MATHEMATICAL, PHYSICAL AND ENGINEERING SCIENCES

FOUNDATIONS OF PSEUDOGROUP THEORY

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A *pseudogroup* $< S: \otimes >$ is a set S of finite order n together with a non-associative binary operation $\otimes$, satisfying the following postulates:

P1. The operation $\otimes$ is closed on S.
P2. The set S has a unique *identity* element with respect to $\otimes$.
P3. Every element of S has a unique *inverse* in S.
P4. For every a, b is S there exists unique x, y in S such that $a \otimes x = b$ and $y \otimes a = b$.

Pseudogroups are interesting algebraic structures more general than groups. Very little is known about them but they are involved in the theory of non-associative real algebras, division rings, as well as in theoretical physics. They satisfy all group postulates except the *associative property* and are therefore helpful in understanding group properties that are not consequences of the associative property.

This paper introduces some of the fundamental properties of pseudogroups and attempts to indicate a program for the development of *Pseudogroup Theory*. In particular, it shall establish the existence of pseudogroups of all orders $n \geq 5$, present basic theorems on their structure, introduce methods and algorithms for constructing and analyzing them, and show some of their applications in both pure and applied mathematics.

AXIOMS – AN ALGORITHM FOR THE ANALYSIS OF FINITE ALGEBRAIC STRUCTURES

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The abstract structure of any finite algebraic system $< G; \otimes >$ of order n is completely defined by its multiplication table which can be represented by an nxn matrix $S(G) = (g_{ij})$ called its *structure matrix*, where $g_{ij} = g_i \otimes g_j$ and $g_i, g_j \varepsilon G$. AXIOMS is a software based on the properties of S(G). It is a computer version of *Characteristic Pattern Analysis* (CPA) – an algorithm for the analysis of finite structures. Given the matrix S(G) of $< G; >$, AXIOMS can determine if it is a groupoid, a pseudogroup, or a group, derive important matrices from S(G) and decompose them into their components for study.

PIEZOELECTRIC QUARTZ RESONATOR AS A BIOSENSING DEVICE FOR ODORANT MOLECULES

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Piezoelectric quartz crystals have long been used as frequency and time standards with accuracy down to one part per trillion (10^9). These stable elements have been exploited for chemical biochemical sensing by depositing an adsorbent film or membrane on the crystal surface. The coating on the quartz crystals interacts with the substance being analyzed, and the interaction leads to an increase in the mass of the crystal and a consequent decrease in its oscillation frequency. This sensing principle was applied to the detection of odorant chemicals. Cast films and Langmuir – Blodgett membranes of lipids and compounds displayed distinct behavioral patterns that indicate the feasibility of identification through a multivariate analysis of the data. The odor-sensing device based on this system would be very useful in the food, beverage and perfume industries, as well as in environmental and health monitoring.

DEVELOPMENT OF NEW PROCESS FOR COCONUT OIL EXTRACTION

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Quantity of coconut oil and copra residue export has been consistently decreasing due to the decrease of the quality of the coconut oil and copra meal which was contaminated by aflatoxin. This study aimed to develop a new process using the Gamanase enzyme for the extraction of coconut oil directly from fresh coconut meat in order to have a good quality oil.

The effect of temperature, pH and enzyme concentration was optimized in a batch process using a randomized fractional factorial design. The optimization of process conditions were analyzed by three dimension structures aided by a computer.

The effects of pH and temperature were found to be parabolic, while the effect of the enzyme concentration was linear. The highest coconut oil recovered was 89-92% at pH 4.5, process temperature of 50°C and 0.75 ml gamanase/100 g fresh coconut meat. Oil extracted was colorless and had a flavor of fresh coconut meat. Besides this, protein and coconut residue of high quality were also obtained.

SIDE CHAIN LIQUID CRYSTAL POLYMERS AS BINDERS IN PDLC FILMS

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With the prime interest being in formulating better indices binders for polymer-dispersed liquid crystal (PDLC) films, we have synthesized a series of side chain liquid crystal epoxy-based polymers from the condensation of an epon resin, ethyleneglycol diglycidyl ether and mesogenic amines, 4-(ω - aminoalkoxy) - 4' -cyanobiphenyl. The amines with alkyl group ranging from five to nine methylene units were found to exhibit an enantiotropic nematic phase. The obtained epoxy-based materials were oligomeric and exhibited low glass and melting temperatures. Some adjustments in transition temperatures were achieved by structural modifications such as crosslinking, copolymerization, capping and changing the backbone constitution. Phase separation study was conducted using polarized microscopy.

LAHAR AND SAND DUNES AS RAW MATERIALS IN THE MANUFACTURE OF STRUCTURAL CLAY PRODUCTS

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Lahar, sand dunes and ordinary clay were used as raw materials for the making of structural clay products. Different mixtures were formulated with the use of the tri-axial diagram.

The objective of the study was to determine the optimum combination of lahar, sand dunes and clay for the manufacture of structural clay products. Sample test bars were made and different physical testing were undertaken.

Air-dried test bars are porous compared to high clay formulations. However, after air and oven drying, they were found to have minimal shrinkage. For the slaking test, the test blocks took less than 5 minutes.

The test bars were fired at 859°C, 950°C and 1050°C. All the clay formulations were able to withstand up to 950°C. However, at this temperature they started to change phase. At 1050°C, all the test bars fused and became shiny.

The findings indicate that lahar and sand dunes can be used as materials for structural clay products and can even be used for glazing.