Experiment No. 01

1.1 Experiment Name

Body composition analysis using four electrode bio impedance measurement technique

1.2 Objectives

- To gain knowledge about the composition of the human body in terms of its percentage of body fat, water, and muscle mass.
- To obtain practical knowledge and skills in utilizing the four-electrode bioimpedance measurement technique
- To learn to categorize health status based on the results of bioimpedance analysis and identify potential health risks associated with body composition imbalances

1.3 Theory

The four-electrode method, a well-established technique dating back to the late 19th century, measures the resistivity of materials using separate pairs of electrodes for current injection and voltage measurement. In this application, one electrode pair was strategically placed at the finger joint, while the other pair was positioned on the wrist. To ensure proper measurements, the black and red leads must be consistently paired across both locations. This configuration allows for accurate and reliable determination of resistivity through the analysis of the induced voltage drop in response to the injected current.

Human body impedance measurements offer valuable insights into health and body composition. While cadavers exhibit an average impedance of 1,000 Ω, living bodies show significantly lower values at 500 Ω. Notably, electrode-skin contact impedance decreases significantly within the 10 Hz to 1 MHz frequency range. In terms of body composition for 18–30-year-olds, the average fat range is 12-18% for males and 20-26% for females. Additionally, water content, encompassing both extracellular and intracellular water, averages 55-65% for males and 50-60% for females at that age.

The "prediction marker," defined as the ratio of impedance at 200 kHz to 5 kHz, serves as a key indicator of health status. This analysis provides valuable information about a person's overall health and well-being.

Furthermore, the phase angle measures the functionality of cell membranes, essentially assessing the "battery life" of our cells. Leakage in the cell membrane impairs its ability to hold a voltage, leading to a decrease in the phase angle. Based on this measurement, individuals can be categorized into different health groups: poor (3.5-5.4), satisfactory (5.4-6.4), good (6.4-7.9), and outstanding (7.9+).

Finally, the impedance curve, a graph depicting the relationship between resistance and reactance for the human body, provides additional insights into health. The angle between the vector and reactance is known as the phase angle. While the experiment's sample size was limited to 2-3 individuals, the obtained data offer valuable preliminary findings for further research in this area.

1.4 Apparatus

- ❖ Carbon coated electrode (4 pieces)
- ❖ Body stat device (1 piece)
- ❖ Covering tape
- ❖ Weight machine
- ❖ Subject

1.5 Data Table

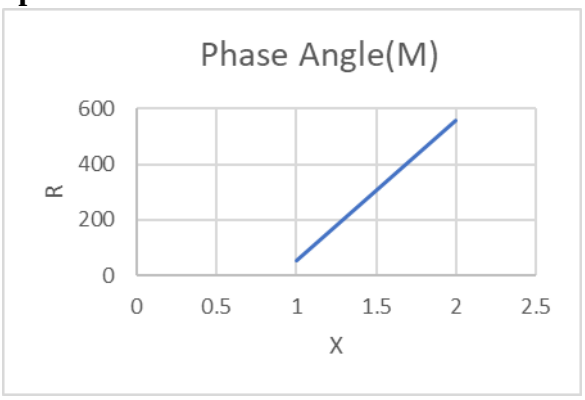
Table 1: Basic Information

Serial No.	*Name*	*Gender*	*Age*	*Weight*	*Height*
117	Modhusudan	Male	25	57	1.65
118	Efaz	Male	25	75.5	1.7
119	Noman	Male	23	74.5	1.63
120	Rakibul	Male	24	68	1.68
121	Pranto	Male	24	72.5	1.65
123	Maliha	Female	24	52	1.55
124	Mayesha	Female	24	53	1.57
126	Ifthekhar	Male	25	65	1.75
127	Saad	Male	25	79	1.73
128	Rokon	Male	24	81	1.83

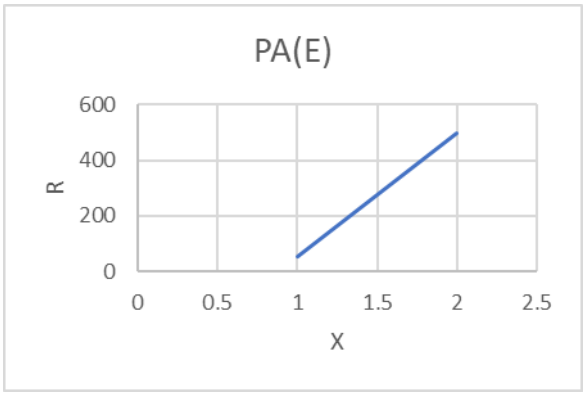
Table 2: Analytical Data

Serial. No.	*Fat(%)*	*TBW(%)*	*Lean(%)*	*Z at 50Khz*	*PA*	*Status*	*BMI*	*Status*
117	13.5	61.6	86.5	557.4	5.62	Satisfactory	19.2	Underwieght
118	22.1	47.7	77.9	498.4	6.32	Satisfactory	28.5	Overweight
119	14.6	74.8	85.4	402.2	8.25	Outstanding	28	Overweight
120	21	46.1	79	562.9	5.58	Satisfactory	26	Overweight
121	22.5	61.1	77.5	500.4	7.3	Good	29	Overweight
123	19.4	47.6	80.6	546.4	7.05	Good	20.8	Healthy
124	30.5	42.9	69.5	653.2	4.36	Poor	23.8	Healthy
126	14.7	53.5	85.3	582.4	5.44	Satisfactory	21	Healthy
127	20.6	49.5	79.4	473.5	6.2	Satisfactory	28.3	Overweight
128	18.1	52.2	81.9	526.5	7.2	Good	25.1	Overweight

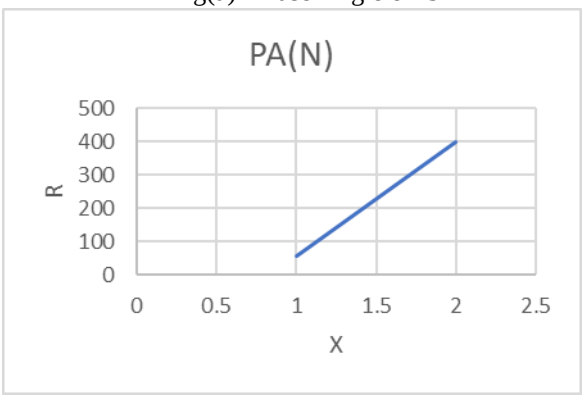
Impedances Curves



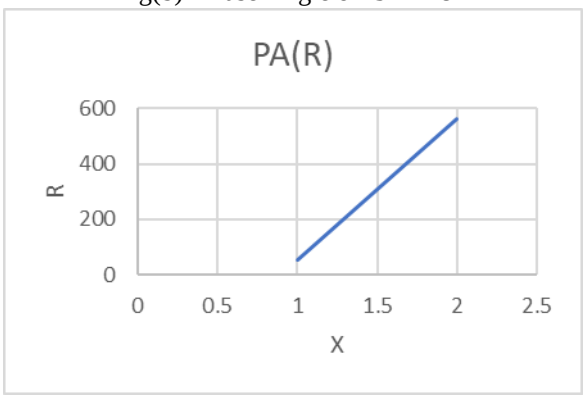
Fig(a) Phase Angle of SN 117



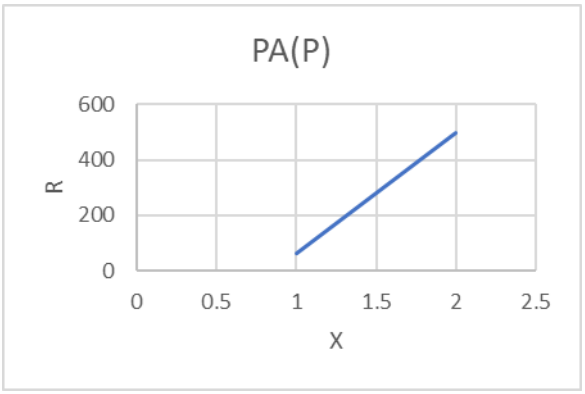
Fig(b) Phase Angle of SN 118



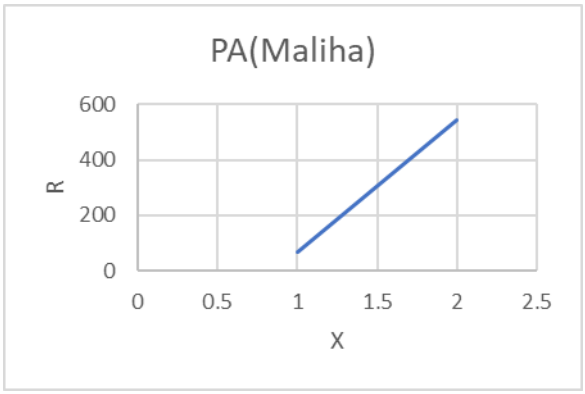
Fig(c) Phase Angle of SN 119



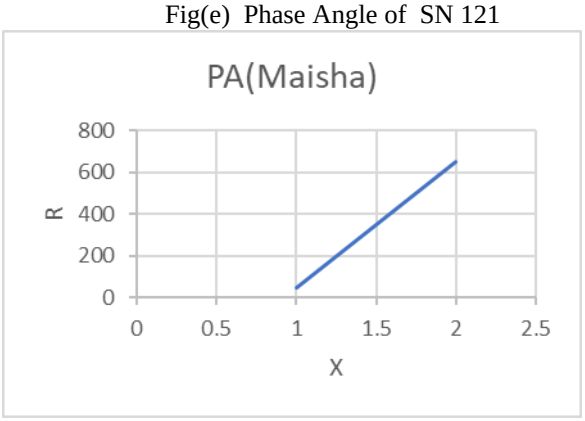
Fig(d) Phase Angle of SN 120



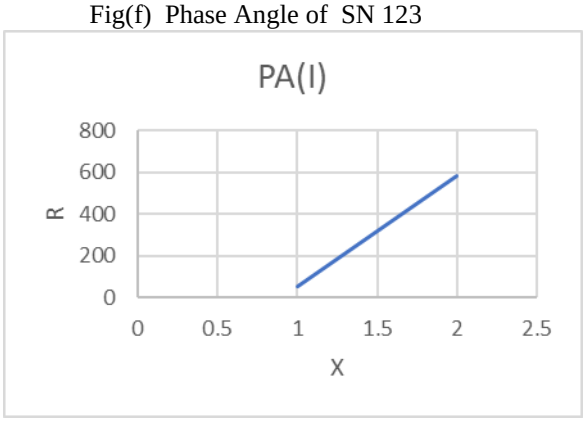
Fig(e) Phase Angle of SN 121



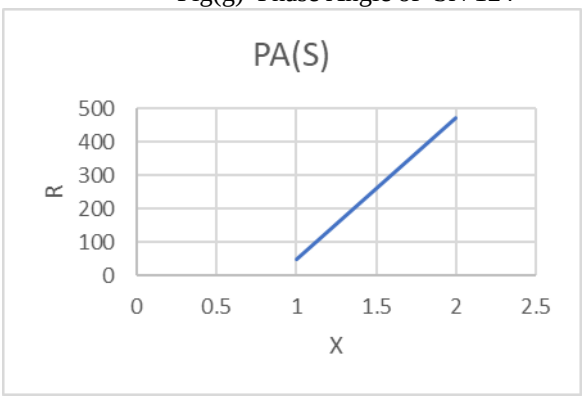
Fig(f) Phase Angle of SN 123



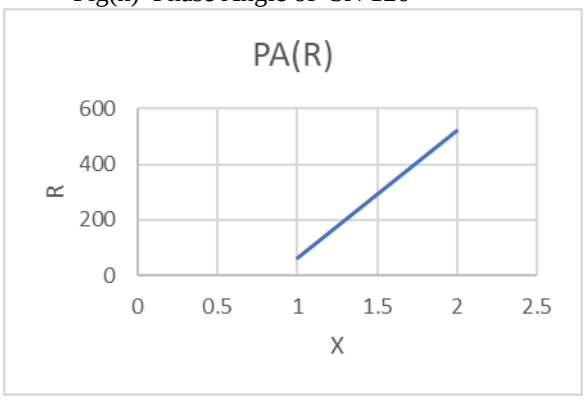
Fig(g) Phase Angle of SN 124



Fig(h) Phase Angle of SN 126



Fig(i) Phase Angle of SN 127



Fig(j) Phase Angle of SN 128

1.6 Discussion & Conclusion

This experiment successfully employed electrode bioimpedance analysis to assess body composition. Prior to the analysis, thorough background knowledge was acquired, and necessary precautions were implemented. Data was meticulously collected and analyzed using computer software. Standard charts facilitated the interpretation of the results and provided insights into the health status of the participant. An impedance diagram was also generated for further analysis. While limitations such as electrode-related errors and tape repetition time may have been present, all objectives were ultimately achieved, solidifying the experiment's successful execution.