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V Semester Diploma Examination, December-2023

AUTOMATION & ROBOTICS

Time : 3 Hours]

[Max. Marks : 100

Instruction : Answer one full question from each section.

SECTION - I

1. (a) A semi-manual Biscuit Manufacturing Plant is modified to have automation included in the industry. Explain the importance of automation in industry and its benefits if implemented in the above Biscuit industry. 10
- (b) A Laptop manufacturing industry having permanent automation was not able to meet the demands of market supply due to slow production. Explain how the change over to programmable automation by the Laptop industry could improve its productivity. 10
2. (a) Justify why VFD has major role in conveyor control system and how it can be implemented in industries. 10
- (b) Illustrate the role of sensors to check the Quantity & Quality of any beverages filled in a bottle of a beverage manufacturing industry. 10

SECTION - II

3. (a) A person sees a car moving without a driver. What is the technology used ? Identify & explain the different types of sensors used in such cars. 10
- (b) In a leather manufacturing automation industry, the temperature and pressure of a boiler system has to be controlled to a certain pre-determined values. Explain how it can be achieved. 10
4. (a) In a milk processing industry, automation is implemented in milk storage and milk packaging system. Identify and explain the communication protocols used in it. 10
- (b) Explain how milk tank level and its flow is controlled between milk packaging process and milk stock container tank. 10



SECTION - III

5. (a) Discuss the importance of HMI and SCADA in any industry. 10
 (b) How would you test and analyse the functionality of Dam Shutter control system to meet exact operational specifications? 10
6. (a) Illustrate a system to automate the pumping and distribution of water supply in your department institution. 10
 (b) Compare :
 (i) PLC and Microcontroller
 (ii) PLC and PAC

SECTION - IV

7. (a) A Robot can be used for different applications to simplify the task of a human. Discuss the various parts and technical features of Robots used in different applications. 10
 (b) Illustrate a line following Robot to transport raw materials from stock yard to production line. 10
8. (a) Material handling was executed manually in a Warehouse for picking & placing the objects. Identify and explain suitable Robot to do the above work efficiently. 10
 (b) In current era, Robots are extensively used in the medical field. Identify & analyse the various applications of robots in medical field. 10

SECTION - V

9. (a) Discuss how Maze Solving Robot can be used in industrial applications and mention its advantages. 10
 (b) ROS plays a very important role in Robotics. Emphasize the need for ROS in development of Robot with examples. 10
10. (a) Discuss significance of Artificial Intelligence in Robotics. 10
 (b) Write a brief note on ROS and explain ROS communication tools. 10

SCHEME OF VALUATION
December 2023 Examination
Dept. of Electronics and Communication
AUTOMATION AND ROBOTICS – 20EC53I

Q. NO	DESCRIPTION	MARKS
1a	Automation factors with explanation(10m) Note: Listing of factors(3m)	5*2m=10m ✓
1b	Explanation on Programmable Automation+ any 5 benefits	5m+5m=10m
2a	Explanation on VFD+ Implementation explanation	5m+5m=10m
2b	Role of any 5 sensors with its working	5*2m=10m
3a	Identification of technology involved+ sensors used in this method with explanation	2m+(4*2m)=10m
3b	Block diagram+ Explanation	5m+5m=10m
4a	Explaining any 5 protocols Note: Listing of Protocols(2m)	5*2=10m
4b	Block diagram+ Explanation	4m+6m=10m
5a	Explanation about HMI & SCADA	5m+5m=10m
5b	Block diagram+ Explanation	4m+6m=10m
6a	Block diagram+ Explanation	5m+5m=10m
6b	Any 5 differences for each one.	5m+5m=10m
7a	Diagram with explanation+ various features with diagram	5m+5m=10m
7b	Block diagram+ Explanation	5m+5m=10m
8a	Block diagram+ Explanation	3m+7m=10m
8b	Any 5 applications with explanation	5m*2m=10m
9a	Explanation+ any 4 advantages	6m+4m=10m
9b	Any 5 important need with explanation	5m*2=10m
10a	Explanation of AI in Robotics	10m
10b	Note on ROS+ communication tools	5m+5m=10m

Section 1

I. a) A semi-manual Biscuit Manufacturing plant is modified to have automation included in the Industry. Explain the importance of automation in industry and its benefits if implemented in the above Biscuit Industry.

10marks

Industrial automation is the use of control devices such as Computers / PLCs (Programmable Logic Controller) / PACs (Programmable Automation Controller) etc. to control industrial processes and machinery by removing as much labour intervention as possible, and replacing dangerous assembly operations with automated ones.

Benefits of Automation in Industry

- 1. Reduction in cost:** Industrial automation helps improve productivity, quality and system performance, which in turn reduces the operating expenses or OPEX. However, the major advantage of an industrial automation system is the reduction in manufacturing costs. Instead of a floor full of workers, a few supervisors and key personnel, can ensure that the systems are running properly. Instead of a pile full of defective products or parts, a streamlined system can be designed to have very few, if any, defective products.
- 2. Increase in productivity :**These systems allow continuous mass production which can run 24/7. In simple words, automation systems will improve productivity because they never have to take a break, go home, or stop running. Another benefit of automation system running is that it free's up humans to do what they do best: The staff need not have to perform monotonous job, they have the room to be creative and productive at work.
- 3. Enhances quality:** By means of adaptive control and monitoring in different stages and industrial processes, these industrial automation systems are useful in eliminating human error, thus improving the quality of the products offered. If programmed correctly and without any external interruptions, automated system will behave exactly as intended until the program is changed or the system is turned off. Because there is very little, if any, room for human interference, the chance for error is removed.
- 4. Precise results :**Data automation is based on accurate data integration and connectivity. When accurate information is used in the production process, you will get precise results. All solutions helps to get detailed data that can be analyzed using data analytics tools to get accurate information to improve industrial processes.
- 5. Promotes industrial safety :**Another huge benefit of automation is improved safety in the workplace. Industrial automation keeps workers from going too close to the assembly lines, thereby enhancing the safety of the workers. Thermal sensors continually check the temperatures in the production area. In some cases, the thermal sensors can identify any spike in temperature and send an alert. Immediately after, certain precautions can be taken to ensure the safety of everyone on the production floor.

6. **Increase in human efficiency:** The systems that a company implements to automate their services will not only perform the tasks that a human being would do, but these automated systems are capable of performing functions that exceed the capabilities of a real person.
7. **Predictive maintenance:** A huge benefit of industrial automation is that it helps in monitoring and predictive maintenance. Production lines and the production floor can be continuously monitored using sensors. These sensors track temperature, acoustics, time, frequency, oil pressure, and other parameters related to the production process. If the sensors detect any change in these parameters, they will immediately send an alert. When the alert is received, the technicians can immediately identify the cause of the change. If it is noted that the changes in parameters may cause equipment problems or issues in the production process, then immediate service or repairs can be done. Automation can therefore help identify possible issues before they blow up into huge problems that can result in production downtime.

b] A Laptop manufacturing industry having permanent automation was not able to meet the demands of market supply due to slow production. Explain how the changeover to programmable automation by the Laptop industry could improve the productivity. 10M

Industrial automation is a system that allows manufacturing companies to increase productivity through computerized technologies. Programmable automation is one such automated manufacturing system designed to accommodate batch processes and facilitate changeover of products. Like any industrial automation process, programmable automation features production equipment toolled with computer-controlled devices that control and monitor a sequence of Industrial automation systems are systems designed to replace the repetitive and mechanical tasks associated with one person and decisions made by them in the manufacturing process. Intended to operate automatically to achieve output at a higher and consistent level, automated devices can be programmed to control processes, but also have the capability of making decisions during production processes.

Programmable automation utilizes an assortment of CNC (Computer Numerical Controlled) machine tools, industrial robotic applications and programmable logic controllers (PLC) that work in real time. Operational efficiency is accomplished through the application of logical programming commands with automation technologies that power equipment and machinery. As an automated process, programmable automation:

- Dramatically increases production and output
- Lowers associated costs
- Improves the work environment for employees by not only intellectually engaging them in production
- Removes humans from performing repetitive or hazardous tasks
- Greater accuracy, which makes them ideal for applications .
- Remote access, which allows for easier monitoring and troubleshooting .
- Data logging, which helps to reduce downtime and improve overall efficiency.

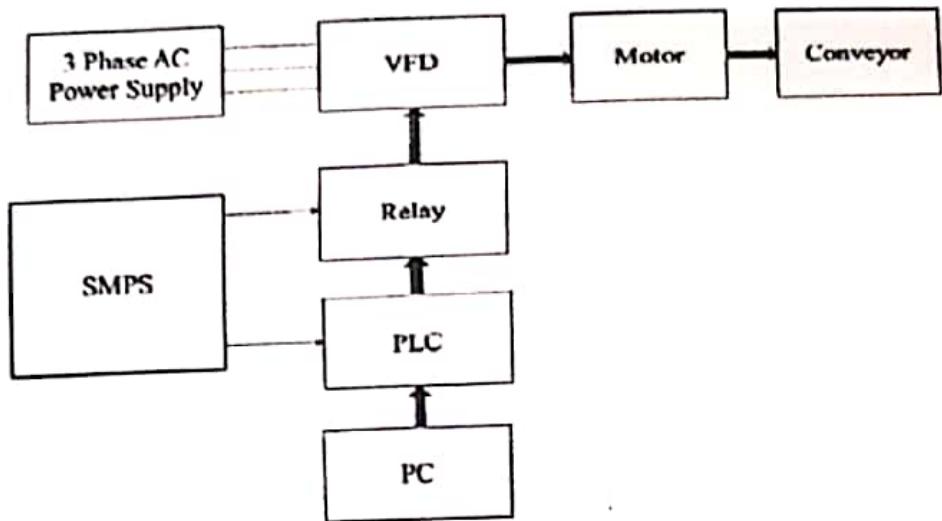
2. a] Justify why VFD has major role in conveyor control system and how it can be implemented in industries. 10marks

The present industrial world needs advancement in the field of technology to build better automation process. The Motion control of the systems is one common scenario needed in all the industries. Earlier Gear Boxes were used for control of machines and DC drives were mostly used for variation of speed in industries for small scale applications only. With the coming of AC Drives there is a major breakthrough in which motion control of large devices became comfortable. Conveyor is being greatly used in the Industrial processes. Hence control of conveyor is of paramount need along with the PLC and VFD leading to work automatically.

To incur an accurate controlling of a Conveyor, PLC ought to be interfaced with VFD Drive, Personal computer and other equipment. Relay that is a switching device decides the operation of VFD and Induction Motor. Variable frequency Drive (VFD) is being utilized in the industry that can provide a control on various motor parameters. It finds its application in the manufacturing process, machines, pumps, rolling mills etc. Thus, VFD when compared with other starting and control methods is proved to be a better alternative. VFD raises the productivity in terms of quality and product system efficiency thereby reducing the cost of operation of the system.

PLC sequentially scans the input devices then it will update its memory and finally indicate the status of its action in a PLC ladder logic. It exploits the output coil of it in order to change condition of device at the output side. Then interfacing of VFD to the conveyor through induction motor is exercised. By means of logic functions like Start, Reverse, Reset and Jog the automatic control conveyor motor is accomplished. When Start is on the first relay gets activated then the conveyor runs in forward direction. If Reverse action takes second relay runs, then the conveyor is in reverse direction. Reset operation is performed when there occurs error in execution then the conveyor doesn't run and simultaneously the third relay gets activated. The conveyor performs Jog operation when the Jog logic is being executed and fourth relay is in action. Four inputs to PLC is given by push buttons. By then the Outputs from PLC is fed to relays input. This will process inputs availing the logic given via ladder program. It will then initiate output to VFD which upon performing its operation send signals to the induction motor. Then, accordingly VFD control of speed and direction of the conveyor is caused. For the speed control of the Conveyor if the frequency of the induction motor which is connected to the conveyor then the speed of the conveyor can be easily regulated. The following formula clearly depicts this control action.

BLOCK DIAGRAM



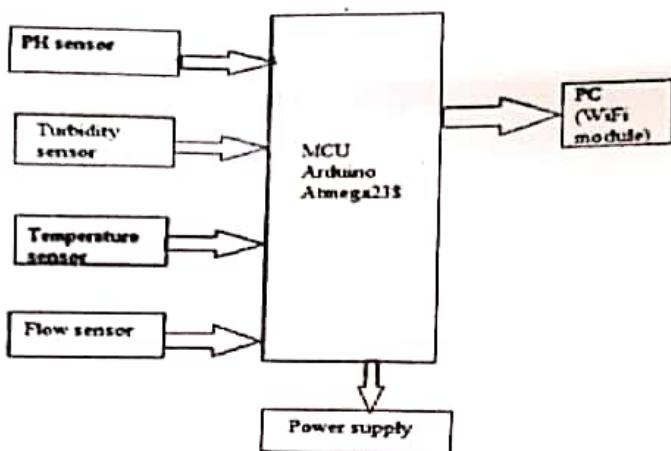
b] Illustrate the role of sensor to check the Quantity & Quality of any beverages filled in a bottle of a beverage manufacturing industry. 10marks

NOTE: Any beverage manufacturing industry can be considered

Water pollution is one of the biggest fears for the green globalization. In order to ensure the safe supply of the drinking water the quality needs to be monitor in real time. In this paper we present a design and development of a low cost system for real time monitoring of the water quality in IOT(internet of things). The system consist of several sensors is used to measuring physical and chemical parameters of the water. The measured values from the sensors can be processed by the core controller. The Arduino model can be used as a core controller. Finally, the sensor data can be viewed on internet using WI-FI system.

The water quality parameters pH measures the concentration of hydrogen ions. It shows the water is acidic or alkaline. Pure water has 7pH value, less than 7pH has acidic, more than 7pH has alkaline. The range of pH is 0-14 pH. For drinking purpose it should be 6.5-8.5pH. Turbidity measures the large number of suspended particles in water that is invisible. Higher the turbidity higher the risk of diarrhoea, collera. Lower the turbidity then the water is clean. Temperature sensor measures how the water is, hot or cold. Flow sensor measures the flow of water through flow sensor.

BLOCK DIAGRAM



This proposed block diagram consist of several sensors (temperature, pH, turbidity, flow) is connected to core controller. The core controller are accessing the sensor values and processing them to transfer the data through internet. Arduino is used as a core controller. The sensor data can be viewed on the internet wi-fi system.

pH sensor: The pH of a solution is the measure of the acidity or alkalinity of that solution. The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution. It operates on 5V power supply and it is easy to interface with arduino. The normal range of pH is 6 to 8.5.

Turbidity sensor: Turbidity is a measure of the cloudiness of water. Turbidity has indicated the degree at which the water loses its transparency. It is considered as a good measure of the quality of water. Turbidity blocks out the light needed by submerged aquatic vegetation. It also can raise surface water temperatures above normal because suspended particles near the surface facilitate the absorption of heat from sunlight.

Temperature sensor: Water Temperature indicates how water is hot or cold. The range of DS18B20 temperature sensor is -55 to +125 °C. This temperature sensor is digital type which gives accurate reading.

Flow sensor: Flow sensor is used to measure the flow of water through the flow sensor. This sensor basically consists of a plastic valve body, a rotor and a Hall Effect sensor. The pinwheel rotor rotates when water / liquid flows through the valve and its speed will be directly proportional to the flow rate.

Colour Sensor: are used in food and beverage industry. By using light beams to detect a specific object. A colour sensor can determine the presence and absence of the target material.

Section 2

3. a] A person sees a car moving without a driver. What is the technology used? Identify & explain the different types of sensors used in such cars. 10marks

Ans: Yes, which is Self-Driving Car or Driverless car, also called as Artificial Intelligence car. Self-driving cars rely on computers, sensor systems, algorithms, machine learning, and artificial intelligence to accurately perceive and safely navigate their environments. Self-driving Cars Use Sensors to Work Like people, self-driving cars

must sense their surroundings to safely navigate. People use senses like hearing, sight, taste, smell, and touch to interact with their environments. Autonomous car technology developers provision self-driving cars with high-tech sensor systems to sense analogously. The following are the different sensors used in Driverless car:

➤ Illuminating the world with LIDAR

LIDAR (light detection and ranging), also known as 3D laser scanning, is a tool that self-driving cars use to scan their environments with lasers. A typical LIDAR sensor pulses thousands of beams of infrared laser light into its surroundings and waits for the beams to reflect off environmental features. Many pulses create point clouds (sets of points representing 3D forms in space) of light.

Lidar systems measure the amount of time it takes to emit a laser signal and sense the same light beam reflected from a physical surface onto its photodetectors. Lidar uses the speed of light to calculate distances to objects. The longer it takes for a lidar photodetector to receive a return light signal, the farther away an object is.

➤ Reading the Environment with RADAR

RADAR (radio detection and ranging) is useful in many contexts such as weather forecasting, astronomy, communications, ocean navigation, military operations, and autonomous driving. Autonomous cars can emit radio waves in known directions with radar transmitters. Reflected waves that return to a car's radar receiver help the car derive information about environmental objects like the objects' angles, ranges, and velocities.

➤ Hearing with SONAR

Self-driving cars can use SONAR (sound navigation and ranging) to detect and communicate with objects, and to navigate. Sonar can be passive or active. Passive sonar systems passively listen for sounds made by nearby objects. Active sonar systems emit sound pulses and read echoes returned from physical surfaces. Self-driving cars can use sonar to detect large objects made of solid materials (e.g. metal, ceramic) at short distances. Sonar sensors don't require light to operate. However, sonar sensors are constrained by the speed of sound.

➤ Capturing Images with Cameras

Autonomous vehicles can visualize their environments with high-resolution digital camera images. Self-driving cars can use camera images to "see" and interpret environmental details (e.g. signs, traffic lights, animals) in ways that approximate human vision (aka computer vision). Self-driving cars can use many types of input data for computer vision.

Examples include:

- Multi-dimensional data from 3D scanning devices
- Video segments
- Camera images captured from different viewing angles

b] In a leather manufacturing automation industry, the temperature and pressure of a boiler system has to be controlled to a certain pre-determined values. Explain how it can be achieved.

10marks

Boiler automation is getting to be mainstream because of its various advantages in industry as the quantity of mishances occurs in the business are expanded in incredible degree. These mishaps are principally caused because of framework or apparatus disappointment or because of sporadic unreliable checking and controlling of the boiler framework. Such mishances winds up Hazardous for human life working with that condition. Today such mishances occurred because of framework blunder we need to control the framework parameter consequently. The framework proposed in this paper gives propel answer for the checking and controlling of the mechanical Industrial Boiler parameter from any place.

Block diagram :



Methodology

Step 1 : read the sensor values, temperature value, pressure value, water level

Step 2: first check water level of the boiler before turning it ON

Step 3: if water level is good then turns on HEATER SYSTEM

Step 4: monitor the Temperature and Pressure value

Step 5: if Temperature <= threshold value

Step 6: if pressure <= threshold value

Step 7: boiler is in good condition until Step 5 and Step 6 are true

Step 8: if any one condition is set to fail the boiler temperature is reduced by controlling the heater or it will be turned off.

Temperature Sensor:

LM35DZ is the temperature sensor from National Semiconductor. This sensor yield voltage is straightly corresponding to the Celsius. Temperature runs between - 55 Degree Celsius to and 150 Degree Celsius and the precision is about +2.0 Degree Celsius and yield scale 10mV/C.

Pressure sensor:

The pressure sensor converts pressure of gases or liquid into electrical magnitude with the pressure sensing element, and generates the analog output proportional to applied pressure level or the switching output toggled at the set pressure value, pressure range 0 to 16 bar, output value 0 to 5v.

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Themed Section: Science and Technology

Design and Implementation of Arduino Based Industrial Boiler Automation

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4. a] In a milk processing industry, automation is implemented in milk storage and milk packing system. Identify and explain the communication protocols used in it. 10

1. The Communication protocols is the way to trans-receive the data with a set of rules that sends or receives between two or more devices. The communication protocol is the media or channel between two or more communicating devices. By using the communication protocols, two devices can connect and communicate with each other. Without communication protocol, devices can only be connected but not communicated.

2. The communication protocols not only being to used expand the PLC network and also its used to expand number of IO devices by connecting additional modules (Expansion modules).

3. Most commonly used protocols with milk processing industry are:

- Modbus RTU .
- EtherNet/IP and Ethernet TCP/IP
- Modbus TCP/IP
- Profibus
- Profinet

* Modbus RTU: Modbus RTU is an open serial protocol derived from the Master/Slave architecture. It is a widely accepted serial level protocol due to its ease of use and reliability. Modbus RTU is widely used within Industrial Automation Systems (IAS), Home Automation, Building Management, Robotics etc. This protocol primarily uses an RS-232 or RS-485 serial interfaces for communications and is supported by almost every commercial SCADA, HMI, OPC Server and data acquisition software program in the marketplace.

- ❖ EtherNet/IP and Ethernet TCP/IP :
 - EtherNet/IP is an open application protocol, maintained and distributed by ODVA. It is used by Ethernet modules for several PLC's including Allen Bradley, Schneider Electric and Omron.
 - EtherNet/IP is an Ethernet adaptation of the Control Information Protocol (CIP) in the same way that DeviceNet is a CAN adaptation of CIP and ControlNet is a CT DMA adaptation of CIP.
 - EtherNet/IP I/O provides a mechanism of deterministically sending data in both directions between a PLC and remote device. This data is sent on an interval called the Requested Packet Interval (RPI).
 - EtherNet/IP I/O is a very fast and easy-to-use method of communication. It reduces the amount of ladder logic required for communication, and communication occurs even when the PLC is in Program mode.
 - Ethernet TCP/IP is responsible for the transmission of the packets, which are composed of Modbus frames containing commands to read/write into the shared memory of a device.
- ❖ Modbus TCP/IP: Modbus TCP/IP is a simple Modbus protocol running on Ethernet over a TCP interface. Modbus is an application protocol that assigns the ways of managing and passing data between various layers without being affected by the protocol used by the next immediate layer.
- ❖ Profibus :
 - Profibus as process field bus, is a standard for fieldbus communication in automation technology, which is extensively used by Siemens.
 - Profibus communicates via a serial protocol behind which a complex machinery is housed to transport the data reliably through an industrial environment.
 - The Profibus protocol is designed for high-speed communications with distributed I/O devices (remote I/O).
 - Profibus connection port look like DB-9 serial connector but protocol is totally different Profinet.

Profinet

- It is process field net, is an Ethernet-based communication protocol. The physical interface used for Profinet is a standard RJ-45 Ethernet jack.
- Profinet cables are easily recognizable by their green color.
- Due to its high-speed operation and a response time of less than 1 millisecond, Profinet is ideal for high-speed applications.

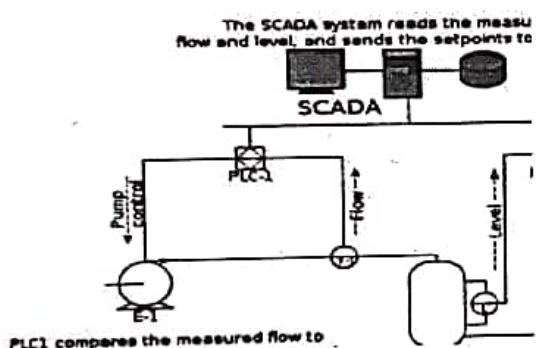
4. b] Explain how milk tank level and its flow is controlled between milk packaging process and milk stock container tank.

10marks

5. a] Discuss the importance of HMI and SCADA in any industry. 10

A large number of processes occur in large industrial establishments. Every process, you need to monitor is very complex because each machine gives the different output. The SCADA system used to gather data from sensors and instruments located in remote areas. The computer then processes this data and presents it promptly. The SCADA system gathers the information (like a leak on a pipeline occurred) and transfers the information back to the system while giving the alerts that leakage has occurred and displays the information in a logical and organized fashion. The SCADA system used to run on DOS and UNIX operating systems. This entire process is known as automation. SCADA stands for supervisory control and data acquisition. It is a type of software application program for process control. SCADA is a central control system that consists of controllers network interfaces, input/output, communication equipment, and software. SCADA systems are used to monitor and control the equipment in the industrial process

which includes manufacturing, production, development, and fabrication. The infrastructural processes include gas and oil distribution, electrical power, water distribution. Public utilities include a bus traffic system, airport. The SCADA system takes the reading of the meters and checks the status of sensors in regular intervals so that it requires minimal interference of humans.



The SCADA system performs the following functions

- Data Acquisitions
- Data Communication
- Information/Data presentation
- Monitoring/Control

These functions are performed by sensors, RTUs, controllers, a communication network. The sensors are used to collect the important information and RTUs are used to send this information to the controller and display the status of the system. According to the status of the system, the user can give the command to other system components. This operation is done by the communication network.

OR

Ans: 5 ways SCADA & HMI can Improve food processing industry. Automation of food and beverage manufacturing processes provides manufacturers with valueadding advantages along the entire supply chain, all the way

from the field, through the factory to the end user. SCADA is one automation solution that can improve production efficiency and increase profitability. Here, we look at five areas of food and beverage manufacturing that benefit from SCADA. SCADA uses real-time data from process devices to monitor and control equipment, this improves production efficiency, visibility and increases profitability in food processing industries.



1. Packaging

Packaging in food and beverage manufacturing operations are made up of various machines with differing functions, including cartoning, wrapping, labelling, shrinking, sealing, case and tray forming, capping, cleaning and sterilising, as well as inspection and detecting machines. SCADA can improve packing operations in a number of ways including:

- **Better alarming capabilities:** Better diagnostic and alarming capabilities can help reduce downtime and product waste. SCADA can help monitor packaging machines and send alarms to Human Machine Interface (HMI) devices when set parameters have been exceeded.
- **Predictive and preventative maintenance:** Unexpected downtime for food and beverage manufacturers can be costly, so having predictive and preventative maintenance capabilities mitigates these risks. SCADA systems can collect real-time performance data of all machines in operation, this allows informed decisions to be made about when maintenance should be performed or scheduled.
- **Improved integration:** Production requirements can change quickly in the food and beverage manufacturing industry, so having system flexibility is desirable for an efficient and scalable operation. SCADA can provide integration flexibility with disparate hardware and systems along with keeping the system or products updated if changes within the industry or company are required.
- **Traceability:** High food safety standards require manufacturers to trace products throughout the entire packaging process. SCADA automatically collects real-time data and collates it in one central system, allowing manufacturers to link a particular product to a shipment of ingredients, its associated packaging line or even where it was distributed.

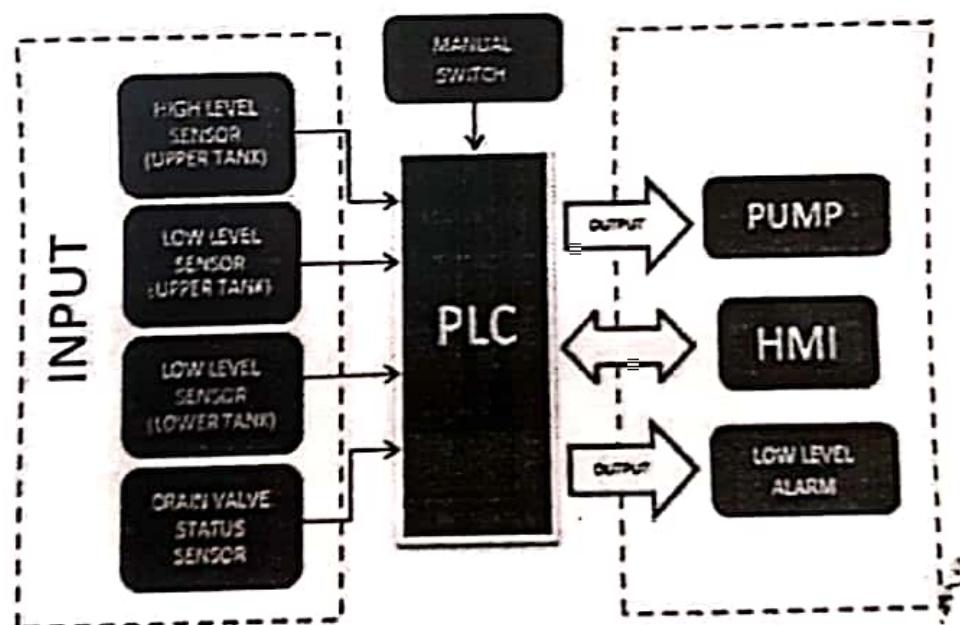
2. Recipe re-creation

Milk level management using PLC is designed to control the level of milk and avoid wastage of milk in the tank. The system has an automatic pumping system attached to it. We are controlling the milk level by using PLC, Sensors and motor. The purpose for doing this project is reducing time consumption and human resource consumption, increase product revenue and greater accessibility or more security. Also by using this project the wastage of milk occurred by overflowing of tanks can be avoided. In future by making some changes this project can be used in different industries related to fluids like petroleum industries or oil refineries for controlling the level of filling the tanks and avoid wastage.

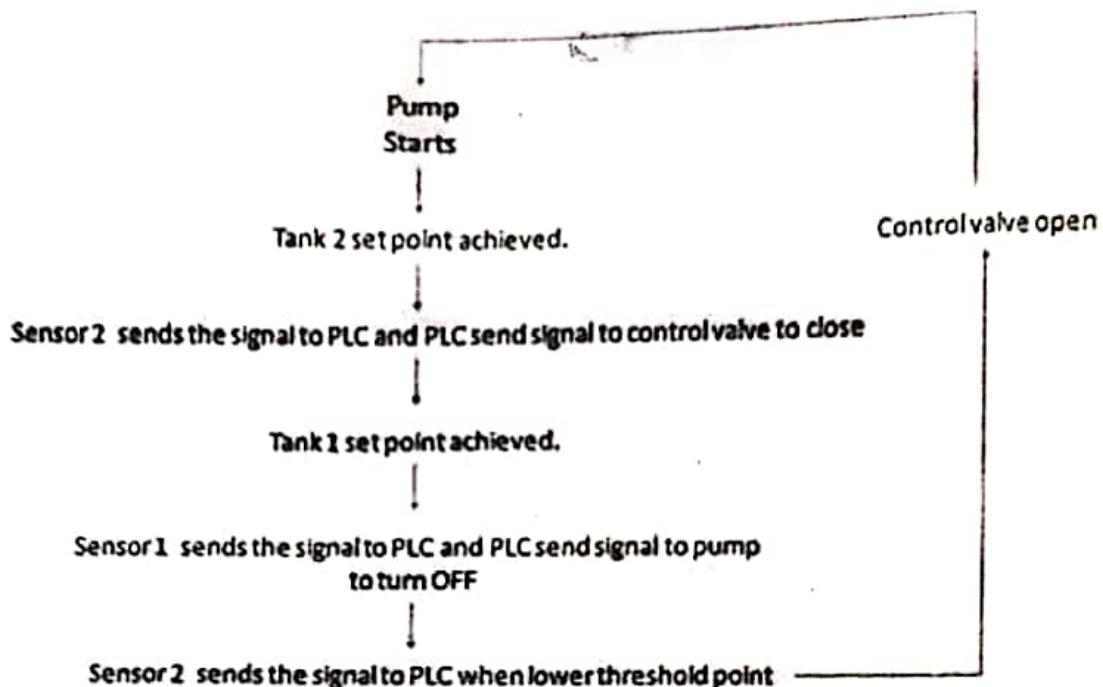
A Programmable Logic Controller, PLC or Programmable Controller may be a computer used for automation of mechanical device processes. It is used to convert previously used "Relay Logic" or "Wired Logic" for automation of industrial purposes into "Ladder Logic".

The system has an automatic pumping system hooked up thereto thus on refill the tank once the liquid gets to the lower threshold, while offing the pump once the liquid gets to the higher threshold.

The proposed system will control the liquid level of the tank continuously and will ensure that a sufficient level of milk is maintained in tanks.



Block diagram represents the idea of processes that takes place when input is given by using ladder logic to the PLC. Level sensors are used as input to the PLC and according to that reading the PLC will give output by using pump and solenoid valves.



When we switch ON the power supply, pump will start pumping the milk in tank 2 through tank 1 and control valve (CV). When upper threshold of tank 2 is achieved then sensor 2 will sense the milk level of tank 2. S2 will send the signal to the PLC about upper threshold of tank 2. Now, PLC will send the analog signal to the control valve (CV) to interrupt the liquid flow. Then milk will fill the tank 1. When upper threshold of tank 1 is achieved then sensor 1 will sense the milk level of tank 1. S1 will send the signal to the PLC about upper threshold of tank 1. PLC will send the analog signal to the pump. Pump will stop pumping milk to tank. When milk from tank 2 is drained out sensor 2 will sense the lower threshold of milk level in tank 2. S2 will send the signal to the PLC about lower threshold of tank 2. PLC will send the analog signal to the control valve (CV) to let the liquid from tank 1 flow in tank 2. When lower threshold of tank 1 is achieved then sensor 1 will sense the milk level of tank 1. S1 will send the signal to the PLC about lower threshold of tank 1. PLC will send the analog signal to the pump. Pump will start pumping milk to tank. This operation will take place continuously and required result is obtained .

Source Research paper:



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Research Article



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Water Tank Level Controller by using PLC

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SCADA can be used to create user-defined recipes within the system automatically, this removes the need for manual supervision each time a new product batch starts production, it also guarantees a high-quality and consistent product by monitoring recipes. These recipes can also be imported or exported along with real-time data, so provides many options for data gathering and reporting. The increased control over food and beverage production has several benefits for manufacturers, including:

- Eliminating errors when entering step times for every recipe
- Removes the need for traditional pen and paper systems of maintaining recipes
- Automatic update of temperature set points rather than manual adjustment
- Simplified operator control
- Monitoring allows problems to be detected and corrected before any faulty product is distributed

3. Maintaining quality standards

Food and beverage manufacturers need to be able to meet the various standards that are applicable in the countries they operate in. The use of ingredients, processing aids, colourings, additives, vitamins and minerals, and the composition of some foods, as well as some labelling requirements for packaged and unpackaged food. SCADA can trace products through the packaging process in real time, it can also be used to track a food or beverage product throughout the entire production, process and distribution chain.

4. Greater visualization of production

SCADA can be used to get greater visualization on the status of production by tracking the realtime status of machines and its components. This information can be used to find trends and patterns, as well as for logging comparisons. Manufacturers can compare this data across their chosen timeframes - from minutes, to hours, and days - and use it to get a quick understanding of how a machine or its components are running, and identify when there is a problem or when maintenance needs to be performed.

5. Creation of reports

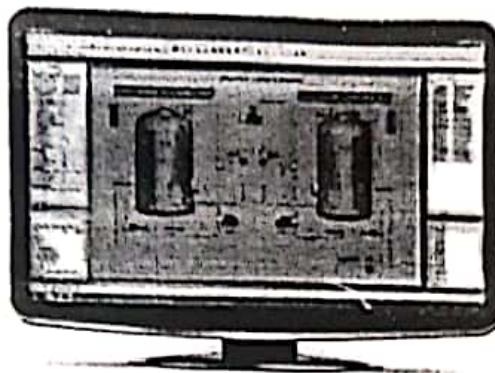
SCADA can also create reports, enabling manufacturers to identify, analyse and improve various processes within the organization. These reports can help identify bottlenecks, analyse production downtime causes, calculate key performance indicators and report the relevant information in a clear and concise format to the appropriate people allowing them to make the correct decisions at the right time.

Reference 0 <https://www.automationit.com/blog/73-5-ways-scada-can-improve-food-andbeverage-manufacturing>

Human Machine Interface

The SCADA system uses the human-machine interface. The information is displayed and monitored to be processed by a human. HMI provides access to multiple control units which can be PLCs and RTUs. The HMI provides the graphical presentation of the system. The Human-Machine Interface (HMI) provides an important visual of what is going on inside the control system. It is also an easy way to see multiple events in

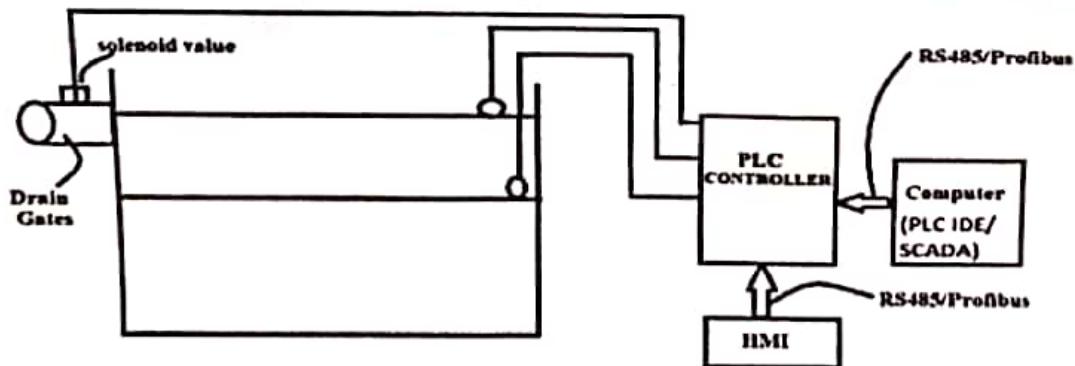
real time. It is mainly providing better safety to operator, increase productivity and create troubleshooting easier. For example, it provides a graphical picture of the pump connected to the tank. The user can see the flow of the water and the pressure of the water. The important part of the HMI is an alarm system that is activated according to the predefined values



5. b] How would you Test and Analyse the functionality of Dam shutter control system to meet exact operational specifications?

10marks

The ability to quickly and safely perform reservoir drawdown can be crucial to the protection and preservation of a dam. A reservoir low level outlet works and/or drain system with adequate capacity should be provided in all dams to provide a method of lowering the reservoir level in an emergency within a reasonable period. In several instances, dam failures have been averted by lowering the reservoir in response to emergency conditions detected at dams. "PLC based Automatic Dam Shutter Control System" will overcome the failures that occur in manual control system. It will manage the water level of the water reservoir automatically. At two different level, water is sensed according to which the gate is closed or open. That is when the water level goes above the threshold mark point level, door opens and it raises buzzer (or siren or GSM signal to a mobile phone) and the solenoid valve opens. When the water level goes down the door shuts automatically.



The PLC integrated development environment allows us to monitor the status of the field devices while the application is running. The working can be tested before, during and after installation.

Before installing, the ladder logic functioning can be tested using simulator software in the PLC IDE.

During installation, the sensors working can be tested without connecting the field devices (solennoid controlled gates). The change in sensor state will reflect in 'Data file window' of the PLC IDE tool. The proper actuation of the output devices according to the sensor values can be analyzed in the same window.

After installation, the real time working can also be tested using PLC IDE. As the water inflow to the dam changes, it is reflected through the sensors. As these sensors are connected to the input modules of PLC, the status of corresponding inputs can be seen in the IDE. When the water level change is not reflected in 'Data file window' of PLC IDE, the corresponding connections/PLC Input module/Processor Module has to be trouble shoted.

When the sensor data is reflected properly, the actuators working has to be monitored. Based on the sensors, actuator status has to change. This can be seen in the IDE tool. The status of the output port is Proper, then only the field devices has to be checked.

Networking protocols used

PLC and computers communicate using Profibus or RS485 communication protocols. Network Protocols are a set of guidelines governing the exchange of information in a simple, dependable and secure way.

Serial communication is the basic communication system provided for every controller such as a PLC. This communication is implemented by using protocol standards such as RS232, RS422 and RS485. The acronym RS stands for Recommended Standard which specifies serial communication characteristics in terms of electrical, mechanical and functional features.

Serial communication interfaces are either built into the CPU or process module (consider, for a Programmable Logic Controller) or it can be a separate communication module. These RS interfaces are mainly used to transfer the data reasonably at high data rate between a PLC and the remote device.

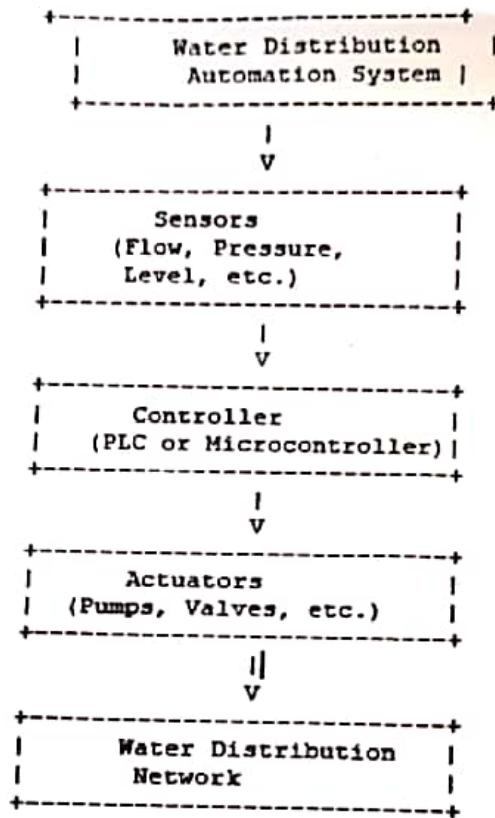
Profibus It is one of the well known and widely implemented open-field networks. These networks are mainly used in process automation and factory automation fields. It is most suitable for complex communication tasks and time-critical applications such as Dam shutter control system. There are three different versions of Profibus namely, Profibus-DP (Decentralized Periphery), Profibus-PA (Process Automation) and Profibus-FMS (Fieldbus Message Specification)

Mostly PLC communication is done by the serial transmission of information, PLC's can be connected by using data cables (Ethernet, shielded pair, or coaxial) by using the data cables we can connect two PLC's. This data cable will be very useful to do the connection between the PLC and the RTU, HMI's, meters, and protective relays. By this data transmission can be achieved, the data could be either analog or discreet.

The real time working of Dam shutter control system can also be tested and analyzed using HMI and SCADA interfaces. The network protocols for communication between computer (SCADA) and HMI can be either Profibus /Serial communication.

6. a] Illustrate a system to automate the pumping and distribution of water supply in your department/institution.

10



Flow Diagram:

1. Sensors Specification:

- **Flow Sensor:** Measures the flow rate of water.
- **Pressure Sensor:** Monitors water pressure within the distribution system.
- **Level Sensor:** Tracks the water level in tanks or reservoirs.
- **Temperature Sensor (optional):** Measures water temperature for control purposes.

2. Automation Process:

○ **Sensors Monitoring:**

Sensors continuously monitor flow, pressure, level, and other parameters.

○ **Controller Logic:**

PLC or microcontroller processes sensor data and makes decisions based on predefined logic and set parameters.

Decision-making includes turning pumps on/off, adjusting valve positions, and managing water flow based on demand or preset conditions.

- o **Actuators Control:**

Actuators such as pumps and valves are controlled by the controller based on the input received from sensors and the programmed logic.

Pumps are activated/deactivated based on water demand and system requirements.

Valves are adjusted to direct water flow to different areas of the institution as needed.

3. Water Distribution:

- o **Distribution Network:**

Water is pumped through pipes to different areas of the institution.

Valves direct the flow to specific zones or sections based on requirements.

4. Safety and Monitoring:

- o **Alarm Systems:**

Incorporate alarms for critical situations like excessive pressure, low water levels, or system failures.

- o **Remote Monitoring (Optional):**

Implement remote monitoring capabilities to track system performance, detect faults, and make adjustments from a central control room or through a remote interface.

This system ensures efficient water management by automating the pumping and distribution process based on real-time data from sensors and predefined control logic. It optimizes water usage, maintains adequate pressure, and ensures reliable distribution throughout the institution while enabling monitoring and control for enhanced efficiency and safety.

OR

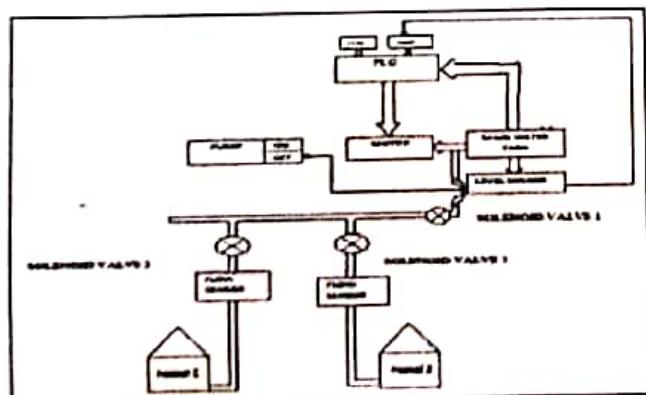


Fig.1 Block Diagram[6]

Pumping section is connected to PLC. If the water level goes below the set point the pump will automatically turn ON. Checking the level in storage tank is the first process. If the level attains the set point, overall system is started. The water is flow through the pump when the main solenoid valve opens. The flow rate is measured with the help of pulse output from the flow sensor .

The people can get water until the set point is reached. Once the water usage attains solenoid valve is automatically close. Once the main solenoid valve gets opened, the water flow through the pump. The water level in the storage tank gets decreased. We can measure the water level using the sensor attached to the storage tank. When the water decreased below 80% the pump is on.

Solenoid valve is a two port valve. It will be used to turn on and off condition. In this system three solenoid valves are used. 24V supply is given to the main solenoid valve. PLC output is connected to the solenoid valve. The output from the PLC in the range of 24V DC. So it is necessary to give switch function on and off the solenoid valve. If the water level in the storage tank is reached the 80%, main solenoid valve is automatically turned on. The set point is fixed for solenoid valve. If anyone one of its valve or both the valve attains the set point the solenoid valve is turned off. (Shown in Fig.4) normally closed solenoid valve is used to control the flow rate

Flow sensor is used to measure the flow rate of the water. Flow sensor contains pin wheel in its. Pinwheel contains 6 teeth. The pulse output is comes from the pin wheel sensor. If the teeth rotate at one time, it will give the pulse output according to the specification of the flow sensor. From the pulse output easily measure the amount of water passed through the pipe. The pulse is converted to voltage with the help of Hall Effect sensor. Flow sensor output is in the range of 5V DC. So it is necessary to give signal conditioning. Optocoupler is used to amplifying signal.

b] Compare:

(i) PLC and Microcontroller

5marks

Particulars	PLC	Microcontroller
Shock and vibration	PLC is capable of withstanding strong amount of both shock and vibration common to warehouse environment.	Microcontroller requires special mounting and connection considerations designed to hold the abuse
Corrosion	In some environments, equipment is around vapour/fumes that corrode wiring and other components.	PLC has coatings that cut down on the bare/exposed metal on their boards. Also their wires include corrosion resistant materials.
Noise	PLC has better level of protection against standard electronic noise or magnetic fields without issues.	Microcontroller could go into fault mode or lose its program if the noise interference is significant.
Temperature levels	PLC can withstand extreme temperatures even when installed in outdoor enclosure,	Microcontroller can work well only in temperature controlled environment.
Industry standards for testing	International electro technical commission (IEC) and Underwriters Laboratories (UL) include standards as per it, each PLC system will include documentation that lists tests completed and methodologies used.	Most microcontrollers does not undergo such extensive testing, which becomes difficult to know their capabilities

(ii) PLC and PAC

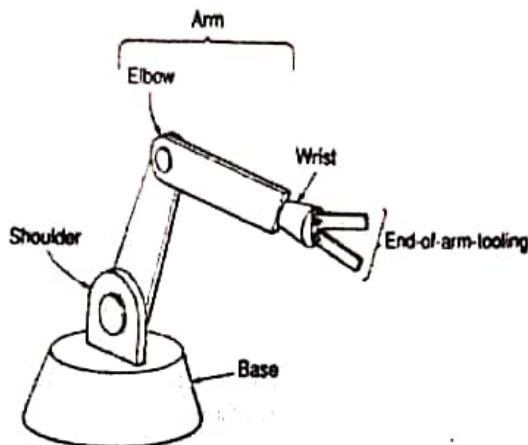
5marks

SI no	PLCs	PACs
1	PLC is a single microprocessor device which is used to control manufacturing, infrastructure, transportation and machine/station control automation equipment operation.	Programmable Automation Controller (PAC) is a multiprocessor device which is built with two or more number of processor like any other personal computers.
2	PLCs are programmed through ladder logic diagrams.	PACs are programmed through structured text, Functional block diagrams and ladder logic diagrams.
3	Programmable Logic Controllers (PLC) has built-in networks which enable them to communicate between multiple PLCs, I/Os, HMIs (human machine interfaces) and SCADA (supervisory-control and data acquisition) systems.	Programmable Automation Controllers (PAC) is incorporated with modular design open architecture use for communicating, monitoring, and controlling equipment covering multiple networks and devices.
4	PLCs comprise high-level program execution speed, but have limited memory and separate I/O device.	PACs have huge memory size for larger projects and systems.
5	Programmable Logic Controllers (PLC) uses Ladder Logic Diagram Programming.	PAC programming is done through structured text, function block diagrams, ladder logic diagram and also other programming languages like C or C++ etc.
6	PLCs are the perfect model for simple and high-speed machinery controlling, such as automated spray equipment, assembly equipment, dispensing systems and motion control systems to name few.	Programmable Automation Controllers (PACs) are ideal for large-scale automation projects and operations.

Section 4

7.a] A Robot can be used for different applications to simplify the task of a human. Discuss the various parts and technical features of Robots used in different applications. 10marks

BASIC PARTS OF ROBOT SYSTEM



Parts of the Robot are

1. Body – Robot are mounted on a Base. The body is attached to the base.
2. Arm - The arm is assembled to the body
3. Wrist - At the end of the arm is wrist which holds the gripper or end effector that performs the work.

Arm and Body motion:-

Arm and Body moment include 3 motions like

- Verticle motion- this motion includes up and down movements of the arm.
- Radial motion-Radial motion includes in & out moments i.e front and back.
- Rotational motion – This includes rotation of the arm .

Wrist Motion :-

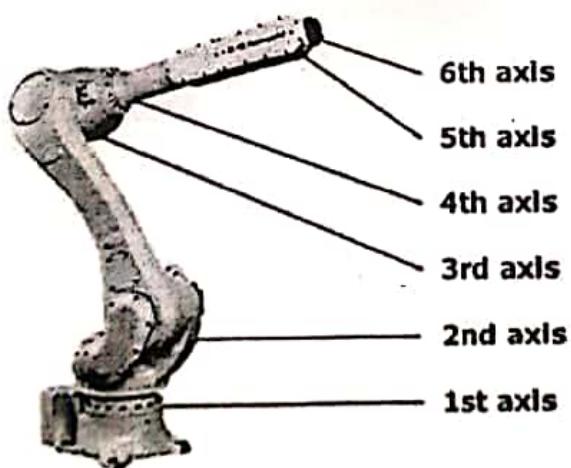
- Wrist rotation movement –It is the rotation of the wrist perpendicular to the end of the arm .
- Wrist bend :-It is the movement of the wrist in up and down direction .

Degrees Of Freedom :-

A typical robot arm will have 6 DOF. Only 3 DOF are necessary to get it anywhere in space, but 6 gives it more versatility.

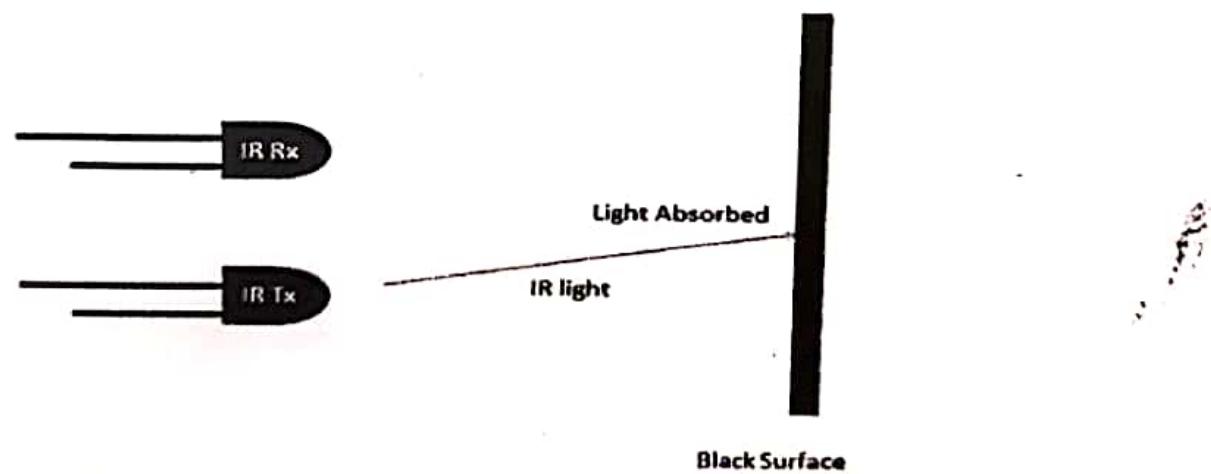
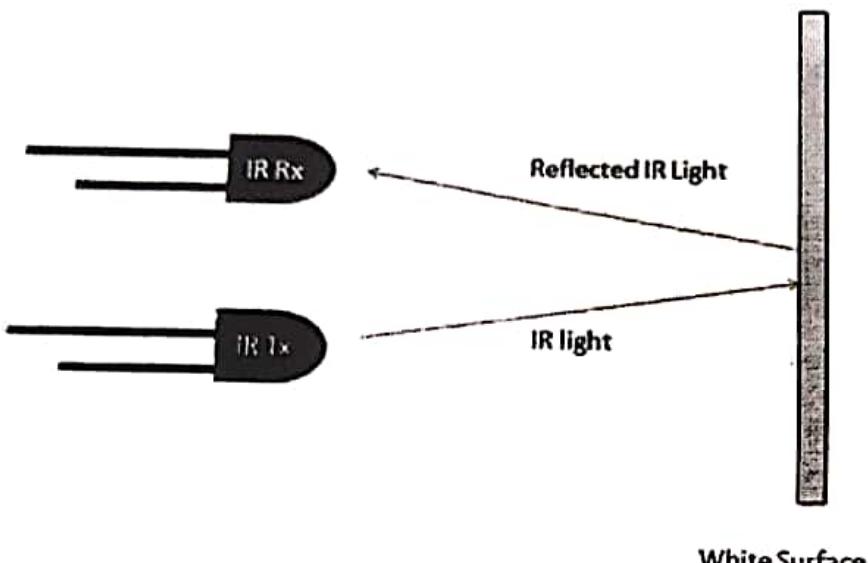
Each of the following is one degree of freedom:

- 1.moving up and down(heaving)
- 2.moving left and right(swaying)
- 3.moving forward and back(surging)
- 4.tilting up and down(pitching)
- 5.turning left and right(yawing)
6. tilting side to side(rolling)



b] Illustrate an line following Robot to transport raw materials from stock yard to production line. 10marks

The concept of working of line follower is related to light. We use here the behavior of light at the black and white surfaces. When light falls on a white surface it is almost fully reflected and in the case of a black surface light is completely absorbed. This behavior of light is used in building a line follower robot.



In this **Arduino based line follower robot**, we have used IR Transmitters and IR receivers also called photodiodes. They are used for sending and receiving light. IR transmits infrared lights. When infrared rays falls on the white surface, it's reflected back and caught by photodiodes which generate some voltage changes. When IR light falls on a black surface, light is absorbed by the black surface and no rays are reflected back, thus photo diode does not receive any light or rays. Here in this Arduino line follower robot when the sensor senses white surface then Arduino gets 1 as input and when senses black line Arduino gets 0 as input.

Block diagram Explanation

The whole **Arduino line follower robot** can be divided into 3 sections: sensor section, a control section, and driver section.

Sensor section:

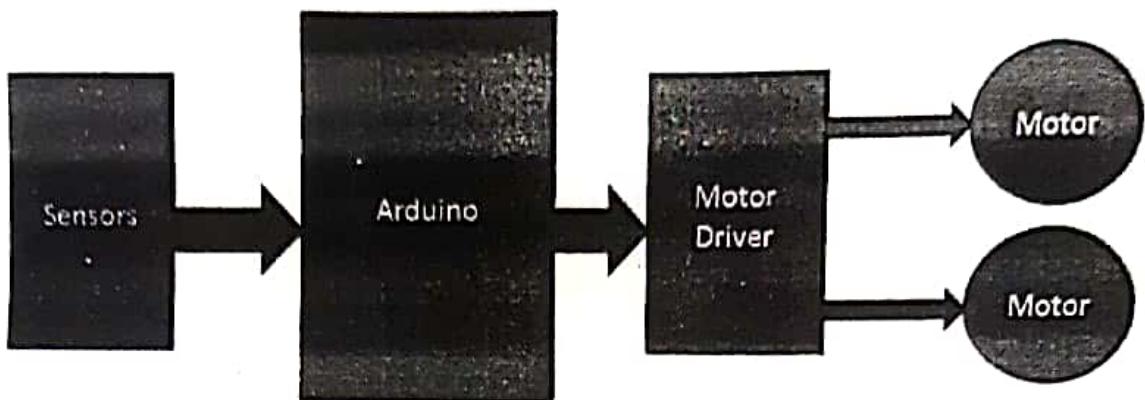
This section contains IR diodes, potentiometer, Comparator (Op-Amp) and LED's. The potentiometer is used for setting reference voltage at comparator's one terminal and IR sensors are used to sense the line and provide a change in voltage at the comparator's second terminal. Then the comparator compares both voltages and generates a digital signal at the output. Here in this **line follower circuit**, we have used two comparators for two sensors. LM 358 is used as a comparator. LM358 has inbuilt two low noise Op-amps.

Control Section:

Arduino Pro Mini is used for controlling the whole the process of the line follower robot. The outputs of comparators are connected to digital pin numbers 2 and 3 of Arduino. Arduino read these signals and send commands to driver circuit to driveline follower.

Driver section:

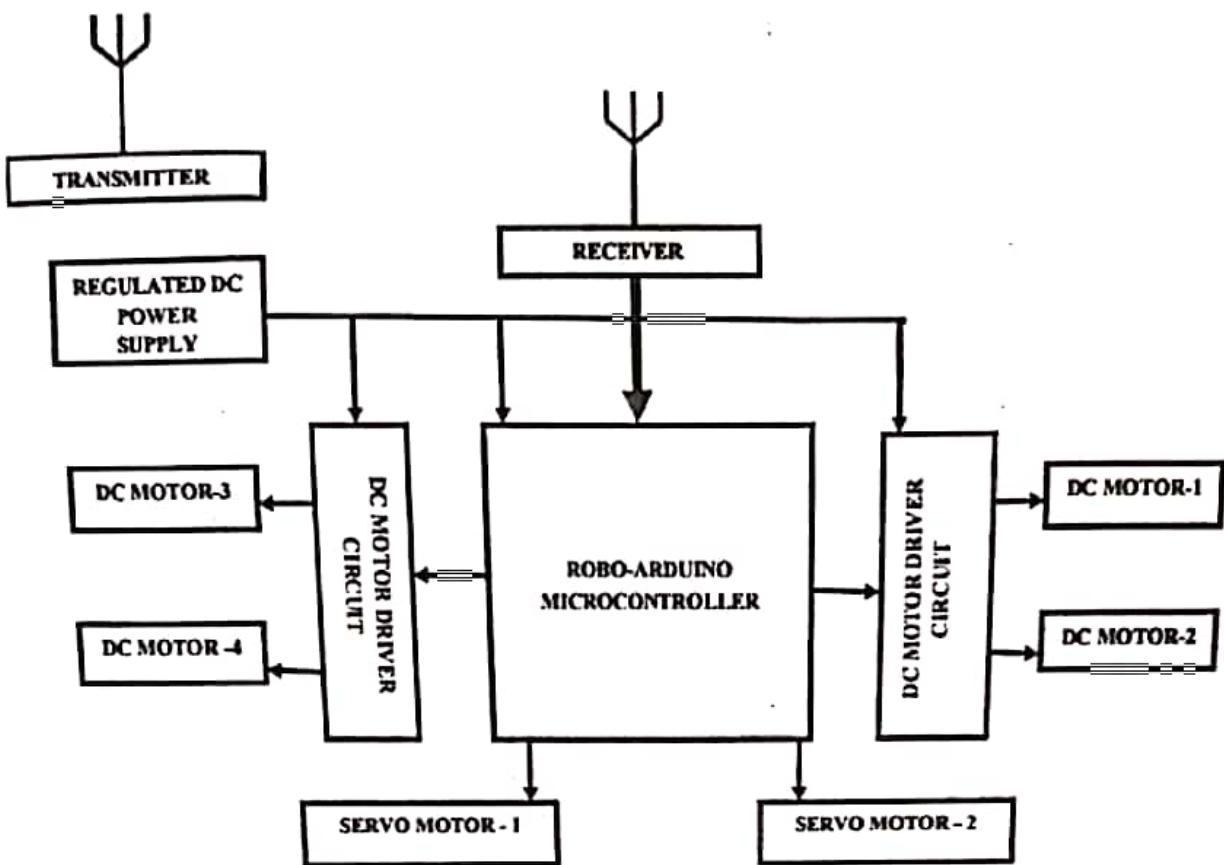
The driver section consists of motor driver and two DC motors. The motor driver is used for driving motors because Arduino does not supply enough voltage and current to the motor. So we add a motor driver circuit to get enough voltage and current for the motor. Arduino sends commands to this motor driver and then it drives motors.



8. a] Material handling was executed manually in a Warehouse for picking and placing the objects. Identify and explain suitable robot to do the above work efficiently.

Since many years people try to replace human work with machines. Machines called robots are faster and more effective than people. The term robotics is practically defined as the study, design and use of robot systems for manufacturing. Robots are generally used to perform unsafe, hazardous, highly repetitive, and unpleasant tasks. They have many different functions such as material handling, assembly, arc welding, resistance welding and machine tool load and unload functions, painting, spraying, etc. Many elements of robots are built with inspiration from the nature. Construction of the manipulator as the arm of the robot is based on human arm. The robot has the ability to manipulate objects such as pick and place operations. It is also able to function by itself. The development of electronic industry robot system technology has been expanded increasingly. As one such application, the service robot with machine vision capability has been developed recently.

Methodology:



The block diagram of the proposed system is shown in Fig. It consists of an Atmega328 Microcontroller IC, four DC Motors with driver IC, two servo motors and power supply. The pick and place robotic arm consists of a robotic arm placed on a moving vehicle (chassis). The vehicle is able to move along any type of surfaces irrespective of it is smooth or rough. The pick and place robot uses four motors for the operation of the chassis, two servo motors for the operation pick and place operation. The pick and place arm consists of an arm assembly with a jaw, which is only able to move in up and down direction.

There are two motors for the arm assembly, one for the up and down motion and other for jaw opening and closing. For the controlling of motor, motor driver IC and Atmega328 micro controller is used. The input signal or controlling signal is given from a wireless play station, which is interfaced with the microcontroller by a RF receiver module. When the signal is sent from the play station it is decoded in the controller and proper controlling signal is sent to actuators (dc motors or servo motor) in the system.

b] In a current era, Robots are extensively used in medical field. Identify & analyse the various applications of robots in medical field.

The development of a wide range of robots serves a variety of roles within the medical environment.

For example:

- Surgical and rehabilitation robots specializing in human treatment
- Assistive and therapeutic robots helping patients recover from serious conditions like strokes
- Empathic robots assisting in the care of elderly or disabled individuals

Below are six uses for robots in the field of medicine today.

1. Telepresence

Physicians use robots to help them examine and treat patients in rural or remote locations, giving them a "telepresence" in the room.

"Specialists can be on call, via the robot, to answer questions and guide therapy from remote locations,"

2. Surgical Assistants

These remote-controlled robots assist surgeons with performing procedures, typically those that are minimally invasive.

"The ability to manipulate a highly sophisticated robotic arm by operating controls, seated at a workstation out of the operating room, is the hallmark of surgical robots," says Keefe.

3. Rehabilitation Robots

Rehabilitation robots play a crucial role in the recovery of people with disabilities in areas such as improved mobility, strength, coordination, and quality of life.

4. Medical Transportation Robots

Medical transportation robots deliver supplies, medications, and meals to patients and staff thereby optimizing communication between doctors, hospital staff members, and patients.

5. Sanitation and Disinfection Robots

With the increase in antibiotic-resistant bacteria and outbreaks of deadly infections like Ebola, more healthcare facilities are using robots to clean and disinfect surfaces.

6. Robotic Prescription Dispensing Systems

The biggest advantages of robots are speed and accuracy—two features that are very important to pharmacies.

Section 5

9. a] Discuss how Maze solving robot can be advantageous in industrial applications and mention its advantages. 10

• Modern robotics technologies are focused on developing self-navigating autonomous robots to automate our day-to-day processes. This means that most of the research focuses on improving sensors and algorithms to build flexible and accurate robots.

• The maze solving robot also known as a micro mouse is designed to find a path without any assistance or help. As a type of autonomous robot, it has to decode the path on its own to solve the maze successfully. So its logic is quite different from the line following robot which follows a predetermined route.

• The possible applications for maze solving vehicles range from simple tasks such as transferring goods through factories, office buildings, classrooms and other workspaces, to hazardous tasks in difficult to reach areas like evacuating people from dangerous buildings, bomb sniffing, etc.

• Autonomous maze solving robotic systems can be applied to:

➢ **Manufacturing:** Robots can be used to transport items and tools from one location to another in a fast and accurate manner across a complicated terrain, where paths must first be explored to accomplish the delivery. The Flexible Manufacturing System (FMS) that employs autonomous robots are currently dominated by the use of Automatic Guided Vehicle (AGV).

➢ **Home automation:** Domestic robots are designed to assist human with tasks including:— lawn moving, vacuum cleaning and home monitoring. A mobile robot can be used as a vacuum cleaner, navigating itself effectively around the house whilst simultaneously cleaning.

➢ **Traffic control:** This is a real example of maze solving technology that enables fire-fighters or paramedics to find the best route to an emergency. Therefore, appropriate traffic control is a critical issue in highway work zone safety, in order to control the robotic system to safely travel from one location to another one.

There are several Advantages to making a maze solving robot, including:

- ✓ **Problem-solving skills:** Building a maze solving robot requires the use of skills, such as algorithm development and debugging. These problem-solving skills can be transferred to other areas of robotics and computer science. applications, such as search and rescue missions, warehouse automation
- ✓ **Real-world applications:** Maze solving robots can be used in a variety of realworld) and navigation for self-driving cars.
- ✓ **Challenging and fun:** Building a maze solving robot can be a challenging and fun project, especially if you are interested in robotics and computer science.
- ✓ **Educational:** Building a maze solving robot can be a great educational tool, as it requires a combination of knowledge in programming, electronics and mechanics. It can be used to teach students about robotics and problem-solving.
- ✓ **Increasing efficiency:** Robots can solve mazes much faster than humans and with precision and consistency. This can be particularly useful in situations greater where speed and accuracy are critical, such as in manufacturing and logistics.

b] ROS plays a very important role in Robotics. Emphasize the need for ROS in development of Robot with examples. 10marks

1. ROS is general

The same base code and knowledge can be applied to many different kinds of robots : robotic arms, drones, mobile bases, ... Once you've learned about how communication is done between all the nodes of the program, you can setup new parts of an application very easily. In the future, if you need to switch to a totally different robotics projects, you won't be lost.

2. ROS packages for everything

You need to compute a trajectory for your robot ? There is a package for that. Use your joystick to control the robot ? There is also a package for that. Or you want to map out a room with a drone ? There are many packages to do that.

Well, if you search a little bit, you'll find many, many ROS packages for almost any robotic application.

3. ROS is language-agnostic

You can easily communicate between a Python node and a C++ node. It means a lot of reusability and possibilities of coworking. Many libraries also allow you to use other languages (because ROS has mainly targeted C++ and Python).

4. ROS has great simulation tools

You can't always get your robot running for real, so you need simulation tools. ROS has many great tools, such as Rviz and Gazebo. With Gazebo you can even add some physical constraints to the environment, so when you run the simulation and the real robot, the outcome is pretty much the same. Imagine mapping a room in 3D with a drone directly on your computer, that could save you a huge amount of time.

The simulation tools also allow you to see and use other robots that you don't possess, for educational purposes or to test in a specific environment.

5. You can control multiple robots with ROS

ROS can work with multiple ROS masters. It means that you can have many independent robots, each with its own ROS system, and all robots can communicate between each other.

6. ROS is light

The core base of ROS doesn't take much space and resources. You can quickly install the core packages and get started in a few minutes. Plus, you can also use ROS on embedded computers, such as Raspberry Pi 3 boards. Thus you can easily start a new project without much trouble.

7. More and more compatible ROS products

When you build a robot, you don't necessarily want to reinvent or recreate every part of it. You might want to focus on some development points, and integrate the rest from other manufacturers. The good news here is you can find many robotics products – such as grippers, controller boards, ... – that already have a ROS package. So, in addition to the physical tool, the software that goes with it is directly compatible with your ROS system.

8. ROS is an open source project with a permissive license

One of the greatest strength of ROS is that it's open source. Most of the core packages are released under a BSD license. A BSD license allows you to modify and use the code for commercial purposes, without having to release your code with an open source license. This can be a good point when a company decides to integrate an open source software. But, hey, don't forget about the open source spirit :)

10. a) Discuss significance of Artificial Intelligence in Robotics. 10marks

Role of Artificial Intelligence (AI) technology used in Robotics

✓ **Computer Vision**

- Robots can also see, and this is possible by one of the popular Artificial Intelligence technologies named Computer vision. Computer Vision plays a crucial role in all industries like health, entertainment, medical, military, mining, etc.
- Computer Vision is an important domain of Artificial Intelligence that helps in→ meaningful information from images, videos and visual inputs and extracting takes action accordingly.

✓ **Natural Language Processing (NLP)**

- NLP can be used to give voice commands to AI robots. It creates a strong humanrobot interaction.
- NLP is a specific area of Artificial Intelligence that enables the communication→ between humans and robots. Through the NLP technique, the robot can understand and reproduce human language.
- Some robots are equipped with NLP so that we can't differentiate between humans→ and robots.
- Similarly, in the health care sector, robots powered by Natural Language Processing→ may help physicians to observe the decease details and automatically fill in HER.
- Besides recognizing human language, it can learn common uses, such as learn the→ accent, and predict how humans speak.

✓ **Edge Computing**

- Edge computing in robots is defined as a service provider of robot integration, testing, design and simulation.
- Edge computing in robotics provides better data management, lower connectivity→ cost, better security practices, and more reliable and uninterrupted connection.

✓ **Complex Event Process**

- Complex event processing (CEP) is a concept that helps us to understand the multiple events in real time. An event is described as a Change of processing of State, and one or more events combine to define a Complex event.
- The complex event process is most widely used term in various industries such as— healthcare, finance, security, marketing, etc. It is primarily used in credit card fraud detection and also in stock marketing field.

Some examples of artificial intelligence applied to robotics are:

- a) **Robotics in Household** - Robot vacuum cleaner can navigate around furniture using artificial intelligence. There is robot on wheels uses artificial intelligence and camera to navigate autonomously around the home, acting as eyes and ears when the owner of the house is not around.
- b) **Robotics in manufacturing** - In manufacturing AI is used for robot to algorithmically navigating its way around a busy warehouse to perform complex tasks. It is also used to patrol a construction site, scan the project and analyze data for possible quality issues
- c) **Robotics in business** - Equipped with mapping systems, sensors and AI, the little robot on wheels can figure out the best route to take on the fly, and can avoid the dangers of the outside world.
- d) **Robotics in healthcare** - Robotics are capable of performing operations with incredible accuracy and a steady hand, these can be used as substitute for tried medical professionals. Robot can be used to administer needless vaccination without needing any kind of human supervision.
- e) **Robotics in agriculture** - AI can be used to assess the ripeness of each fruit harvested. AI with robotics can be used to increase plant yield and use less water.
- f) **Robotics in aerospace** - Robots are designed to assist astronauts with their day-to-day tasks and reduce stress via speech recognition, while also operating as an early-warning system to detect problems.
- g) **Robotics for military** - AI can be used to design autonomous military drones
- h) Robotics also employed in volcanoes, deep oceans, extremely cold places, or even in space where normally humans can't survive.

10 • b) Write a brief note on ROS and explain ROS communication tools.

ROS (Robot Operating System) is actually a set of software libraries and tools made to ease the development of robotic applications. ROS is widely used in robotics companies,

universities and robotics research institutes for designing, building and simulating a robot model and interfacing it into real hardware. The point of ROS is to create a robotics standard, because it is open-source, you have the flexibility to decide where and how to use ROS, as well as the freedom to customize it for your needs. ROS is a framework that is used by techies and various companies across the world in the field of Automation and Robotics. ROS acts as an easy entry point for beginners in the robotics programming field. As you can see ROS plays a major role in the robotics and automation industry. ROS is a BSD licensed system for controlling robotic components from a PC.

A ROS system is comprised of a number of independent nodes, each of which communicates with the other nodes using a publish/subscribe messaging model. For example, a particular sensor's driver might be implemented as a node, which publishes sensor data in a stream of messages. These messages could be consumed by any number of other nodes, including filters, loggers, and also higher level systems such as guidance, path finding, etc.

ROS comes with 3 main communication tools which help the programs communicate between each other:

1. **Topics** – This tool is used mainly for sending data streams between nodes Ex: When monitoring the temperature of a motor on the Robot, the node monitoring this motor will send a data stream with temperature. Any other node can subscribe to this topic and get the data. Topic is like a shared mailbox. Nodes can put messages on this mailbox and are called publishers. Nodes that subscribed to that topic will receive a copy of the message. We can have multiple publishers, one publisher broadcasting to multiple subscribers or even one publisher and a single subscriber.
2. **Services** – This will allow you to create a simple synchronous client/server communication between nodes. It's very useful for changing setting on the Robot or ask for a specific action like enable free drive mode, ask for specific data etc. Services can send inputs and receive a reply. The service node that sends the request is called a "service client" and the one that sends the response is called a "service server".
3. **Actions** – A little bit more complex, they are in fact based on topics. They exist to provide you with an asynchronous client/server architecture, where the client can

send a request that takes a long time (ex: asking to move the robot to a new location). The client can asynchronously monitor the state of the server and cancel the request anytime.

CERTIFICATE

This is to certify that the above model answers is prepared by me which are within the syllabus prescribed by DTE, and have given relevant solutions whose reference is taken from genuine websites / Industry / Real time exposure.

VANITHA M H
LECTURER IN E&C,
GOVERNMENT POLYTECHNIC, KR PET,
MANDYA DIST

Scrutinized

Mamatha

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