

# **12th INTERNATIONAL MARDIN ARTUKLU SCIENTIFIC RESEARCHES CONFERENCE**

**August 17-19, 2024 / Mardin, Turkiye**



## **Abstracts Book**

**Editors**

**Assoc. Prof. Dr. Naseem AKHTER**

**Gulnaz GAFUROVA**

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**ABSTRACTS BOOK**

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## CONTENTS

<b>CONGRESS ID</b>	I
<b>PHOTO GALLERY</b>	II
<b>PROGRAM</b>	III
<b>CONTENT</b>	IV

## ABSTRACTS

AUTHOR	TITLE	No
A.Dinesh babu E.Velmurugan Shanur Rahman srinivasan	NEUROPROTECTIVE AGENTS, NATURAL PLANT HERBS & DRUGS IN ISCHEMIC STROKE: A REVIEW	1
Abdullah Hilmi LAV Hüseyin ÇUHA	REGRESSION ANALYSIS OF ROAD STRUCTURE: ROUGHNESS PREDICTION WITH MACHINE LEARNING MODELS	2
ABRU, John Obri	ARTISTIC HISTORICAL RECREATION AND REVOLUTIONARY PRESSURES IN HUSSIEN'S KINJEKETILE	4
Ait Hmeid H Akodad M El Halim M Omdi F.E Baghour M Skalli A Chahban M Aalaoul M	SEDIMENTOLOGY AND CHARACTERIZATION PHYSICO-CHEMICAL AND TEXTURAL PROPERTIES OF BENTONITES KERT NEOGENE BASIN	5
Ait Hmeid Laila	PERSONALIZED MOVIE RECOMMENDATION SYSTEM	6
AKIGHIRGA, Luter Richard ALIDU, John Paul AKULEGA, Theophilus ORKUMA, Terungwa Gabriel	DESIGN AND IMPLEMENTATION OF 5BITS UP AND DOWN COUNTER USIMG J K FLIP FLOP	7
Aliyu Hassan	A CASE STUDY OF THE TUDUN ILU NEIGHBORHOOD IN KADUNA, NIGERIA, EXAMINING THE EFFECTS OF UNCONTROLLED WASTE DISPOSAL AND ITS EFFECTS DURING THE COVID-19 PANDEMIC	8
Alperen AĞCA	HOW DO MILITARY EXPENDITURES AND OIL CONSUMPTION AFFECT ECONOMIC GROWTH DURING RUSSIA AND UKRAINE CONFLICT? A PANEL ARDL STUDY	9
Alphones Abbas Zheer Ahmed	REVEALING TIME DISPARITIES, WHILE UNPACKING THE SOCIAL CONSTRUCT OF TEMPORALITY	10
Amel RIAH Salim BOUSBA Dhirar BEN SALEM	REDUCTION OF CRYSTAL VIOLET DYE FROM WATER BY NANOSTRUCTURED CARBON: INFLUENCING FACTORS AND ADSORPTION BEHAVIOUR	11

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Habip TAK Haluk KORKMAZ	THE ROLE AND LEGAL OBLIGATIONS OF BANKS IN FIGHTING MONEY LAUNDERING	76
HAGAR ALILABIB GOKHAN GELISEN	COMPARISON OF CRYPTOCURRENCIES AND SUSTAINABLE ENERGY AS INVESTMENT OPPORTUNITIES	78
HAJJAJ Mohammed Amine BEL-MKADDEM Zakariae	AN ANALYSIS OF MOROCCO'S GDP GROWTH: EXAMINING THE IMPACT OF TECHNOLOGICAL INTEGRATION ON ECONOMIC DEVELOPMENT	79
Haruna Karamba Zainab Umar Zandam Usaini Aliyu	ECONOMIC IMPORTANCE OF TOBACCO MOSAIC VIRUS (TMV) A REVIEW	80
Hayatem Hamal	THE MOMENTS AND CENTRAL MOMENTS OF KANTOROVICH TYPE OF BERNSTEIN OPERATORS VIA ( $p,q$ )-CALCULUS	81
Hazar KESKİN Hayri ABAR	THE EVALUATION OF REGIONAL ELECTRICITY CONSUMPTION IN TÜRKİYE FROM THE PERSPECTIVE OF ENERGY EFFICIENCY	82
Hector Miguel Azpe-Santiago Manoj-Kumar Arthikala Kalpana Nanjareddy	TRANSCRIPTIONAL DOWNREGULATION OF <i>PvPCO1</i> : EFFECTS ON ROOT AND ROOT HAIR GROWTH IN <i>PHASEOLUS VULGARIS</i>	84
İbrahim Halil POLAT	TRB2 BÖLGESİNDE BİYOKÜTLE ENERJİSİNİN POTANSİYELİ VE TERSİNE LOJİSTİK FAALİYETİ ÜZERİNE BİR DEĞERLENDİRME	85
İsmail AKÇAY	HEAVY METAL DISTRIBUTIONS IN SURFACE SEDIMENTS OF A COASTAL REGION (MERSİN BAY, TÜRKİYE)	87
Ismail Olaniyi MURAINA Imran Ademola ADELEKE	EMOJI USE IN SCIENCE: FOSTERING COLLABORATION OR FUELING CONFUSION?	88
K. Kumararaja B. Sivaraman	OPTIMIZING HEAT PIPE OUTLET TEMPERATURE WITH HYBRID NANOFUIDS THROUGH DEEP NEURAL NETWORK	89
K.Pushparaj R.Selva kumar Manikandan R.Srinivasan	BIOLOGICAL AND MEDICINAL PROPERTIES OF COUROUPITA GUIANENSIS	90
Kadirhan Önk Hatice Ekici	A REVIEW OF INTERGROUP CONTACT INTERVENTIONS ON THE ISLAND OF CYPRUS	91
Khalid Elatife Abdellatif El Marjani Zakaria Lafdaili	APPLICATION OF THE DOE METHOD TO OPTIMIZE A RADIAL IMPULSE TURBINE FOR WAVE ENERGY CONVERSION	93
Kinza Zulfiqar Hafeez Anwar	ENHANCING EFFICIENCY OF PEROVSKITE SOLAR CELLS FROM SURFACE PASSIVATION OF Cr <sup>3+</sup> DOPED CuGaO <sub>2</sub> AS AN INORGANIC HOLE TRANSPORT MATERIAL (HTM)	94
Kiril Degtyarev Vasyl Gnitko Denys Kriutchenko Vitaly Naumenko Olena Sierikova Elena Strelnikova	LIQUID SLOSHING IN FUEL TANKS UNDER PERIODIC LOADS WITH DAMPING	95

## LIQUID SLOSHING IN FUEL TANKS UNDER PERIODIC LOADS WITH DAMPING

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### Abstract

**Objective.** This research focuses on analysing the stability of fluid movement within tanks subjected to coupled external periodic loads, incorporating the effects of damping. An efficient computational method has been developed, utilizing the method of given modes and the one-dimensional boundary element method. Upon solving the spectral problem and determining the natural frequencies and modes of liquid oscillations in a rigid tank, a system of differential equations is derived to describe the free surface's movement over time. These equations are obtained using the dynamic condition on the free surface. The stability of liquid movement under vertical harmonic loads is examined using the Ince-Strutt diagram for each fundamental frequency.

**Relevance.** New conditions of using equipment and introduction of new materials have significantly altered the stress-strain states and vibration characteristics of elements in modern structures. This necessitates enhanced research into the strength and dynamic characteristics of equipment operating under increased force and temperature conditions, especially when interacting with various aggregates. The issue of liquid sloshing in tanks first emerged in the 1960s with the advent of space vehicle flights. Poor design choices led to significant liquid fluctuations in fuel tanks, resulting in stability loss, deviations from calculated trajectories, and even complete destruction of launch vehicles. Designing powerful new launch vehicles demands innovative tank designs, which can now take on quite exotic forms [1]. Consequently, interest in studying the motion stability of reservoirs and fuel tanks has persisted for several decades [2]-[4].

**Conclusion.** A method has been developed to determine the time-varying level of the free surface of a liquid in rigid shells of rotation. The spectral problem of identifying the frequencies and modes of liquid oscillations in a truncated conical tank is addressed by reducing it to a system of one-dimensional integral equations. Using the Ains-Strett diagram, zones of instability in fluid movement under harmonic vertical loads have been identified. The influence

of Rayleigh damping on the growth of the free surface level has been clarified. Future work will focus on studying the oscillations of elastic shells of rotation containing liquid, using various composite materials [7].

**Keywords:** free surface, liquid sloshing in tanks, singular integral equations, boundary element method, damping, Ince-Strutt diagram