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Internal Assessment Test 1 – Sept. 2019

Sub:	Automation & Robotics			Sub Code:	17ME563	Branch:	Mech
Date:	9/9/19	Duration:	90 min's	Max Marks: 50	Sem / Sec:	V/A&B	OBE

	Answer ALL the Questions	MARKS	CO	RBT
1	Briefly describe the various elements of an automated system.	[10]	CO1	L2
	(Or)			
	Write short notes on i) Advanced automation functions ii) Continuous versus Discrete control	[5] [5]	CO1	L1
2	Using a block diagram, explain the working principle of analog to digital convertors	[10]	CO1	L2
	(Or)			
	Explain the functions of computer process control.	[10]	CO1	L2
3	What is an automated production line? Explain its various configurations.	[10]	CO2	L2
	(Or)			
	Explain the various types of automated assembly systems with a neat sketch.	[10]	CO2	L2

4.	Briefly explain the bar code technology.	[10]	CO2	L2
	(Or)			
	What do you mean by RFID? Explain the working principle.	[10]	CO2	L2
5.i)	Write short notes on storage buffers.	[10]	CO2	L2
ii)	List out the applications of automated production lines	[10]	CO2	L2
	(Or)			
	Write short notes on i) Components of AIDC and its classification ii) Advantages and limitations of RFID	[5] [5]	CO2	L2

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Answer Key

1a). Briefly describe the various elements of an automated system

An automated system consists of three basic elements:

(1) *power* to accomplish the process and operate the system.
(2) a *program of instructions* to direct the process, and
(3) a control system to actuate the instructions.

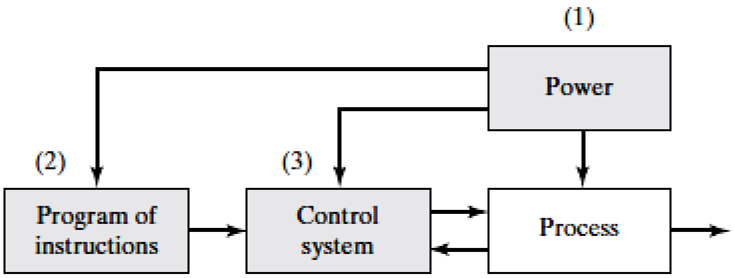

Figure 4.2 Elements of an automated system: (1) power, (2) program of instructions, and (3) control systems.

1. Power to accomplish the automated process

An automated system is used to operate some process, and power is required to drive the process as well as the controls. The principal source of power in automated systems is electricity. Electric power has many advantages in automated as well as non-automated processes.

In addition to driving the manufacturing process itself, power is also required for the following material handling functions:

- *Loading and unloading the work unit.* All of the processes listed in Table 4.1 are accomplished on discrete parts. These parts must be moved into the proper position and orientation for the process to be performed, and power is required for this transport and placement function. At the conclusion of the process, the work unit must be removed. If the process is completely automated, then some form of mechanized power is used. If the process is manually operated or semi automated, then human power may be used to position and locate the work unit.
- *Material transport between operations.* In addition to loading and unloading at a given operation, the work units must be moved between operations.

Power for Automation.

Above and beyond the basic power requirements for the manufacturing operation, additional power is required for automation. The additional power is used for the following functions:

- *Controller unit.* Modern industrial controllers are based on digital computers, which require electrical power to read the program of instructions, perform the control calculations, and execute the instructions by transmitting the proper commands to actuating devices.

- *Power to actuate the control signals.* The commands sent by the controller unit are carried out by means of electromechanical devices, such as switches and motors, called *actuators* The commands are generally transmitted by means of low-voltage control signals. To accomplish the commands, the actuators require more power, and so the control signals must be amplified to provide the proper power level for the actuating device.
- *Data acquisition and information processing.* In most control systems, data must be collected from the process and used as input to the control algorithms. In addition, for some processes, it is a legal requirement that records be kept of process performance and/or product quality. These data acquisition and record-keeping functions require power, although in modest amounts.

2. Program of instructions

The actions performed by an automated process are defined by a program of instructions. Whether the manufacturing operation involves low, medium, or high production, each part or product requires one or more processing steps that are unique to that part or product. These processing steps are performed during a work cycle. A new part is completed at the end of each work cycle (in some manufacturing operations, more than one part is produced during the work cycle: for example, a plastic injection molding operation may produce multiple parts each cycle using a multiple cavity mold). The particular processing steps for the work cycle are specified in a work cycle program, called *part programs* in numerical control.

3. Control System

The control element of the automated system executes the program of instructions. The control system causes the process to accomplish its defined function, which is to perform some manufacturing operation.

The controls in an automated system can be either closed loop or open loop. A ***closedloop control system***, also known as a *feedback control system*, is one in which the output variable is compared with an input parameter, and any difference between the two is used to drive the output into agreement with the input.

1b) Advanced Automation functions

Advanced automation functions include the following:

(1) safety monitoring,
(2) maintenance and repair diagnostics, and
(3) error detection and recovery.

Safety Monitoring

Safety monitoring in an automated system involves the use of sensors to track the system's operation and identify conditions and events that are unsafe or potentially unsafe. The safety monitoring system is programmed to respond to unsafe conditions in some appropriate way. Possible responses to various hazards include one or more of the following:

(1) completely stopping the automated system,
(2) sounding an alarm,
(3) reducing the operating speed of the process, and
(4) taking corrective actions to recover from the safety violation

The following list suggests some of the possible sensors and their applications for safety monitoring:

- ✓ Limit switches to detect proper positioning of a part in a workholding device so that the processing cycle can begin.
- ✓ Photoelectric sensors triggered by the interruption of a light beam; this could be used to indicate that a part is in the proper position or to detect the presence of a human intruder in the work cell.
- ✓ Temperature sensors to indicate that a metal work part is hot enough to proceed with a hot forging operation. If the work part is not sufficiently heated, then the metal's ductility might be too low, and the forging dies might be damaged during the operation.
- ✓ Heat or smoke detectors to sense fire hazards.
- ✓ Pressure-sensitive floor pads to detect human intruders in the work cell.
- ✓ Machine vision systems to perform surveillance of the automated system and its surroundings.

Maintenance and Repair diagnostics

Three modes of operation are typical of a modern maintenance and repair diagnostics subsystem:

1. *Status monitoring.* In the status monitoring mode, the diagnostic subsystem monitors and records the status of key sensors and parameters of the system during normal operation. On request, the diagnostics subsystem can display any of these values and provide an interpretation of current system status, perhaps warning of an imminent failure.

2. *Failure diagnostics.* The failure diagnostics mode is invoked when a malfunction or failure occurs. Its purpose is to interpret the current values of the monitored variables and to analyze the recorded values preceding the failure so that its cause can be identified.

3. *Recommendation of repair procedure.* In the third mode of operation, the subsystem recommends to the repair crew the steps that should be taken to effect repairs. Methods for developing the recommendations are sometimes based on the use of expert systems in which the collective judgments of many repair experts are pooled and incorporated into a computer program that uses artificial intelligence techniques.

Error detection and recovery

Error Detection. The error detection step uses the automated system's available sensors to determine when a deviation or malfunction has occurred, interpret the sensor signal(s), and classify the error. Design of the error detection subsystem must begin with a systematic enumeration of all possible errors that can occur during system operation. The errors in a manufacturing process tend to be very application-specific. They must be anticipated in advance in order to select sensors that will enable their detection.

Error Recovery. Error recovery is concerned with applying the necessary corrective action to overcome the error and bring the system back to normal operation. The problem of designing an error recovery system focuses on devising appropriate strategies and procedures that will either correct or compensate for the errors that can occur in the process.

1b)ii) Continuous versus Discrete control

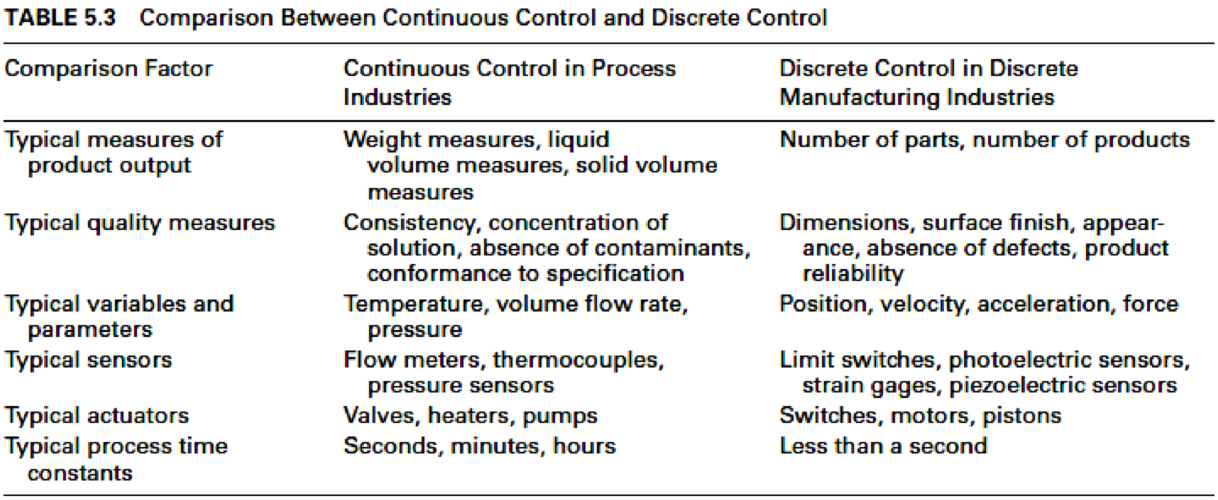

TABLE 5.3 Comparison Between Continuous Control and Discrete Control

Comparison Factor	Continuous Control in Process Industries	Discrete Control in Discrete Manufacturing Industries
Typical measures of product output	Weight measures, liquid volume measures, solid volume measures	Number of parts, number of products
Typical quality measures	Consistency, concentration of solution, absence of contaminants, conformance to specification	Dimensions, surface finish, appearance, absence of defects, product reliability
Typical variables and parameters	Temperature, volume flow rate, pressure	Position, velocity, acceleration, force
Typical sensors	Flow meters, thermocouples, pressure sensors	Limit switches, photoelectric sensors, strain gages, piezoelectric sensors
Typical actuators	Valves, heaters, pumps	Switches, motors, pistons
Typical process time constants	Seconds, minutes, hours	Less than a second

2.a) Using a block diagram, explain the working principle of analog to digital convertors

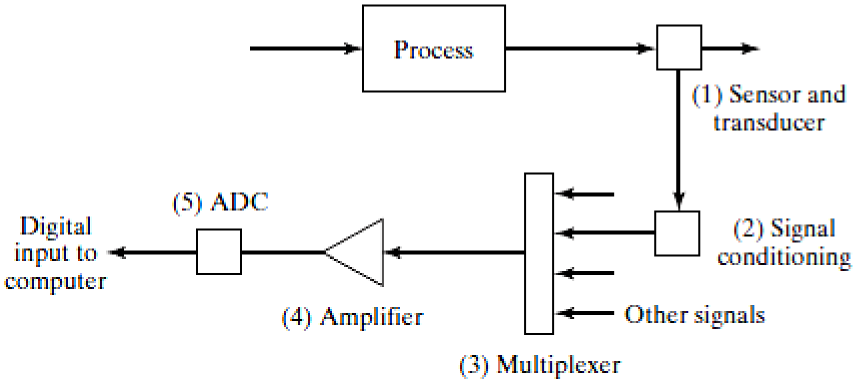

Figure 6.9 Steps in analog-to-digital conversion of continuous analog signals from process.

The procedure for converting an analog signal from the process into digital form typically consists of the following steps and hardware devices, as illustrated in Figure 6.9:

1. ***Sensor and transducer***. This is the measuring device that generates the analog signal

2. ***Signal conditioning***. The continuous analog signal from the transducer may require conditioning to render it into more suitable form. Common signal conditioning steps include (1) filtering to remove random noise and (2) conversion from one signal form to another, for example, converting a current into a voltage.

3. ***Multiplexer***. The multiplexer is a switching device connected in series with each input channel from the process; it is used to time-share the analog-to-digital converter (ADC) among the input channels. The alternative is to have a separate ADC for each input channel, which would be costly for a large application with many input channels. Because the process variables need only be sampled periodically, using a multiplexer provides a cost-effective alternative to dedicated ADCs for each channel.

4. ***Amplifier***. Amplifiers are used to scale the incoming signal up or down to be compatible with the range of the analog-to-digital converter.

5. ***Analog-to-digital converter***. As its name indicates, the function of the ADC is to convert the incoming analog signal into its digital counterpart.

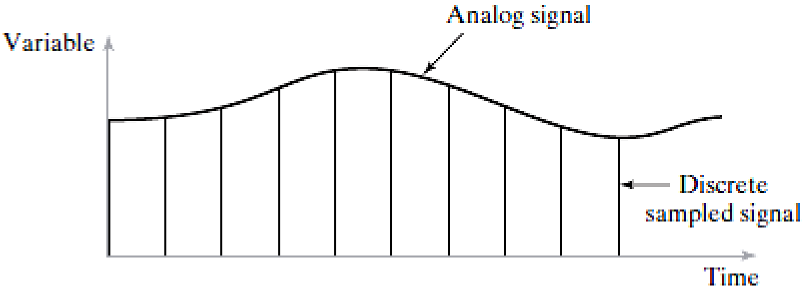

Figure 6.10 Analog signal converted into series of discrete sampled data by analog-to-digital converter.

Consider the operation of the ADC, which is the heart of the conversion process. Analog-to-digital conversion occurs in three steps: (1) sampling, (2) quantization, and (3) encoding. Sampling consists of converting the continuous signal into a series of discrete analog signals at periodic intervals, as shown in Figure 6.10. In quantization, each discrete analog signal is assigned to one of a finite number of previously defined amplitude levels. The amplitude levels are discrete values of voltage ranging over the full scale of the ADC

In the encoding step, the discrete amplitude levels obtained during quantization are converted into digital code, representing the amplitude level as a sequence of binary digits. In selecting an analog-to-digital converter for a given application, the following factors are relevant: (1) sampling rate, (2) conversion time, (3) resolution, and (4) conversion method.

The sampling rate is the rate at which the continuous analog signals are sampled or polled. A higher sampling rate means that the continuous waveform of the analog signal can be more closely approximated. When the incoming signals are multiplexed, the maximum possible sampling rate for each signal is the maximum sampling rate of the ADC divided by the number of channels that are processed through the multiplexer. For example, if the maximum sampling rate of the ADC is 1,000 samples/sec, and there are 10 input channels through the multiplexer, then the maximum sampling rate for each input line is 1,000>10 = 100 sample>sec. (This ignores time losses due to multiplexer switching.)

The maximum possible sampling rate of an ADC is limited by the ADC conversion time. Conversion time of an ADC is the time interval between the application of an incoming signal and the determination of the digital value by the quantization and encoding steps of the conversion procedure. Conversion time depends on (1) the type of conversion procedure used by the ADC and (2) the number of bits *n* used to define the converted digital value.

2b) Explain the functions of computer process control.

1. ***Process-initiated interrupts***. The controller must be able to respond to incoming signals from the process. Depending on the relative importance of the signals, the computer may need to interrupt execution of a current program to service a higher-priority need of the process. A process-initiated interrupt is often triggered by abnormal operating conditions, indicating that some corrective action must be taken promptly.

2. ***Timer-initiated actions***. The controller must be capable of executing certain actions at specified points in time. Timer-initiated actions can be generated at regular time intervals, ranging from very low values 1e.g., 100 ms2 to several minutes, or they can be generated at distinct points in time. Typical timer-initiated actions in process control include (1) scanning sensor values from the process at regular sampling intervals, (2) turning on and off switches, motors, and other binary devices associated with the process at discrete points in time during the work cycle, (3) displaying performance data on the operator's console at regular times during a production run, and (4) re-computing optimal process parameter values at specified times.

In addition to these basic requirements, the control computer must also deal with other types of interruptions and events. These include the following:

3. ***Computer commands to process***. In addition to receiving incoming signals from the process, the control computer must send control signals to the process to accomplish a corrective action. These output signals may actuate a certain hardware device or readjust a set point in a control loop.

4. ***System- and program-initiated events***. These are events related to the computer system itself. They are similar to the kinds of computer operations associated with business and engineering applications of computers. A system-initiated event involves communications among computers and peripheral devices linked together in a network. In these multiple computer networks, feedback signals, control commands, and other data must be transferred back and forth among the computers in the overall control of the process. A program-initiated event occurs when the program calls for some non-process-related action, such as the printing or display of reports on a printer or monitor. In process control, system- and program-initiated events generally occupy a low level of priority compared with process interrupts, commands to the process, and timer-initiated events.

5. ***Operator-initiated events*****.** Finally, the control computer must be able to accept input from operating personnel. Operator-initiated events include (1) entering new programs; (2) editing existing programs; (3) entering customer data, order number, or startup instructions for the next production run; (4) requesting process data; and (5) calling for emergency stops.

3.a) What is an automated production line? Explain its various configurations

(1) in-line, (2) segmented in-line, and (3) rotary.

The in-line configuration consists of a sequence of stations in a straight line arrangement, as in Figure. This configuration is common for machining big work pieces, such as automotive engine blocks, engine heads, and transmission cases. Because these parts require a large number of operations, a production line with many stations is needed. The in-line configuration can accommodate a large number of stations. In-line systems can also be designed with integrated storage buffers along the flow path

The segmented in-line configuration consists of two or more straight-line transfer sections, where the segments are usually perpendicular to each other. Figure shows several possible layouts of the segmented in-line category. There are a number of reasons for designing a production line in these configurations rather than in a pure straight line: (1) available floor space may limit the length of the line, (2) a workpiece in a segmented in-line configuration can be reoriented to present different surfaces for machining, and (3) the rectangular layout provides for swift return of work-holding fixtures to the front of the line for reuse.

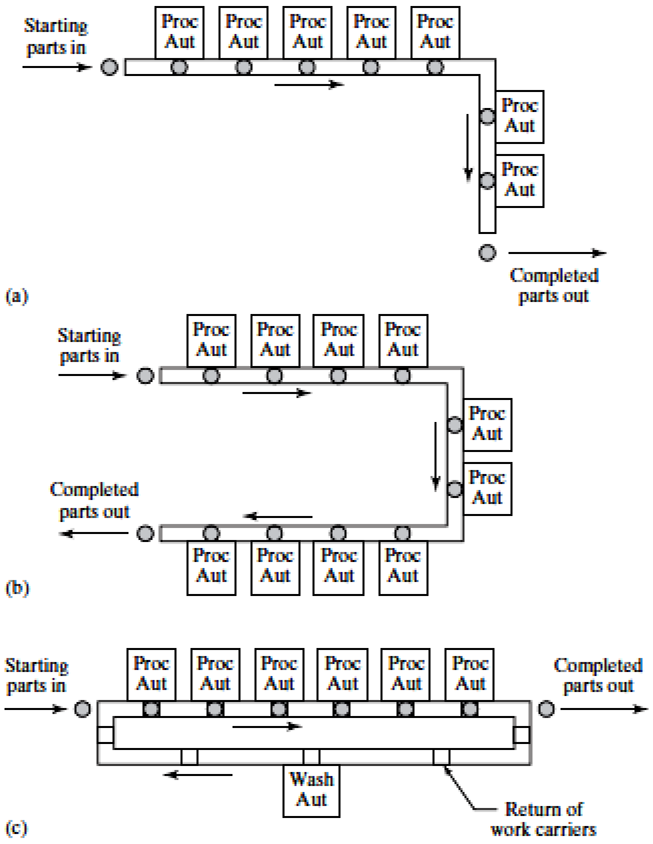

Figure 16.2 Several possible layouts of the segmented in-line configuration of an automated production line: (a) L-shaped, (b) U-shaped, and (c) rectangular. Key: Proc = processing operation, Aut = automated workstation, Wash = work carrier washing station.

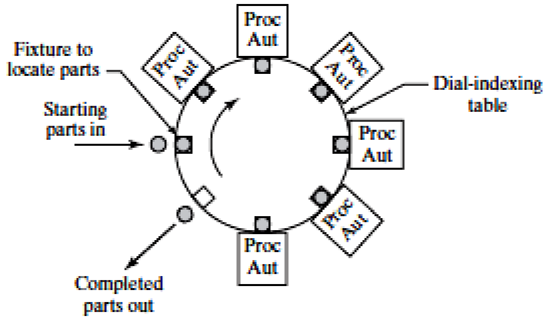

Figure 16.4 Rotary indexing machine (dial-indexing machine). Key: Proc = processing operation, Aut = automated workstation.

In the rotary configuration, the work parts are attached to fixtures around the periphery of a circular worktable, and the table is indexed (rotated in fixed angular amounts) to present the parts to workstations for processing. The worktable is often referred to as a dial, and the equipment is called a *dial-indexing machine*.

3.b) Explain the various types of automated assembly systems with a neat sketch.

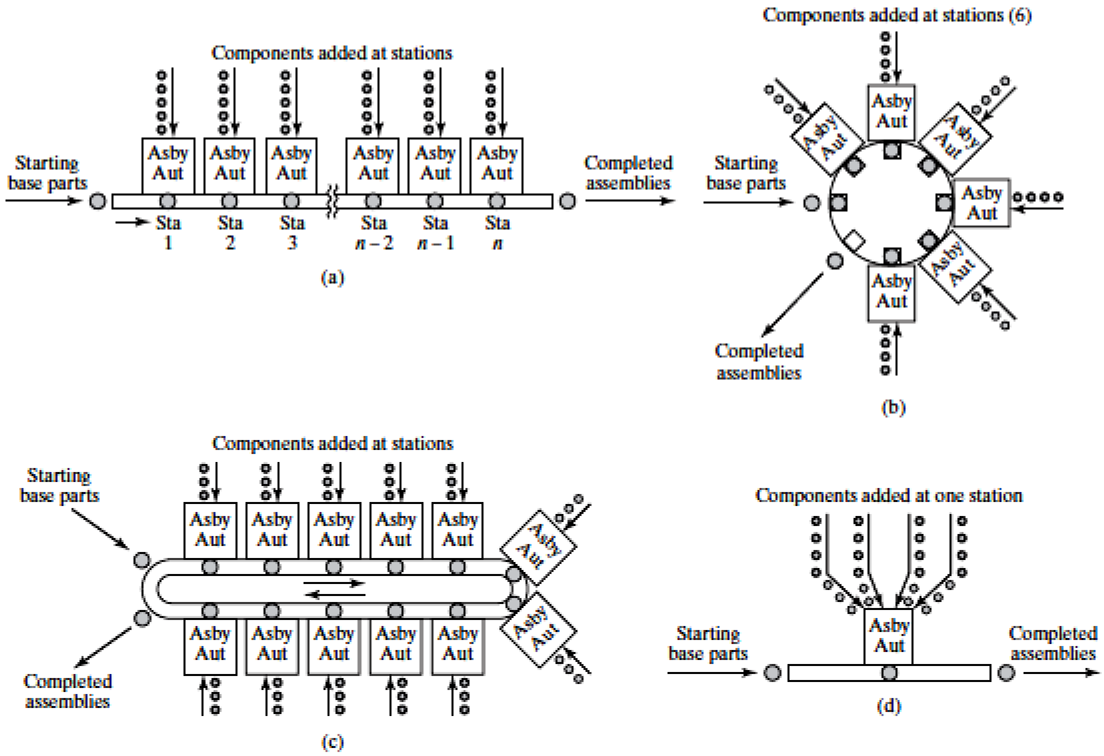

Figure 17.1 Types of automated assembly systems: (a) in-line, (b) dial-type, (c) carousel, and (d) single station.

Automated assembly systems can be classified according to physical configuration. The principal configurations, illustrated in Figure 17.1, are (a) in-line assembly machine, (b) dial-type assembly machine, (c) carousel assembly system, and (d) single-station assembly machine.

The in-line assembly machine, Figure 17.1(a), is a series of automatic workstations located along an in-line transfer system. It is the assembly version of the machining transfer line. Synchronous and asynchronous transfer systems are the common means of transporting base parts from station to station with the in-line configuration.

In the typical application of the dial-type machine, Figure 17.1(b), base parts are loaded onto fixtures or nests attached to the circular dial. Components are added and/or joined to the base part at the various workstations located around the periphery of the dial. The dial-indexing machine operates with a synchronous or intermittent motion, in which the cycle consists of the service time plus indexing time. Dial-type assembly machines are sometimes designed to use a continuous rather than intermittent motion. This is common in beverage bottling and canning plants, but not in mechanical and electronics assembly.

The carousel assembly system represents a hybrid between the circular work flow of the dial-type assembly machine and the straight work flow of the in-line system. The carousel configuration can be operated with continuous, synchronous, or asynchronous transfer mechanisms to move the work around the carousel.

In the single-station assembly machine, assembly operations are performed on a base part at a single location. The typical operating cycle involves the placement of the base part at a stationary position in the workstation, the addition of components to the base, and finally the removal of the completed assembly from the station. An important application of single-station assembly is the component placement machine, widely used in the electronics industry to populate components onto printed circuit boards.

4.a) Briefly explain the bar code technology

Noncontact bar code readers focus a light beam on the bar code, and a photo-detector reads the reflected signal to interpret the code. The reader probe is located a certain distance from the bar code (several inches to several feet) during the read procedure. Noncontact readers are classified as fixed beam and moving beam scanners. Fixed beam readers are stationary units that use a fixed beam of light. They are usually mounted beside a conveyor and depend on the movement of the bar code past the light beam for their operation. Applications of fixed beam bar code readers are typically in warehousing and material handling operations where large quantities of materials must be identified as they flow past the scanner on conveyors.

Bar code readers interpret the code by scanning and decoding the sequence of bars. The reader consists of the scanner and decoder. The scanner emits a beam of light that is swept past the bar code (either manually or automatically) and senses light reflections to distinguish between the bars and spaces. The light reflections are sensed by a photo detector, which converts the spaces into an electrical signal and the bars into absence of an electrical signal. The width of the bars and spaces is indicated by the duration of the corresponding signals.

Moving beam scanners use a highly focused beam of light, often a laser, actuated by a rotating mirror to traverse an angular sweep in search of the bar code on the object. A scan is defined as a single sweep of the light beam through the angular path. The high rotational speed of the mirror allows for very high scan rates—up to 1,440 scans/sec. This means that many scans of a single bar code can be made during a typical reading procedure, thus permitting verification of the reading. Moving beam scanners can be either stationary or portable units. Stationary scanners are located in a fixed position to read bar codes on objects as they move past on a conveyor or other material handling equipment. They are used in warehouses and distribution centers to automate the product identification and sortation operations.

4.b) What do you mean by RFID? Explain the working principle.

RADIO FREQUENCY IDENTIFICATION

In radio frequency identification, an identification tag or label containing electronically encoded data is attached to the subject item, which can be a part, product, or container (e.g., carton, tote pan, pallet). The identification tag consists of an integrated circuit chip and a small antenna, as pictured in Figure 12.8. These components are usually enclosed in a protective plastic container or are imbedded in an adhesive-backed label that is attached to item. The tag is designed to satisfy the Electronic Product Code (EPC) standard, which is the RFID counterpart to the Universal Product Code (UPC) used in bar codes. The tag communicates the encoded data by RF to a reader or interrogator as the item is brought into the reader's proximity. The reader can be portable or stationary. It decodes and confirms the RF signal before transmitting the associated data to a collection computer.

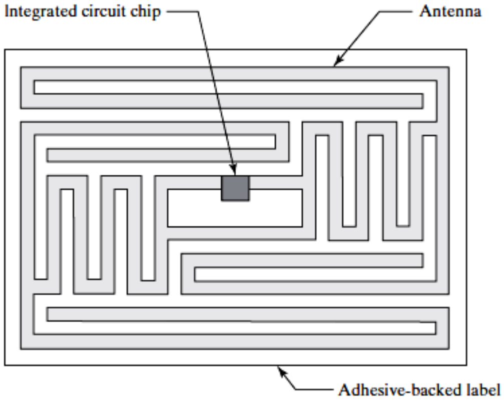

Figure 12.8 RFID label. Approximate size is 20 mm by 30 mm (0.8 in by 1.2 in).

5.a) i) Write short notes on storage buffers.

Automated production lines can be designed with storage buffers. A storage buffer is a location in the production line where parts can be collected and temporarily stored before proceeding to downstream workstations. The storage buffers can be manually operated or automated. When it is automated, a storage buffer consists of a mechanism to accept parts from the upstream workstation, a place to store the parts, and a mechanism to supply parts to the downstream station. A key parameter of a storage buffer is its storage capacity, that is, the number of work parts it can hold. Storage buffers may be located between every pair of adjacent stations, or between line stages containing multiple stations.

There are several reasons why storage buffers are used on automated production lines:

- To reduce the impact of station breakdowns. Storage buffers between stages on a production line permit one stage to continue operation while the other stage is down for repairs.
- To provide a bank of parts to supply the line. Parts can be collected into a storage unit and automatically fed to a downstream manufacturing system. This permits untended operation of the system between refills.
- To provide a place to put the output of the line.
- To allow for curing time or other process delay. A curing time is required for some processes such as painting or adhesive application. The storage buffer is designed to provide sufficient time for curing to occur before supplying the parts to the downstream station.
- To smooth cycle time variations. Although this is generally not an issue in an automated line, it is relevant in manual production lines, where cycle time variations are an inherent feature of human performance.

5.a. ii) List out the applications of automated production lines

Machining Systems

Many applications of machining transfer machines, both in-line and rotary configurations, are found in the automotive industry to produce engine and drive-train components. Machining operations commonly performed on transfer lines include milling, drilling, reaming, tapping, grinding, and similar rotational cutting tool operations.

Transfer Lines. In a transfer line, the workstations containing machining work heads are arranged in an in-line or segmented in-line configuration and the parts are moved between stations by transfer mechanisms such as the walking-beam system. The transfer line is the most highly automated and productive system in terms of the number of operations that can be performed to accommodate complex work geometries. It is also the most expensive of the systems discussed in this section. Machining type transfer lines are pictured in Figure 16.3. The transfer line can include a large number of workstations, but reliability of the system decreases as the number of stations is increased.

Rotary Transfer Machines: A rotary transfer machine consists of a horizontal circular worktable, upon which are fixtured the parts to be processed, and around whose periphery are located stationary work heads. The worktable is indexed to present each part to each work head to accomplish the sequence of machining operations. An example is shown in Figure 16.8. By comparison with a transfer line, the rotary indexing machine is limited to smaller, lighter work parts and fewer workstations.

5.b) i) Components of AIDC and its classification

1**.** ***Data encoder***. A ***code*** is a set of symbols or signals that usually represent alphanumeric characters. When data are encoded, the characters are translated into a machine-readable code. (For most AIDC techniques, the encoded data are not readable by humans.) A label or tag containing the encoded data is attached to the item that is to be identified.

2. ***Machine reader* or *scanner***. This device reads the encoded data, converting them to alternative form, usually an electrical analog signal.

3. ***Data decoder***. This component transforms the electrical signal into digital data and finally back into the original alphanumeric characters.

5.b) ii)Advantages and limitations of RFID

The principal applications of RFID in industry (in approximate descending order of frequency) are (1) inventory management, (2) supply chain management, (3) tracking systems, (4) warehouse control, (5) location identification, and (6) work-in process tracking.

Advantages of RFID include the following: (1) identification does not depend on physical contact or direct line of sight observation by the reader, (2) much more data can be contained in the identification tag than with most AIDC technologies, and (3) data in the read/write tags can be altered for historical usage purposes or reuse of the tag.