CHEMICAL, MATHEMATICAL AND PHYSICAL SCIENCES

CMPS-01

MOLECULAR ASSEMBLY AND ELECTROPOLYMERIZATION OF 3,4-ETHYLENEDIOXYTHIOPHENE ON Au(100) SINGLE CRYSTAL ELECTRODE USING IN-SITU ELECTROCHEMICAL SCANNING TUNNELING MICROSCOPY

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Electrochemical scanning tunneling microscopy (EC-STM) is a powerful technique that can provide molecular-level information regarding electrode surface processes in-situ in electrolyte solvent under ambient conditions. In this study, the adsorption and electropolymerization of an industrially important conducting polymer precursor, 3,4-ethylenedioxythiophene (EDOT), on Au(100) single crystal was probed using EC-STM. The Au(100) single crystal electrode substrate used for this study was fabricated using the well-known Clavilier's flame melting procedure. Cyclic voltammetry (CV) was used along with EC-STM to characterize the bare, EDOT-modifed, and poly(EDOT)-modified Au(100) single crystal electrode. Time-dependent EC-STM imaging at 0.550 V showed the formation of an EDOT self-assembled monolayer through 2-D surface diffusion. The resulting EDOT molecular assembly on Au(100) single crystal electrode was found to fit in a $4\sqrt{2}\,x3\sqrt{2}$ unit cell. Difference in apparent corrugation between molecular rows was attributed to different angular orientation with respect to the substrate. The electropolymerization of EDOT on Au(100) single crystal electrode was done by potentiostatic and potentiodynamic methods. Both methods suggested a solution-process mechanism for EDOT electropolymerization.

Keywords: conducting polymers, electrochemical scanning tunneling microscopy, cyclic voltammetry, molecular self-assembly, electropolymerization

CMPS-02

PREPARATION AND CHARACTERIZATION OF CARBON-SUPPORTED PTSN ELECTROCATALYSTS FOR ETHANOL OXIDATION: POSSIBLE APPLICATION FOR INKJET INK FORMULATIONS

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The study aimed to utilize inkjet printing technique as a possible fabrication method for developing new Pt-based anode systems with enhanced electrocatalytic behavior towards ethanol oxidation, while reducing the cost of preparation. Carbon-supported Pt and PtSn catalysts of different atomic ratios (90:10, 80:20, 70:30, 60:40 and 50:50) were synthesized by using a modified polyol method. X-ray diffraction (XRD) data revealed that the estimated particle sizes of all synthesized catalysts were approximately 2.0-3.0 nm. Cyclic voltammetry (CV) was used to evaluate the catalytic activity of the synthesized catalysts towards ethanol oxidation. CV data showed that $Pt_{80}Sn_{20}$ exhibited the highest activity with current density of 88.192 mA•cm^{-2}. Chronoamperometry (CA) data confirmed that $Pt_{70}Sn_{30}$ was the most stable among the prepared catalysts with long-term poisoning rate of 4.25 x 10^{-3} (% per s), which was 4 times lower thanPt (1.70 x 10^{-2}). The catalyst with the optimum performance was used as the ink pigment of the inkjet ink formulations. It was seen that the addition of dispersant to the formulations affects the stability and catalytic performance of the ink catalysts. The ink formulations are being characterized by its dispersion stability, preservation stability, drying characteristic and clogging tendency.

Keywords: PtSn catalyst, Polyol method, cyclicvoltammetry, Ethanol oxidation, Inkjet printing technique, ink formulation

CMPS-03

PREPARATION AND CHARACTERIZATION OF DYE-SENSITIZED SOLAR CELL BASED ON PT NANOPARTICLES/ POLY(3,4-ETHYLENEDIOXYTHIOPHENE)-POLY(STYRENESULFONATE) ON FLUORINE-DOPED TIN OXIDE AS COUNTER ELECTRODE ELECTROCATALYST

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Dye-sensitized solar cells (DSSCs) have attracted an increasing interest as an alternative source of energy because of its low cost, easy production, relatively high efficiency, potential transparency and flexibility. In this study, a simple and fast fabrication of DSSC counter electrode was demonstrated based on electrodeposition of Pt nanoparticles on Poly (3,4-ethylenedioxythiophene) poly(styrenesulfonate) (PEDOT:PSS)-modified Fluorine-doped Tin Oxide (FTO) glass substrate. Cyclic Voltammetry (CV) shows that the electrocatalytic activity towards triiodide/ iodide redox reaction of the electrodeposited Pt/PEDOT:PSS on FTO (I_{pc} = -2.07μA/cm^2) is more superior as compared to the spin-coated Pt/ PEDOT:PSS electrocatalyst (I_{pc} = -1.47μA/cm^2). It was also found that the electrocatalytic activity of the Pt particles was enhanced when PEDOT:PSS was used as a support matrix for the Pt particles. Similarly, an increase in the conversion efficiency of DSSC, prepared using Pt nanoparticles-based counter electrodes, was obtained when these nanoparticles were electrochemically deposited on PEDOT:PSS support matrix (6.6%) rather than on bare FTO substrate (6.2%). This efficiency is comparable to the DSSC fabricated using commercial Pt paste (~6.9%) counter electrode. Meanwhile, Field Emission Scanning Electron Microscopy (FESEM) revealed the dispersion and approximate size of Pt particles (~5 nm) on the FTO glass substrate.

Keywords: Dye-sensitized solar cells, counter electrode, platinum nanoparticles, PEDOT:PSS, CV, FESEM

CMPS-04

GOLD NANOPARTICLES IN SILICA SOL-GEL MATRIX: PREPARATION, CHARACTERIZATION, AND APPLICATION

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Gold nanoparticles are attracting much attention in the field of analytical chemistry. In recent years, many attempts have been made to successfully immobilize gold nanoparticles for applications in sensors such as electrochemical and optical sensors. In this study, the feasibility of immobilizing gold nanoparticles in glass substrates using sol-gel method were investigated. The organosilanes: methyltrimethoxysilane (MTMOS) and (3-mercaptopropyl)-trimethoxysilane (MPTMS) were used for the preparation of sol-gel. MTMOS sol-gel was prepared using the solvent system EtOH:MTMOS:0.1MHCl (7.5:3.75:1.0,v/v) and for MPTMS sol-gel, the solvent systems 1%MPTMS in toluene and MPTMS:MeOH:0.1M HCl (1:3:3, molar ratio) were utilized. Spin-coating and dipping techniques were also evaluated for the application of the sol-gel onto the glass substrate prior to the immobilization of AuNPs. The immobilized AuNPs were then characterized using UV-Vis spectroscopy. Spectra of the immobilized AuNPs using MTMOS sol-gel showed no absorbance peaks both in dipping and spin-coating methods indicating the unsuccessful immobilization of the AuNPs. Using MPTMS sol-gel, the dipping technique produced an immobilized AuNPs with absorbance peaks at 565nm and 560nm for MPTMS:MeOH:0.1M HCl and 1%MPTMS in toluene solvent systems, respectively. While the spin-coating technique produced an immobilized AuNPs with an absorbance peak of 580nm only for the MPTMS:MeOH:0.1M HCl solvent system. The potential application for metal ion sensing was demonstrated by exposing the immobilized AuNPs to aqueous solutions of Cd2+, Cr3+, Pb2+ and Ni2+. Varying shifts in the absorbance peaks of the immobilized AuNPs were observed after exposure to these metal ions.

Keywords: Gold nanoparticles, Spin-coating method, Methyltrimethoxysilane sol-gel, (3-mercaptopropyl)-trimethoxysilane sol-gel, UV-Vis spectroscopy

CMPS-05

SECONDARY METABOLITES FROM THE LEAVES OF *Psychotria gitingensis* Elmer

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Phytochemical studies involving the genus *Psychotria* (Rubiaceae) have been conducted and it has been established that many species under this genus contain interesting chemical constituents, mostly comprised of alkaloid-type metabolites. This research intends to isolate and identify the secondary metabolites from the crude foliar extract of *P. gitingensis* Elmer, a plant species endemic to the Philippines. The crude methanolic extract was subjected to acid-base partitioning which gave the crude base extract. Initial normal phase gravity column chromatography (silica gel 60) of the crude base extract afforded nine major fractions (PgC-A to PgC-I) and PgC-F and PgC-G gave light orange spots in TLC using Dragendorff's reagent, which may be indicative of the presence of alkaloids. Further normal phase gravity column chromatographic purification of PgC-F and PgC-G both led to the isolation of vomifoliol, a sesquiterpenoid whose structure was elucidated based on extensive spectroscopic analyses (1D and 2D NMR, and MS) and comparison with reported literature. Vomifoliol was also tested for its antimicrobial activity using the agar diffusion paper-disc method and it showed moderate activity towards *Klebsiella oxytoca* at 0.5 mg/mL. Structure identification and antibacterial evaluation of the other isolated constituents are in progress. The results of this study present an implication on the chemotaxonomic relationship of *P. gitingensis* with other members of genus *Psychotria*. This study represents the first phytochemical work on Philippine *Psychotria*, particularly on *P. gitingensis*, and the first isolation of vomifoliol from the genus *Psychotria*.

Keywords: *Psychotria gitingensis*, Rubiaceae, secondary metabolites, vomifoliol, Dragendorff's reagent

CMPS-06

CUSTOM SYNTHESIS OF ISOTOPE-LABELLED *Apis meliifera* PHEROMONE

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The object of this study is to determine the optimum conditions for the synthesis of isotope-labelled isopentyl acetate. Isopentyl acetate is widely used as a raw material in industries, in syntheses, and is utilized as a sex attractant (pheromone) by the bee species, *Apis mellifera*. The isotope labelling of isopentyl acetate will allow tracking of the fate and movement of the isopentyl acetate in the environment, in chemical transformations, and in biological systems. Esterification by alcoholysis of acetic acid was optimized for the preparation of Carbon -14 (^{14}C)-labelled isopentyl acetate from ^{14}C- labelled acetic acid and isoamyl alcohol. The different conditions studied were: (1) The effects of acid catalysis and or reflux on the amount of yield of the product. (2) The effects of acid catalysis and/or reflux on the incorporation and retention of the isotope label on the product. The efficiency of label incorporation and retention was determined through the beta radioactivity of Carbon 14 in each of the synthetic constructs. Determination of the beta radioactivity concentration of ^{14}C in the isopentyl acetate product was done using low level liquid scintillation spectrometry. Each of the synthetic products was mixed with UltimaGold scintillation cocktail in a low potassium glass scintillation vial, and analysed in a low-level Wallac 1414 scintillation counter. The application of catalysis without reflux resulted in the highest yield (35%). The same condition also resulted in the highest abundance of carbon isotope label with 2.40 Bequerels per cubic centimetre, Bq/cc (measurement unit for radioactivity).

Keywords: liquid scintillation, radiolabelling, carbon 14, isotope, isopentyl acetate

CMPS-07

DEVELOPMENT OF LABORATORY METHOD FOR THE SIMULTANEOUS DETERMINATION OF GROSS ALPHA AND GROSS BETA ACTIVITIES IN WATER BY LIQUID SCINTILLATION COUNTING

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The Philippine National Standards for Drinking Water (PNSDW) includes the determination of the radiological quality of drinking water to ensure that water is safe from contamination due to fallout, or suspected sources of radiological impurities . The standard limits are: 0.1 Bq/L for gross alpha counts and 1.0 Bq/L for gross beta counts. A liquid scintillation (LSA) based method that requires smaller sample quantities, less sample preparation time and operator intervention, and produces adequate minimum detection levels for local drinking water guidelines has been developed. It involves the enrichment of the sample 10 times by evaporation and counting for two hours, the alpha and beta emissions simultaneously by pulse shape analysis using the Guardian 1414 liquid scintillation counter. The method overcomes the self-attenuation problems typical of high dissolved solid waters and gas flow proportional counting that was previously used. Additionally, the need to evaporate large volumes of water, quantitatively transfer residues to counting planchets and developing operator skills in producing homogeneous and evenly distributed samples are eliminated. Operator intervention is also minimized during sample preparation and counting. This resulted in the reduction of analysis time to 1/5 and analysis cost to 1/3 from that using the former procedure. The detection limits: 0.03 -0.06 Bq/L for alpha and 0.2-0.5 Bq/L for beta, are sufficiently low for the required regulatory limits. Detection limits of ≤0.05 Bq/L for gross alpha and ≤0.3 Bq/L for gross beta were achieved for a total of two hours counting per sample.

Keywords: radiological testing, water, liquid scintillation, gross alpha, beta

CMPS-08

POTENTIOMETRIC SENSOR FOR MELAMINE USING ELECTROPOLYMERIZED POLYANILINE MEMBRANE

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A simple, rapid, and inexpensive way of quantifying melamine was devised using a potentiometric sensor based on the molecularly imprinted- polymer (MIP). Polyaniline (PAni) membrane was electrodeposited on a graphite/ epoxy composite electrode using potentiostatic polymerization. Melamine, which served as the template molecule, was extracted from the polymer membrane. Several parameters were optimized such as the applied potential, polymerization time, melamine and aniline molar concentration ratio, conditioning time and pH. The linear range for melamine determination was $1.0x10^{-10}$ - $1.0x10^{-2}$ M in buffered solution with a sensitivity of 0.5380 mV/ decade, linearity of 0.9990 (n= 3) and a limit of detection of $2.5x10^{-15}$ M. The sensor response was found to be repeatable. The morphology of the polymer was probed by scanning electron microscopy (SEM).

Keywords: potentiometry, graphite/ epoxy composite, electropolymerization, polyaniline, molecular imprinting

CMPS-09

EFFECT-DIRECTED ANALYSIS OF POTENTIAL ENDOCRINE DISRUPTORS FROM THE EXTRACTS AND FRACTIONS OF SEDIMENTS FROM LAGUNA LAKE, PHILIPPINES USING THE LYES-ASSAY

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Sediments of aquatic systems serve both as sink and secondary sources of contaminants. Previous studies reported that sediments from Laguna Lake, one of the largest aquatic resources in the Philippines, contain a complex mixture of substances. A large range of these chemicals have shown to act as endocrine-disrupting compounds. The present study, was conducted to further investigate the level of contamination of sediment samples from the lake. The LYES-Assay (Yeast estrogenic screen assay assisted by enzymatic digestion with Lyticase) was performed to screen for estrogenic active fractions in sediment samples from Laguna Lake. Sediment samples from two pre-selected sites within the lake were obtained and subjected to fractionation and effect-directed analysis: Central Bay and East Bay. The sediment samples were extracted using an accelerated solvent extraction method whereas the fractionation of extracts was carried out using the recently-developed automated online multistep fractionation method. Each fraction was tested in seven different dilution steps. Only 5 out of 38 sediment samples showed endocrine activities. In the sediment samples from East Bay four fractions showed a significant endocrine effectiveness at the one fold concentration (fraction 11, 15, 16, 18). The estrogenic activity ranged from 8.43 ± 4.37 ng/L at fraction 18 to 10.79 ± 5.28 ng/L at fraction 15. Only fraction 18 indicated a significant endocrine potential from Central Bay. However, it already showed significant endocrine effectiveness even at the 1/8 fold concentration of 8.80 ± 2.29 ng/L and up to 27.32 ± 18.39 ng/L at the one fold concentration. Overall, the sediment samples did not reveal a very high estrogenic impact when compared with sediments from some European sites. Characterization of fractions exhibiting endocrine activities through further chemical analyses is underway.

Keywords: effect-directed analysis, sediment, endocrine activities, Laguna Lake, LYES assay

CMPS-10

SYNTHESIS OF COBALT BORIDE NANOPARTICLES USING RADIO FREQUENCY THERMAL PLASMA

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Nanosize cobalt boride particles were synthesized from the vapor phase using a 30 kW – 4 MHz radio frequency (RF) thermal plasma. Cobalt and boron powder mixtures used as precursors in different composition and feed rate were evaporated immediately in the high temperature plasma and cobalt boride nanoparticles were produced through the quenching process. The X-ray diffractometry (XRD) patterns of cobalt boride nanoparticles prepared from the feed powder ratio of 1:2 and 1:3 for Co:B showed peaks that are associated with the Co_2B and CoB crystal phases of cobalt boride. The XRD analysis revealed that increasing the powder feed rate results in a higher mass fraction and a larger crystalline diameter of cobalt boride nanoparticles. The images obtained by field emission scanning electron microscopy (FE-SEM) revealed that cobalt boride nanoparticles have a spherical morphology. The crystallite size of the particles estimated with XRD was found to be 18 - 22 nm.

Keywords: cobalt boride nanoparticles, thermal plasma, x-ray diffraction, scanning electron microscopy

CMPS-11

DEVELOPMENT OF LYOPHILIZED COCONUT WATER FOR ISOTONIC BEVERAGES

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Lyophilized coconut water from both young and mature coconuts was developed by ultra low freezing followed by freeze-drying. Lyophilized product with 25% maltodextrin was found to conform with specifications of the commercial product. Likewise, it remained stable up to six months or more after processing as long as it is stored in freezing temperature. Developed product will be used as isotonic beverage or sports drink. Physico-chemical properties of coconut water from young and mature coconuts were characterized and compared. Likewise, microbial evaluation was conducted. Mineral content was further analyzed and compared with sports drink. Results of the analysis showed that mineral contents such as sodium, potassium, calcium, magnesium, iron, copper and phosphorus were found higher in mature coconut water than in young coconut water. There were slight differences in the physico-chemical properties but microbial evaluation showed higher contamination (total plate count and mold & yeast count) in mature coconut water than young coconut water. However, these results including *Pseudomonas* & *Salmonella* counts were found within required limits. Results for *E.coli* and *S. aureus* counts fall slightly below the required limits. Mineral content from both sources was found higher than sports drink in terms of potassium and magnesium content.

Keywords: lyophilized coconut water, isotonic beverages, mineral content, microbial evaluation

CMPS-12

ISOLATION AND STRUCTURE CHARACTERIZATION OF CHEMICAL CONSTITUENTS FROM *Micromelum compressum* WITH *IN VITRO* ANTITUBERCULOSIS ACTIVITY

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This study investigated polymethoxy flavones from the leaves of *Micromelum compressum* with synergistic inhibitory effect against *Mycobacterium tuberculosis* H37Rv. The crude DCM-MeOH extract obtained from the sample exhibited 84% inhibition against *M. tb.* at 128 μg/mL using the colorimetric microplate Alamar blue assay (MABA). It was subjected to acid-base partitioning, followed by partitioning by polarity using petroleum ether, DCM, and water and gave three fractions (McP, McD, and McW). McD was partitioned using vacuum liquid chromatography yielding five fractions where the third showed 96% inhibition against *M. tb.*, while McP showed 92%, at 128 μg/mL. Silica chromatographic purification of McD3 resulted in the isolation of the following: 3,5,7,4'-tetramethoxyflavone (McD3.3), a 1:1 mixture of McD3.3 and 3,5,7,8,4'-pentamethoxyflavone (McD3.5), and a mixture with the pentamethoxyflavone and traces of McD3.3 (McD3.6) The structures were elucidated using HREIMS, 1H-NMR, 13C-NMR, COSY, HSQC and HMBC. MABA showed McD3.3 and McD3.6 to have low inhibition against *M. tb.* Surprisingly, McD3.5, exhibited a good activity with a minimum inhibitory concentration (MIC) of 15.98 μg/mL. The results also uniquely present the synergism of two polymethoxy flavones in enhancing the inhibition of *M. tb.*, making it a potential source of antitubercular constituents.

Keywords: *Micromelum compressum*, polymethoxy flavones, synergistic effect, antitubercular inhibitory activity, antitubercular constituents

CMPS-13

SYNCHRONIZING p TIMEPIECES IN $\Theta(\log_2 p)$ STEPS

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In response to Department of Science and Technology's (DOST) "Juan Time, On Time" program, which aims to encourage Filipinos to use the Philippine Standard Time, we take it further by providing a log(p) broadcast and reduction protocol for automatic synchronization of p timepieces that are connected through some communication media (*e.g.* Wi-Fi, LAN, *etc.*), where the current Berkeley protocol uses p steps. Given p timepieces displaying different time readings T_1, T_2, ..., T_P, respectively, the purpose of the communication schemes is to :

1. Perform a many-to-one reduction with log(p) steps of T_i, for all i's, to a designated master timepiece p_1, incorporating the time-delay due to reduction propagation r_i to each T_i at the ith reduction step.

2. The master timepiece p_1 performs an average T' of the $T_i + r_i$, and then updates its own time by $T'' = T' + C(T')$, where $C(x)$ is the time cost of performing the mathematical operation x.

3. The master then initiates a log(p)-step one-to-many broadcast of T'', where at the ith step of the broadcast, the time-delay b_i due to broadcast propagation is recorded, and the timepieces involved in the broadcast step updates its own clock by $b_i + T''$.

At the end of the reduction and broadcast, all P timepieces will display the same $b_{\log p} + T''$ time, which can be done in exactly $\Theta(\log p)$.

Keywords: clock synchronization, Berkeley algorithm, broadcast, reduction, $\Theta(\log p)$ steps

CMPS-14

THE HANKEL TRANSFORM OF GENERALIZED BELL NUMBERS

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The generalized Bell numbers, denoted by $G_{n,\beta,r}$, are defined by

$$G_{n,\beta,r} = \sum_{k=0}^{n} S(n,k;\beta,r)$$

where $S(n,k;\beta,r) = \lim_{\alpha\to 0} S(n,k;\alpha,\beta,r)$ with $S(n,k;\alpha,\beta,r)$ are the unified generalization of Stirling numbers by L.C. Hsu and P.J-S. Shuie. The numbers $S(n,k;\beta,r)$ are exactly the *r*-Whitney numbers of the second kind and the same numbers considered by Rucinski and Voight. In this paper, the following recurrence relations for $G_{n,\beta,r}$ are established

1. $G_{n,\beta,r+1} = \sum_{k=0}^{n} \binom{n}{k} G_{k,\beta,r}$,

2. $G_{n,\beta,r} = \sum_{k=0}^{n} (-1)^{n-k} \binom{n}{k} G_{k,\beta,r+1}$.

These recurrence relations are used in obtaining the Hankel transform of the sequence $\left(G_{n,\beta,r}\right)$, which is given by

$$\begin{vmatrix} G_{0,\beta,r} & G_{1,\beta,r} & G_{2,\beta,r} & \cdots & G_{n,\beta,r} \\ G_{1,\beta,r} & G_{2,\beta,r} & G_{3,\beta,r} & \cdots & G_{n+1,\beta,r} \\ \vdots & \vdots & \vdots & \cdots & \vdots \\ G_{n,\beta,r} & G_{n+1,\beta,r} & G_{n+2,\beta,r} & \cdots & G_{2n,\beta,r} \end{vmatrix} = \prod_{k=0}^{n} \beta^k k!$$

Keywords: Generalized Bell numbers, Stirling numbers, Hankel transform, Hankel matrix, *r*-Whitney numbers.

CMPS-15

SOME CONVOLUTION-TYPE IDENTITIES AND CONGRUENCE RELATION OF THE LIMIT OF THE DIFFERENCES OF GENERALIZED FACTORIAL

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The generalized Stirling numbers of the first kind $F_{\alpha,\gamma}(n,k)$ are defined by means of the following limit relation

$$F_{\alpha,\gamma}(n,k)=\lim_{\beta\to 0}\frac{\left[\Delta_t^k(\beta t+\gamma\mid\alpha)_n\right]_{t=0}}{k!\,\beta^k}$$

where are real numbers and n, k are nonnegative integers. The limit, when evaluated completely, gives an explicit formula

$$F_{\alpha,\gamma}(n,k)=\sum_{0\le j_1<j_2<\ldots<j_{n-k}\le n-1}\prod_{q=1}^{n-k}\left(\gamma-j_q\alpha\right)$$

In this paper, we establish the following convolution-type identities

1. $\binom{k}{k_1}F_{\alpha,\gamma}(n,k)=\sum_{m=0}^{n}F_{\alpha_1,\gamma_1}(m,k_1)F_{\alpha_2,\gamma_2}(n-m,k_2)$
   where $k=k_1+k_2$ and $\gamma=\gamma_1+\gamma_2$,
2. $F_{\alpha,\gamma}(n,k)=\sum_{l=0}^{k}F_{\alpha,\gamma}(n_1,l)F_{\alpha,\gamma-n_1\alpha}(n_2,k-l)$ where $n=n_1+n_2$.

Consequently, we obtain the following congruence relation

$$F_{\alpha,\gamma}(p,k)\equiv 0(\mathrm{mod}\,p)$$

where $1<k<p$.

Keywords: convolution-type identity, congruence relation, 0-1 tableau, generalized factorial, Stirling numbers

CMPS-16

SHARPNESS OF THE CRITICAL CONSTANT OF THE IMPROVED RELLICH INEQUALITY

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Let Ω be a bounded domain in R^n with $0 \in \Omega$ and $n \geq 3$. For any $1 < p < \frac{n}{2}$, the well-known Rellich inequality

$$\int_\Omega |\Delta u(x)|^p dx \geq \left(\frac{n-2p}{p}\right)^p \left(\frac{p-n}{p}\right)^p \int_\Omega \frac{|u(x)|^p}{|x|^{2p}} dx \qquad (1)$$

holds for any $u \in W_0^{2,p}(\Omega)$. The improvement of inequality (1) gains much attention in the recent years because of its application in Potential and Magnetic Theory. It also allows us to assume $p = \frac{n}{2}$. In this paper, we consider the inequality

$$\int_\Omega |\Delta u(x)|^{\frac{n}{2}} dx \geq \left(\frac{n-2}{\sqrt{n}}\right)^n \int_\Omega \frac{|u(x)|^p}{|x|^{2p}} \left(\log \frac{R}{|x|}\right)^{-\frac{n}{2}} dx + C^* \int_\Omega \frac{|u(x)|^p}{|x|^{2p}} \left(\log \frac{R}{|x|}\right)^{-\frac{n}{2}-1} dx \qquad (2)$$

for any $u \in W_0^{2,\frac{n}{2}}(\Omega)$. This is an improvement of (1) at $p = \frac{n}{2}$. We call this condition, the Critical Case of the improvement. We shall prove the sharpness of the critical constant $\left(\frac{n-2}{\sqrt{n}}\right)^n$ which guarantees further improvement of inequality (2).

Keywords: Rellich Inequality, Critical Constant, Sharp Constant, eigenvalue, Potential Theory.

CMPS-17

ON THE REPRESENTATION OF AB-GENERALIZED LUCAS SEQUENCE BY HESSENBERG MATRICES

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Let n be a positive integer. The Lucas sequence {Ln} has the recurrence relation $L_{n+1} = L_n + L_{n-1}$, where $L_0=2$ and $L_1=1$. A lower Hessenberg matrix $M_n = (a_{ij})$ is an nxn matrix where $a_{jk} = 0$ whenever $k > j+1$ and $a_{j(j+1)} \neq 0$ for some j. In this paper, we introduce the second order linear recurrence relation of the AB-generalized Lucas sequence $\{v_n\}$ and give the relationships between $\{v_n\}$ and Hessenberg permanents and determinants. Moreover, we also give representations of $\{v_{2n}\}$ and $\{v_{2n+1}\}$.

Keywords: Lucas sequence, AB-generalized Lucas sequence, Hessenberg matrix, Hessenberg permanent, Hessenberg determinant

CMPS-18

SUPER-CONTINUITY AND SUPER-CONNECTEDNESS

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This study considered the topological concepts such as super-open, super-closed, super-closure, and super-continuity introduced by Volicko in 1968. Equivalent statements of super-continuity of a function are obtained. Super-connectedness is defined and it is shown that this concept is equivalent to the ordinary concept of connectedness.

The following main results have been generated in this study:

1. Let (X,τ) be a topological space and τ^* be the family consisting of all the super-open subsets of X. Then τ^* is a topology on X.
2. Let $f: X \to Y$ be a function. Then the following statements are equivalent.
   (a) f is super-continuous on X.
   (b) $f^{-1}(F)$ is super-closed for every closed subset F of Y.
   (c) $f^{-1}(B)$ is super-open for every (sub-basic) basic open set B in Y.
   (d) For each $p \in X$ and every open set V in Y containing $f(p)$, there exists an open set O in X such that $p \in O$ and $f(Cl(O)) \subseteq V$.
   (e) $f(Cls(A)) \subseteq Cl(f(A))$ for every subset A of X.
   (f) $Cls(f^{-1}(B)) \subseteq f^{-1}(Cl(B))$ for every subset B of Y.
3. Let (X,τ) be a topological space. Then the following statements are equivalent.
   (a) X is connected.
   (b) X is super-connected.
   (c) The only subsets of X both super-open and super-closed are $\varnothing$ and X.
   (d) No super-continuous function $f: X \to 2$ is surjective, where 2 is the space $Y = \{0,1\}$ with the discrete topology.

Keywords: super-open, super-closed, super-closure, super-continuity, super-connectedness

CMPS-19

ON THE HAMILTONICITY OF PRODUCT GRAPH $G \square S_m$, FOR A GRAPH G OF ORDER n, AND STAR GRAPH S_m, $n \geq m$

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The Cartesian product of two Hamiltonian graphs is again Hamiltonian, but the hamiltonicity of the product of two graphs of which one may not be Hamiltonian is generally unknown. This study will provide the necessary and sufficient conditions for the hamiltonicity of the Cartesian product of two graphs when one of the graphs is Hamiltonian. Given two graphs G and H, the cartesian product, G□H (Cartesian product of graph G and graph H) is the graph whose vertex set is V (G)×V (H) and the set $\{(u_1, v_1), (u_2, v_2)\}$ is an edge if and only if exactly one of the following is true.
(i) $u_1 = u_2$ and $\{v_1, v_2\}$ is an edge in H.
(ii) $v_1 = v_2$ and $\{u_1, u_2\}$ is an edge in G.
A star graph S_m, also known as a complete bipartite graph $K_{1,m}$, is a graph whose vertex set consists of the union of two disjoint sets $V_1 = \{c\}$ and $V_2 = \{v_1, v_2, \ldots, v_m\}$, known as partites, such that no two vertices in V_2 are adjacent to each other but all of them are adjacent to c. A hamiltonian graph is a graph that contains a cycle containing all its vertices. Clearly, S_m is not hamiltonian for all $m \geq 1$.

In this paper the following shall be proven:

Let G be a hamiltonian graph , C_n be a cycle graph and K_n be a complete graph, all of orders n, and S_m be a star graph, $m \geq 1$, then

1. $C_n \square S_m$ is hamiltonian if and only if $n \geq 3$
2. $K_n \square S_m$ is hamiltonian if and only if $n \geq 2$
3. $G \square S_m$ is hamiltonian if and only if $n \geq m$.

Keywords: graph, hamiltonian graph, Cartesian product of graph, complete graph, star graph

CMPS-20

DETERMINATION OF THE INTRUDER'S LOCATION IN A GIVEN NETWORK

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The exact location of an intruder in a given network or graph can be determined using the concept of locating-dominating set in a graph. In this study, the locating-dominating sets in the joins of graphs are characterized in terms of other related concepts and the associated locating-domination numbers are determined. Just like other existing monitoring strategies, the objective in this strategy is to evaluate or determine the minimum number of monitoring devices needed to determine the exact location of a possible intruder in a graph or network. The following main results have been generated in this study:

1. For any connected graph G, $ln(G) \leq \gamma_L(G) \leq \gamma_{SL}(G)$.
2. Let G be a connected graph of order $n \geq 2$. Then $\gamma_L(G) = n - 1$ if and only if $G = K_n$ or $G = K_{n-1}$.
3. Let G and H be connected non-trivial graphs. Then $S \subseteq V(G+H)$ is a locating dominating set in $G+H$ if and only if $S_1 = V(G)\backslash S$ and $S_2 = V(H)\backslash S$ are locating sets in G and H, respectively, where S_1 or S_2 is strictly locating.
4. Let G and H be connected non-trivial graphs. Then $\gamma_L(G+H) = \min\{sln(H) + ln(G), sln(G) + ln(H)\}$.

Keywords: graph, domination, locating, strictly locating, locating domination number

CMPS-21

THE AVERAGE OF THE 10th POWER OF THE L_{10} NORM OVER THE LITTLEWOOD POLYNOMIALS ON THE BOUNDARY OF THE UNIT DISK

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Let $\mathsf{L}_n = \left\{ P : P(z) = \sum_{j=0}^{n} a_j z^j, a_j \in \{1,-1\} \right\}$ be the set of all Littlewood polynomials of degree n where $n \geq 0$ an integer. Further, let $\mu_n(m) = \frac{1}{2^{n+1}} \sum_{P \in \mathsf{L}_n} \|P\|_m^m$ be the average of the m^{th} power of the L_m-norms over L_n where $\|P\|_m = \left\{ \frac{1}{2\pi} \int_0^{2\pi} |P(z)|^m \, d\theta \right\}^{1/m}$ is the L_m-norm of P on the unit circle. The formulae for $\mu_n(m)$ for m = 2 , 4, 6 and 8 have been established in the literature by Borwein and Choi in their paper entitled ``The Average Norm of Polynomials of Fixed Height''. In this paper, the exact formulae for $\mu_n(10)$ which is

$$\mu_n(10) = 120n^5 + 150n^4 - 350n^3 + 265n^2 + 281n - 144 - 75n(-1)^n + 145(-1)^n$$

was derived by the authors in an entirely different approach which makes this result new and is the tip of an iceberg that we explore further.

Keywords: Littlewood polynomial, average, -spaces, norm, unit circle