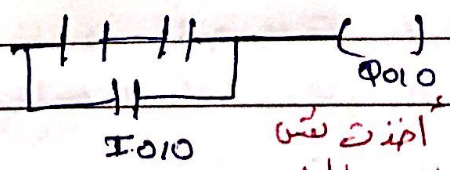
1- If "Start" push button is pressed and a work piece (sensor) is available at the beginning of the conveyor belt (sensor), the conveyor belt actuated until lift your finger.

start → بتضل شغالة ما دام فيش كابسة عليها.

latching → توصيلة parallel حولين الـ input الـ address الها هو نفس الـ output.

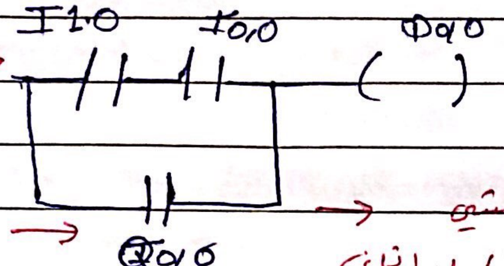


لما افكسها ← انا مرا التيار



أخذت نفس الـ Address

- هنا مبدأ الـ latching بنفس السؤال فلذا شلنا الاصبع عن الـ start فراح يقرأ الـ sensor وما يوصل للـ output.



example 2.

IF "start" push button is pressed and a workpiece is available at the beginning of the conveyor belt, the conveyor belt and the clamper will be actuated until "reset" pushbutton is pressed.

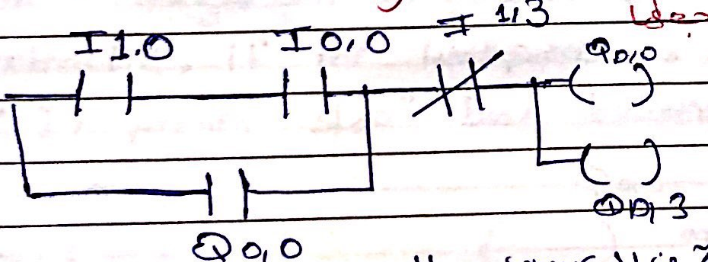
(series – sensor – sensor – sensor – بدنا الـ Latch)

① بدو احط الـ start والـ work piece لحتى يشتغلوا الـ conveyor belt والـ claper

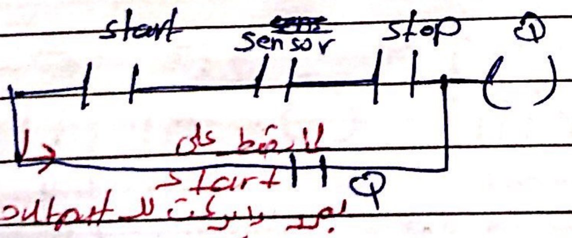
② بعدهم نظلهم شغالين لحتى اكبس على Reset.

بالعادة أغلب الـ address مرجحين على انهم normaly open إلا الـ stop.

③ اي كبسة بدي لما نطفي السستم احطها normaly close.



فعلاً إذا كبسنا start فرت القطعة عند الـ sensor والـ reset الموجودة بتضل اشتغلنا لما اكبسها بس لما أشيل اصبعي عن الـ start بطل يوصل شي للـ output فهون وظيفة الـ latch تشتغل.



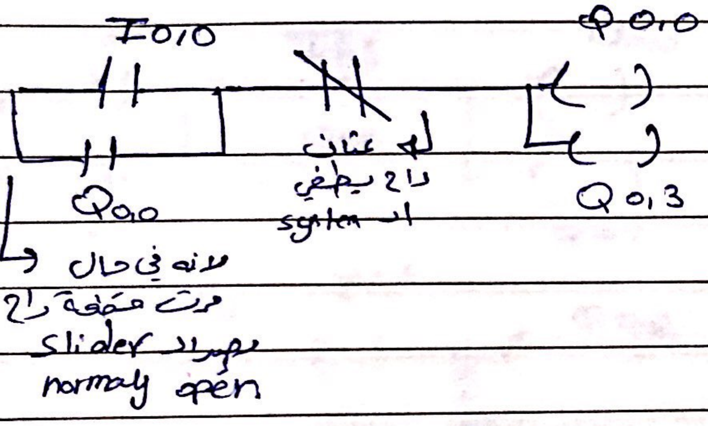
* في حالة الـ stop ←

هيك الـ stop بدنا نطفي الـ system بشكل يعني هي عكس الباقي.

بدنا احط الـ stop normall close.

Example 3.

IF a workpiece (sensor) is available at the start of the conveyor (sensor) belt. the conveyor is activated directly and the clamper (sensor) have retracted. Any time a workpiece has crossed a slider, everything turns off. → latch



① بحكيلي في حال كان ال workpiece شغال فراح يشغل ال conveyor وال clamper.

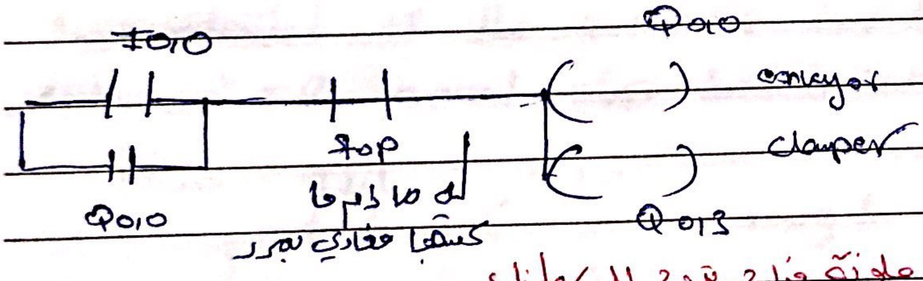
② بقلي ال system بضل شغال لحد ما اي قطعة تمر ال slider ، هون بصير latch.

Example 4.

IF a workpiece (sensor) is available at the start of the conveyorbelt (sensor), the conveyorbelt is activated directly and the clamper (sensor) have retracted, IF the workpiece is colored, goes to the first slider

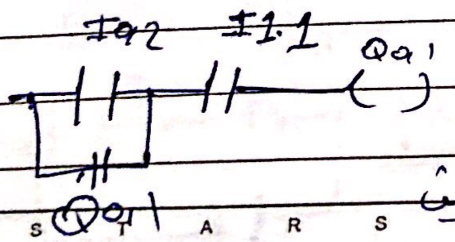
* IF pressed "stop" bush buttons every thing will be stopped.

Flipper = slider



لو بحكيلي اذا كانت القطعة ملونة فراح تروح لل slider

الالوان الموجودين بال plc مهم ال silver red black.



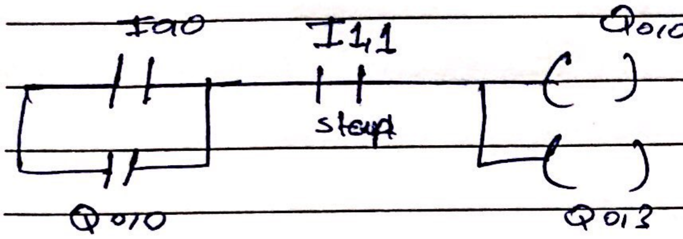
مرت قطعة باللون الاحمر فقلها بمرها بقيت close

او في حال مرت قطعة حدا فوق باجسقل بتعرش ال latch

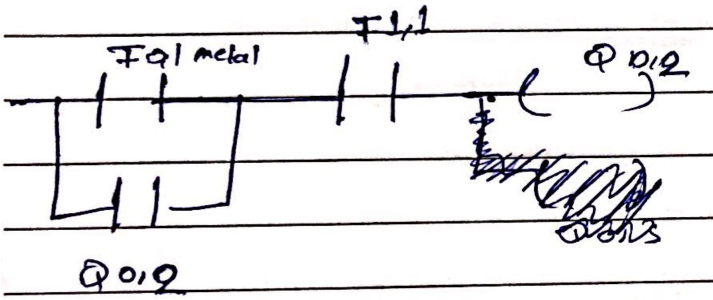
▸ Subject : .... / /

Example 5

If a workpiece (sensor) is available at the start of the conveyorbelt (sensor) the conveyor is actived directly and the clamper (sensor) have retracted. If the workpiece is metal it goes to second slider. Q0,2
"If presed stop" push button everything will be stoped"



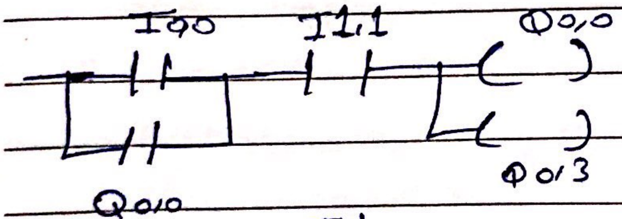
→ الشرط الاول



→ الشرط الثاني

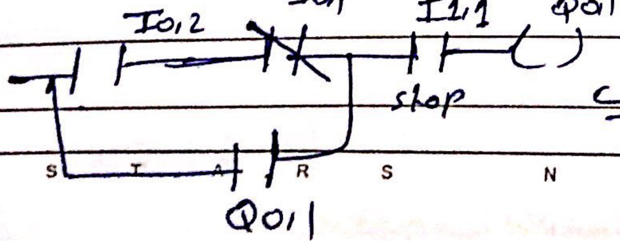
Example 6

if a workpiece (sensor) is available at the start of the convayor (sensor) belt, the convayor is activated directly and the clamper (sensor) have retrected. If the workpiece is red it goes to the first slider. "If pressed stop bush button everything will be stoped.



rung 1 — * هنا أنا بدي sensor ثاني
القطعة الحمرا لحال وما في غيرها

Two sensor



silver + red : بيوخذ اللون الـ I0,2
I0,1 بعبر الـ silver لحال بس انا بدي
هاد ليش حطيته normaly close

S T A R S N O T E B O O K

Scanned with CamScanner

Input and Output Addresses

Address	Description	Identity
I0.1	Work piece is metal (silver)	Inductive proximity sensor
I0.0	Work piece is available at the start of the conveyor belt	Diffuse sensor
I0.3	Work piece is falling at one of any of the 3 sliders	Retro reflective sensor
I0.2	Work piece is black=0 , Work piece is red or metal=1	Diffuse color sensor
I0.6	Second flipper is retracted	Inductive proximity sensor
I0.7	Second flipper is advanced	Inductive proximity sensor
I0.5	First flipper is advanced	Inductive proximity sensor
I0.4	First flipper is retracted	Inductive proximity sensor
Q0.2	Second flipper advances	Rotary cylinder
Q0.0	Conveyor belt	Permanent magnetic DC motor
Q0.1	First flipper advances	Rotary cylinder
Q0.3	Clamper retracts	Linear cylinder
I1.0	START	Push button
I1.1	STOP (normally closed)	Push button
I1.3	RESET	Push button