VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY

Electronics and Communication Engineering

WORKSHOP PROJECT

COURSE: PRODUCT ENGINNERING WORKSHOP (ECP307)

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PROJECT: Artificial Pancreas using Ardinuo Uno

Submitted by:

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AIM:

Build a circuit that models an artificial pancreas by turning insulin delivery on and off in response to blood glucose levels using ardinuo uno.

THEORY:

Our model will use two different liquids to represent blood and insulin: distilled water and tap water. Instead of measuring glucose content of the liquids, you will measure their electrical conductivity by building a circuit that outputs a voltage.

Distilled water is not very conductive. In your model, it will represent blood with high sugar content, which will cause the circuit to output a high voltage. Tap water is much more conductive, so when you add it to distilled water, the conductivity increases. This means you can use tap water to represent insulin in your model. When you add it to distilled water, the conductivity will increase, and the circuit's output voltage will drop, corresponding to a decrease in blood sugar in the model. Table 1 summarizes what happens in the real physical system (the human body) and what is used to represent the same parameters and behaviors in the model.

Human Body	Artificial Pancreas Model
Blood	Distilled water
Insulin	Tap water
Blood glucose levels	Voltage
Adding insulin to blood with high glucose levels causes the glucose levels to decrease	Adding tap water to distilled water causes the voltage to decrease
Eating carbohydrates causes blood glucose levels to increase	Adding more distilled water causes the voltage to increase again

Table 1. Summary of parameters in the human body and what represents them in your artificial pancreas model.

How does circuit work?

It has two main parts. First, a voltage divider measures the conductivity of the water. The voltage divider consists of one fixed resistor (R1) and a pair of electrodes immersed in water (R2). The input voltage (Vin) is the 5 V supply from the Arduino. The output voltage (Vout) is measured by one of the Arduino's analog (continuously variable) inputs. A voltage divider's output voltage is determined by Equation 1:

$$V_{out} = \frac{R_2}{R_1 + R_2} V_{in}$$

Next, the circuit has a pump that is controlled by one of the Arduino's digital (on/off) pins and a transistor. The transistor acts like an electronic valve that controls the current flowing through the pump. A transistor is necessary because the Arduino's digital pins can only supply a small amount of electrical current, about 20 milliamps (mA), while the pump requires about 500 mA. The transistor allows the pump to draw its power directly from the Arduino's 5 V supply, which can provide much more current than the individual digital pins.

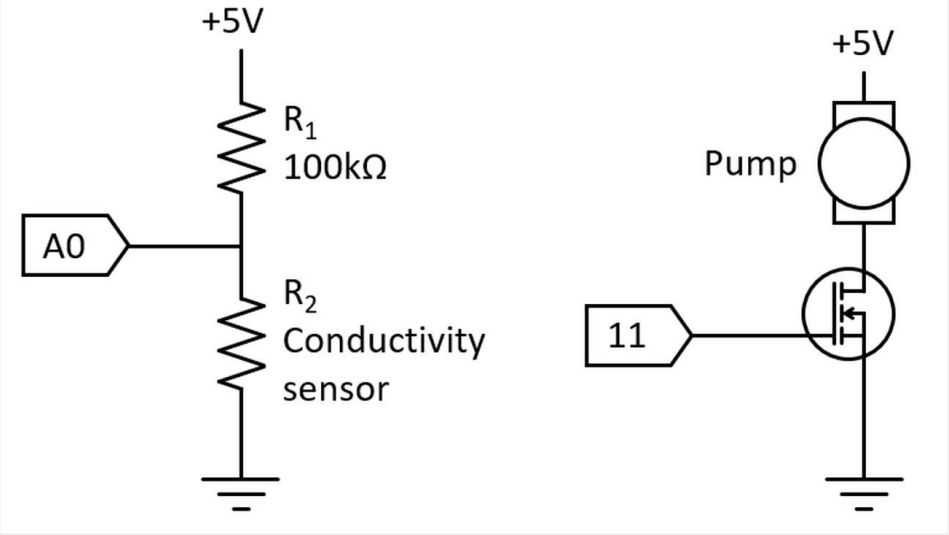
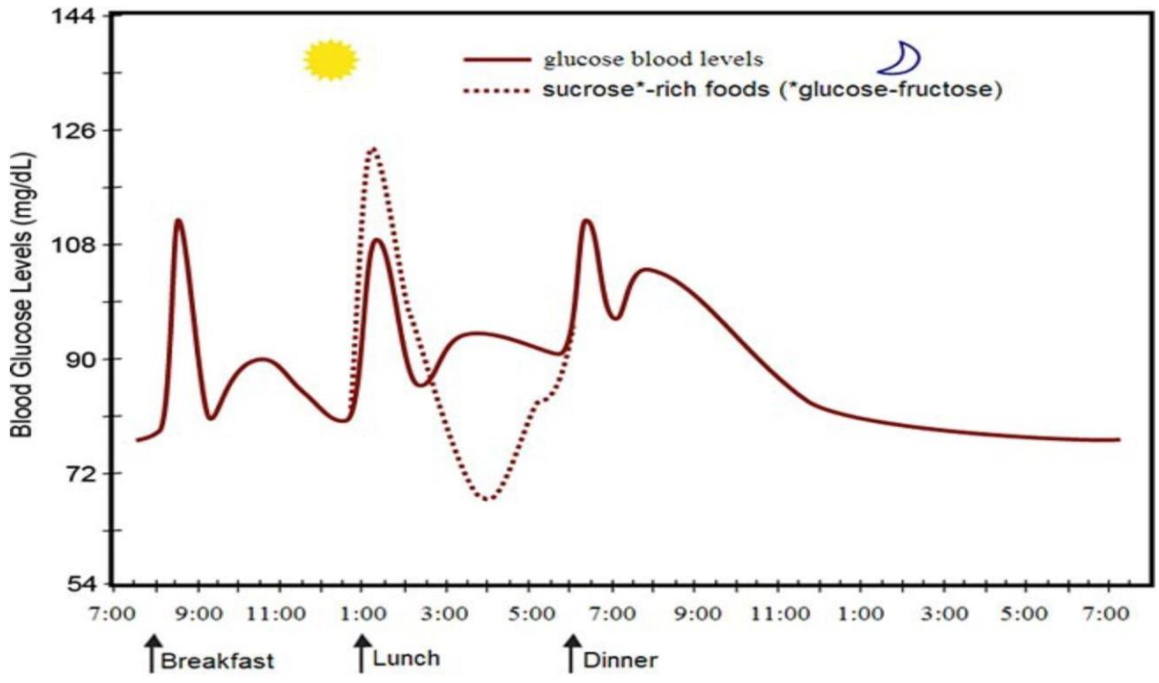


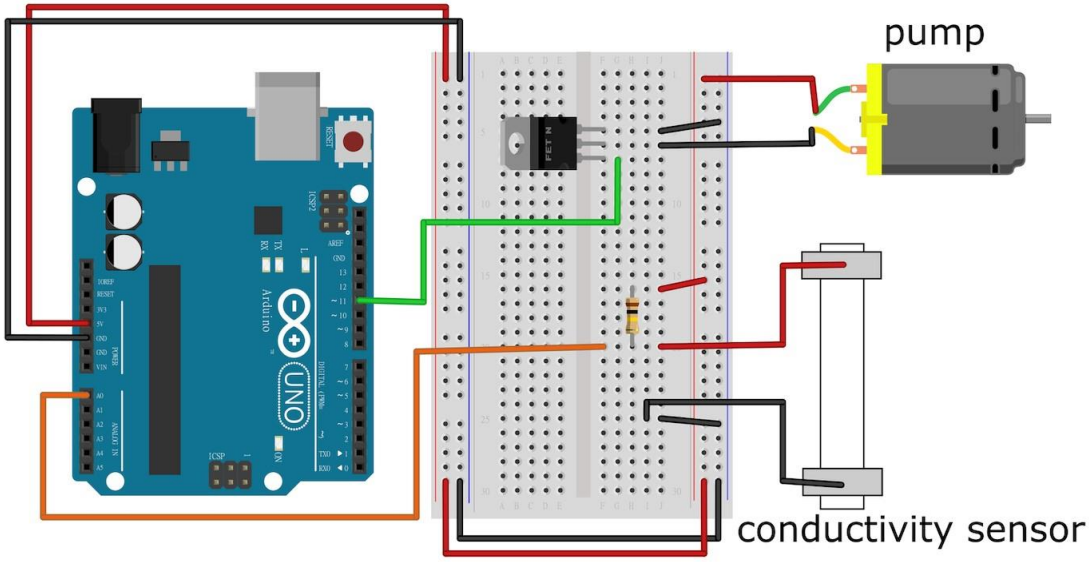
Figure 3. Circuit diagram for the artificial pancreas model.



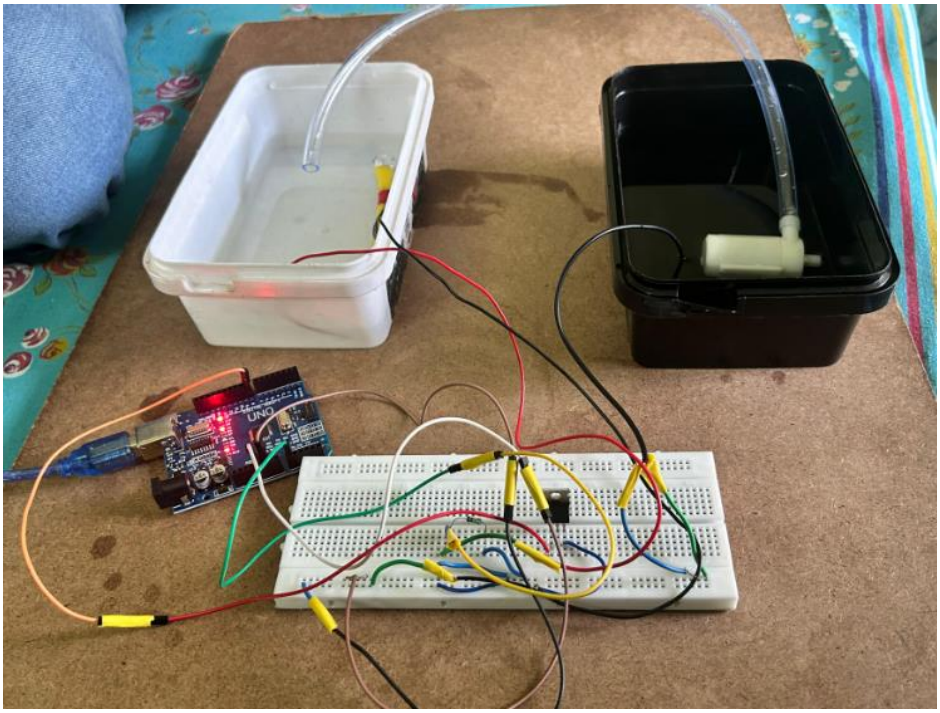
The above graph shows how a person's blood glucose levels may change over the course of a day, and how eating a meal with lots of sugar (sucrose) can affect blood glucose levels. The y-axis shows blood glucose levels (in mg/dL).

Like most of the chemicals in your blood, glucose must be 4ghtly controlled. The level of glucose in your blood is regulated by insulin, a hormone made by the pancreas. When blood glucose levels rise after eating a meal, the pancreas releases insulin, which causes cells in the body (such as liver, muscle, and fat cells) to take up glucose, removing it from the blood and storing it (as glycogen) to use for energy later. When blood glucose levels start falling, the pancreas stops releasing insulin, and the stored glucose is used for energy. If blood glucose levels get too low, the pancreas may produce glucagon, a hormone that increases the levels. This process is how the pancreas and the hormones it produces regulate blood glucose levels.

CIRCUIT SIMULATION :



CIRCUIT:



Applications:-

- **Real-time Blood Glucose Monitoring:** The application continuously monitors blood glucose levels using sensors connected to the Arduino board.
- **Insulin Administration:** Based on the glucose level readings, the Arduino-controlled system administers insulin through an insulin pump to maintain optimal blood sugar levels.
- **Data Monitoring:** The application logs glucose levels, insulin doses, and other relevant data, providing valuable insights for patients and healthcare providers.
- **Customizable Alerts:** Users can set personalized alerts for low or high blood sugar levels, ensuring timely intervention.
- **User Interface:** The system includes a user-friendly interface for monitoring glucose levels, adjusting settings, and viewing historical data.

ADVANTAGES:

- **Improved Diabetes Management:** The Artificial Pancreas automates insulin delivery, reducing the risk of hypoglycemia and hyperglycemia.
- **Enhanced Quality of Life:** Users can experience greater freedom and flexibility in managing their diabetes with minimal manual intervention.
- **Cost-effective Solution:** Arduino technology offers an affordable alternative to traditional medical devices, making the Artificial Pancreas accessible to a wider population.
- **Open-source Development:** The use of Arduino encourages collaboration and innovation within the diabetes community, fostering the development of new features and improvements.

DISADVANTAGE:

Dependency on Battery Power: Reliance on rechargeable batteries for powering the system introduces the risk of power failure or depletion, potentially disrupting insulin delivery and glucose monitoring.

Results Summary:

- Improved Blood Glucose Control: The Artificial Pancreas shows significant improvement in maintaining blood sugar

levels within the target range, reducing hyperglycemia and Hypoglycemia episodes.

- Enhanced User Satisfaction: Users report high satisfaction levels due to the convenience of automated insulin delivery and customizable settings.
- Safety and Reliability: Extensive testing confirms the system's accuracy in detecting glucose changes and administering insulin, ensuring safety and reliability for users.

CONCLUSION:

In conclusion, the Arduino-based Artificial Pancreas project presents a promising avenue for revolutionizing diabetes management through automation and affordability. Despite its potential advantages in improving blood glucose control and enhancing user satisfaction, challenges such as technical complexity, regulatory hurdles, and potential malfunctions must be carefully addressed. With further development and research, this innovative solution holds the potential to significantly enhance the quality of life for individuals living with diabetes.

Sr no	NAME of COMPONENT	PRICE (INR)
1	Ardinuo uno	450
2	USB cable	60
3	Breadboard	120
4	N channel Mosfet	40
5	Water pump	150
6	Pipe(60cm)	40
7	Resistor (100k-5)	10

TOTAL	870

QUESTIONS:

1. **How Is blood and distilled water similar in our case?**

ANS: Blood and distilled water may seem vastly different, but they share similarities in terms of resistivity, which is the measure of a material's ability to resist the flow of electric current. Here are some factors in which they are similar

- Insulating Properties: Because of their high resistivity, both blood and distilled water can act as insulators in certain contexts. For example, they can be used to prevent electrical short circuits in electronic devices or as dielectric materials in capacitors.

- Purity: Distilled water is essentially pure water, devoid of ions and impurities. Blood, while not as pure, also contains a significant amount of water that contributes to its overall resistivity. In both cases, the absence or low concentration of conductive particles leads to higher resistivity.
- Electrical Conductivity: Both blood and distilled water have low electrical conductivity due to their low concentration of ions. This means they offer high resistance to the flow of electric current compared to materials with higher ion concentrations.

2. **How does our project, focusing on an Artificial Pancreas using Arduino , share similarities with real-time Artificial Pancreas systems?**

An Artificial Pancreas using Ardiuno shares several similarities with real-time Artificial Pancreas systems:

- Continuous Monitoring: Both systems continuously monitor blood glucose levels using sensors. In the case of the Arduino-based system, this could be a glucose sensor interfaced with the Arduino board.
- Data Processing: Both systems involve processing glucose data in real-time. The Arduino board processes the sensor data, while real-time systems use sophisticated algorithms for glucose level interpretation.

One more point of similarity between our Arduino-based Artificial Pancreas project and real-time systems is the incorporation of feedback loops. Both systems utilize feedback mechanisms to adjust insulin delivery based on real-time glucose level data, aiming to maintain blood glucose within a target range.