

Kod Rujukan: (Diisi oleh PJI)	
RIG	
Bukti Kolaborasi (Diisi oleh PJI)	

**BORANG PERMOHONAN
GERAN SEMARAK PENYELIDIKAN (GSP) 2024
Bahagian Penyelidikan & Jaringan Industri (PJI)
UiTM CAWANGAN PERLIS**

A	TITLE OF PROPOSED RESEARCH: <i>Tajuk penyelidikan yang dicadangkan :</i> Synthesis and Characterization of Divalent Ca-Fe and Zn-Fe Layered Double Hydroxide (LDH) for Adsorption of Heavy Metal Ions from Aqueous Solutions		
B	DETAILS OF RESEARCHER / MAKLUMAT PENYELIDIK		
B(i)	<table><tr><td>Name of Project Leader: <i>Nama Ketua Projek:</i> WAN NUR ATIKAH HAJI WAN NAFI</td><td>IC / Passport Number: <i>No. Kad Pengenalan/ Pasport:</i> 910211-03-6090</td></tr></table>	Name of Project Leader: <i>Nama Ketua Projek:</i> WAN NUR ATIKAH HAJI WAN NAFI	IC / Passport Number: <i>No. Kad Pengenalan/ Pasport:</i> 910211-03-6090
Name of Project Leader: <i>Nama Ketua Projek:</i> WAN NUR ATIKAH HAJI WAN NAFI	IC / Passport Number: <i>No. Kad Pengenalan/ Pasport:</i> 910211-03-6090		
B(iii)	Faculty/School/Centre/Unit (Please provide full address): <i>Fakulti/Jabatan /Pusat/Unit (Sila nyatakan Kolej pengasas, UiTM CAWANGAN PERLIS, 02600, ARAU, PERLIS.</i> FAKULTI SAINS GUNAAN UiTM PERLIS		
B(iv)	<table><tr><td>Office Telephone No.: <i>No. Telefon Pejabat:</i> -</td><td>Handphone No.: 013-333 8323 <i>No. Telefon Bimbit:</i></td></tr></table>	Office Telephone No.: <i>No. Telefon Pejabat:</i> -	Handphone No.: 013-333 8323 <i>No. Telefon Bimbit:</i>
Office Telephone No.: <i>No. Telefon Pejabat:</i> -	Handphone No.: 013-333 8323 <i>No. Telefon Bimbit:</i>		
B(v)	E-mail Address: atikahnafi@uitm.edu.my <i>Alamat e-mel:</i>		

B(vi)	Date of first appointment with this University: 1 MAC 2024 <i>Tarikh mula berkhidmat dengan Universiti ini:</i>																														
C	RESEARCH INFORMATION / MAKLUMAT PENYELIDIKAN																														
C(i)	Research Domain (Please tick (√)): <i>Domain Penyelidikan (Sila tanda (√)):</i> A. Pure and Applied Sciences (Sains Tulen dan gunaan) <table border="0"> <tr> <td>☒ Chemistry (Kimia)</td> <td>☐ Physic (Fizik)</td> <td>☐ Biology (Biologi)</td> </tr> <tr> <td>☐ Biochemistry (Biokimia)</td> <td>☐ Materials Science (Sains Bahan)</td> <td>☐ Mathematics and Statistics (Matematik dan Statistik)</td> </tr> <tr> <td colspan="3">☐ Materials Science (Sains Bahan)</td> </tr> </table> B. Social Sciences (Sains Sosial) <table border="0"> <tr> <td>☐ Anthropology (Antropologi)</td> <td>☐ Psychology (Psikologi)</td> <td>☐ Sociology (Sosiologi)</td> </tr> <tr> <td>☐ Political Science (Sains Politik)</td> <td>☐ Business and Management (Pengurusan dan Perniagaan)</td> <td>☐ Geography (Geografi)</td> </tr> <tr> <td>☐ Economic (Ekonomi)</td> <td>☐ Human Ecology (Ekologi Manusia)</td> <td>☐ Communication (Komunikasi)</td> </tr> </table> C. Arts and Applied Arts (Sastera dan Sastera Ikhtisas) <table border="0"> <tr> <td>☐ Language and Linguistic (Bahasa dan Linguistik)</td> <td>☐ Literature (Kesusasteraan)</td> <td>☐ Religion (Agama)</td> </tr> <tr> <td>☐ Philosophy (Falsafah)</td> <td>☐ Civilization (Tamadun)</td> <td>☐ History (Sejarah)</td> </tr> <tr> <td>☐ Art (Seni)</td> <td>☐ Culture (Budaya)</td> <td>☐ Education (Pendidikan)</td> </tr> <tr> <td>☐ Policies and Law (Dasar dan Undang-undang)</td> <td>☐ Built Environment (Alam Bina-Aspek Kemanusiaan)</td> <td>☐ Environment (Alam Sekitar-Aspek Kemanusiaan)</td> </tr> </table>	☒ Chemistry (Kimia)	☐ Physic (Fizik)	☐ Biology (Biologi)	☐ Biochemistry (Biokimia)	☐ Materials Science (Sains Bahan)	☐ Mathematics and Statistics (Matematik dan Statistik)	☐ Materials Science (Sains Bahan)			☐ Anthropology (Antropologi)	☐ Psychology (Psikologi)	☐ Sociology (Sosiologi)	☐ Political Science (Sains Politik)	☐ Business and Management (Pengurusan dan Perniagaan)	☐ Geography (Geografi)	☐ Economic (Ekonomi)	☐ Human Ecology (Ekologi Manusia)	☐ Communication (Komunikasi)	☐ Language and Linguistic (Bahasa dan Linguistik)	☐ Literature (Kesusasteraan)	☐ Religion (Agama)	☐ Philosophy (Falsafah)	☐ Civilization (Tamadun)	☐ History (Sejarah)	☐ Art (Seni)	☐ Culture (Budaya)	☐ Education (Pendidikan)	☐ Policies and Law (Dasar dan Undang-undang)	☐ Built Environment (Alam Bina-Aspek Kemanusiaan)	☐ Environment (Alam Sekitar-Aspek Kemanusiaan)
☒ Chemistry (Kimia)	☐ Physic (Fizik)	☐ Biology (Biologi)																													
☐ Biochemistry (Biokimia)	☐ Materials Science (Sains Bahan)	☐ Mathematics and Statistics (Matematik dan Statistik)																													
☐ Materials Science (Sains Bahan)																															
☐ Anthropology (Antropologi)	☐ Psychology (Psikologi)	☐ Sociology (Sosiologi)																													
☐ Political Science (Sains Politik)	☐ Business and Management (Pengurusan dan Perniagaan)	☐ Geography (Geografi)																													
☐ Economic (Ekonomi)	☐ Human Ecology (Ekologi Manusia)	☐ Communication (Komunikasi)																													
☐ Language and Linguistic (Bahasa dan Linguistik)	☐ Literature (Kesusasteraan)	☐ Religion (Agama)																													
☐ Philosophy (Falsafah)	☐ Civilization (Tamadun)	☐ History (Sejarah)																													
☐ Art (Seni)	☐ Culture (Budaya)	☐ Education (Pendidikan)																													
☐ Policies and Law (Dasar dan Undang-undang)	☐ Built Environment (Alam Bina-Aspek Kemanusiaan)	☐ Environment (Alam Sekitar-Aspek Kemanusiaan)																													

D. Natural Sciences and National Heritage (*Sains Tabii dan Warisan Negara*)

☐ Environment
(*Alam Sekitar*)

☐ Forestry
(*Perhutanan*)

☐ Agriculture
(*Pertanian*)

☐ Marine
(*Marin*)

☐ Archaeology
(*Arkeologi*)

☐ Geoscience
(*Geosains*)

☐ Ethnography
(*Etnografi*)

☐ Built Environment
(Heritage Aspect)
Alam Bina (Aspek Warisan)

☐ Culture
(*Budaya*)

☐ Biodiversity
(*Kepelbagaian Biologi*)

E. Information and Communication Technology (*Teknologi Maklumat dan Komunikasi*)

☐ Software and Information System
(*Perisian dan Sistem Maklumat*)

☐ Soft Computing
(*Pengkomputeran Lembut*)

☐ Computer Networking
(*Rangkaian Komputer*)

☐ Information Security
(*Keselamatan Maklumat*)

☐ Multimedia
(*Multimedia*)

☐ Computer Engineering
(*Kejuruteraan Komputer*)

☐ Computer Science
(*Sains Komputer*)

F. Health Sciences (*Sains Kesihatan*)

☐ Basic Medical Sciences
(*Sains Perubatan Asas*)

☐ Pharmacy
(*Farmasi*)

☐ Pharmacology
(*Farmakologi*)

☐ Medical Microbiology
(*Mikrobiologi Perubatan*)

☐ Parasitology
(*Parasitologi*)

☐ Pathology
(*Pathologi*)

☐ Community Medical Prevention
(*Perubatan Pencegahan Masyarakat*)

☐ Clinical Surgical
(*Klinikal Surgikal*)

☐ Clinical Medical
(*Klinikal Medikal*)

☐ Associate Health Science
(*Sains Kesihatan Bersekutu*)

☐ Dental
(*Pergigian*)

☐ Nursing Science
(*Sains Kejururawatan*)

C(ii)	Location of Research: <i>Tempat penyelidikan dijalankan:</i> UiTM Perlis Branch																																		
C(iii)	Duration of this research (Maximum 24 months): <i>Tempoh masa penyelidikan ini (Maksimum 24 bulan):</i> Duration: 2 year <i>Tempoh :</i> From : 1 Jan 2025 <i>Dari :</i> To : 31 Dec 2026 <i>Hingga :</i>																																		
C(iv)	Other Researchers: <i>Ahli-ahli penyelidik yang lain:</i> <table border="1" data-bbox="199 1108 1555 1856"> <thead> <tr> <th data-bbox="199 1108 267 1297">Bil</th><th data-bbox="267 1108 573 1297">Name <i>Nama</i></th><th data-bbox="573 1108 865 1297">IC / Staff Number: <i>No. Kad Pengenalan/ No. Pekerja:</i></th><th data-bbox="865 1108 1235 1297">University / Industry / Agency <i>Fakulti/ P.Pengajian/ Pusat/Unit</i></th><th data-bbox="1235 1108 1555 1297">Academic Qualification/ Designation <i>Tahap Kelayakan Akademik/Jawatan</i></th></tr> </thead> <tbody> <tr> <td data-bbox="199 1297 267 1413">1</td><td data-bbox="267 1297 573 1413">PM DR AMALINA M. AFIFI</td><td data-bbox="573 1297 865 1413">760907-08-5404</td><td data-bbox="865 1297 1235 1413">UNIVERSITI MALAYA</td><td data-bbox="1235 1297 1555 1413">PROF MADYA</td></tr> <tr> <td data-bbox="199 1413 267 1535">2</td><td data-bbox="267 1413 573 1535">DR NABILAH AKEMAL MUHD ZAINI</td><td data-bbox="573 1413 865 1535">921001-03-5448</td><td data-bbox="865 1413 1235 1535">UITM PERLIS</td><td data-bbox="1235 1413 1555 1535">DR</td></tr> <tr> <td data-bbox="199 1535 267 1640"></td><td data-bbox="267 1535 573 1640"></td><td data-bbox="573 1535 865 1640"></td><td data-bbox="865 1535 1235 1640"></td><td data-bbox="1235 1535 1555 1640"></td></tr> <tr> <td data-bbox="199 1640 267 1745"></td><td data-bbox="267 1640 573 1745"></td><td data-bbox="573 1640 865 1745"></td><td data-bbox="865 1640 1235 1745"></td><td data-bbox="1235 1640 1555 1745"></td></tr> <tr> <td data-bbox="199 1745 267 1856"></td><td data-bbox="267 1745 573 1856"></td><td data-bbox="573 1745 865 1856"></td><td data-bbox="865 1745 1235 1856"></td><td data-bbox="1235 1745 1555 1856"></td></tr> </tbody> </table>					Bil	Name <i>Nama</i>	IC / Staff Number: <i>No. Kad Pengenalan/ No. Pekerja:</i>	University / Industry / Agency <i>Fakulti/ P.Pengajian/ Pusat/Unit</i>	Academic Qualification/ Designation <i>Tahap Kelayakan Akademik/Jawatan</i>	1	PM DR AMALINA M. AFIFI	760907-08-5404	UNIVERSITI MALAYA	PROF MADYA	2	DR NABILAH AKEMAL MUHD ZAINI	921001-03-5448	UITM PERLIS	DR															
Bil	Name <i>Nama</i>	IC / Staff Number: <i>No. Kad Pengenalan/ No. Pekerja:</i>	University / Industry / Agency <i>Fakulti/ P.Pengajian/ Pusat/Unit</i>	Academic Qualification/ Designation <i>Tahap Kelayakan Akademik/Jawatan</i>																															
1	PM DR AMALINA M. AFIFI	760907-08-5404	UNIVERSITI MALAYA	PROF MADYA																															
2	DR NABILAH AKEMAL MUHD ZAINI	921001-03-5448	UITM PERLIS	DR																															
C(vi)	Please provide information on academic publications that has been published by the project leader for the last five (5) years. (Example: Journals, Books, Chapters in books, etc) <i>Sila kemukakan maklumat berkaitan penerbitan akademik yang telah diterbitkan oleh ketua penyelidik dalam tempoh lima (5) tahun terakhir. (Contoh: Jurnal, buku, bab dalam buku, dll)</i>																																		

	Title of publication <i>Tajuk penerbitan</i>	Name of journals/books <i>Nama jurnal/buku</i>	Year published <i>Tahun diterbitkan</i>
	Nucleation of PFAS adsorbents using a bubble column evaporator (BCE).	Journal of the Taiwan Institute of Chemical Engineering (Q1, IF: 5.477)	2024
	The effect of amino acids on bubble coalescence in aqueous solution.	Journal of Molecular Liquids (Q1, IF: 6.633)	2023
	Size control of precipitated particles of amino acids using a bubble column evaporator.	Heliyon (Q2, IF: 3.776)	2023
	Removal of hazardous ions from aqueous solutions: Current methods, with a focus on green ion flotation.	Journal of Environmental Management (Q1, IF: 8.910)	2022
	Controlled Growth of Strontium Sulfate Particles in Aqueous Solution: Inhibition Effects of a Bubble Column Evaporator.	Substantia (SCOPUS)	2021
C(vii)	Executive Summary of Research Proposal (maximum 300 words) (Please include the problem statement, objectives, research methodology, expected output/outcomes/implication, and significance of output from the research project) <i>Ringkasan Cadangan Eksekutif Penyelidikan (maksimum 300 patah perkataan)</i> <i>(Meliputi pernyataan masalah, objektif, kaedah penyelidikan, jangkaan hasil penyelidikan/implikasi dan kepentingan output projek penyelidikan)</i> Today, water pollution is seen as one of the major environmental concerns which continuously attracted much attention, especially contaminants from hazardous ion. In fact, without effective treatment, the hazardous ion from heavy metal which inert to biodegradation leads to accumulation in water, soil and air and will remain in our environment. This emerging class of environmental contaminants are toxic as well as carcinogenic, mutagenic and teratogenic effects on aquatic life and humans. Moreover, current technology such as membrane filtration, flotation, chemicals precipitation having its own drawback and inadequate to mitigate these contaminants in water. In this manner, the quest for green materials in remediates these ions remain open which promising clean water for drinking and industrial usage. The present study would like to synthesizes Ca-Fe and Zn-Fe layered double hydroxide (LDH) as the absorbent materials which could possibly remove hazardous ions from aqueous solution. The effectiveness of the LDHs will be characterize using scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy, Fourier transform infrared (FTIR) spectroscopy and inductively coupled plasma optical emission spectroscopy (ICP-OES). This study might open up new frontiers to remediate		

	heavy metal ions in the aqueous solution and this study proposes cost effective and green materials that can be taken into consideration for this endeavour. Keywords: Hazardous ion, heavy metal, water, green materials and adsorbent
C(viii)	Detailed proposal of research project: <i>Cadangan maklumat penyelidikan secara terperinci:</i> (a) Research background including: / <i>Latarbelakang penyelidikan termasuk:</i> i) Problem Statement / <i>Pernyataan Masalah</i> Researchers have conducted comprehensive research on the removal of hazardous ions from heavy metals including using of ion exchange, precipitation, ion floatation and membrane technology. However, these treatments are believed as ineffective and, frequently used them requiring high maintenance and cost. Adsorption offers a simple, effective technique in terms of cost, energy demand and environmental acceptability. One of the commonly used adsorbents to remove hazardous ions in aqueous solution is by using activated carbon was found to be unsatisfactory due to slow adsorption kinetics and reduced performance in the presence of organic matter. To address these concerns, a new class of green adsorbents has emerged. These adsorbents of layered double hydroxides, known as anionic clay family, made up of cationic layers that resemble brucite, with the addition of divalent cations, which offer specific adsorption capacity and selectivity. It is also notable, that effort continue in the water treatment to find new materials to remediate hazardous ions since other materials have its own drawback and still inadequate. Since the needs of safe and clean water availability become the main concern, a scientific research study is needed to determine the most valuable materials that can be used in water treatment process not only to remove the hazardous ion from heavy metals but other emerging pollutants. It is hoped that research on synthesis of green materials using LDH able to assist in removing hazardous ions from heavy metals and PFAS in aqueous solution. ii) Hypothesis / <i>Hipotesis</i>

If the green materials of Ca-Fe and Zn-Fe LDH successfully synthesis, then the hazardous ions such as copper heavy metal in aqueous solution will be remove efficiently and produce clean water.

iii) **Research Questions / Persoalan Penyelidikan**

The central research question which arises out of the literature gaps is expressed as follow:

- Can the green materials of Ca-Fe and Zn-Fe LDH be synthesis and be used to remove emerging contaminants of hazardous ions of heavy metal from aqueous solutions?

The sub-questions which arise out of the literature gaps are as follows:

- How does the effect of varying the parameters such as concentration, cation ratio, adsorbent's dose of LDHs in removing the hazardous ions of heavy metal?
- Why it is necessary to characterize and determine the efficacy of removing the hazardous ion in aqueous solution?

iv) **Literature Reviews / Kajian Literatur**

1. Heavy metals

Water is considered as polluted when it does not support a human and other habitat needs such as drinking water or it is impaired by anthropogenic contaminants [1]. The waste water from industries usually contains hazardous ions of heavy metals which considered as an emerging contaminant passed into the natural water resources or wastewater treatment system. Without effective treatment, these ions will remain for a long period in our environment. In almost all cases, they are difficult to remove as they have high water solubility and unique property. These hazardous ions will lead to health-related issue create a chain of problems like spreading of diseases, pollution of drinking waters and harmful effects on environmental [2-4].

Heavy metals are defined as those elements which have specific density of more than 5 g/cm^3 and atomic weights ranging from 63.5 to 200.6 g/mol [5-6]. Majority of hazardous ions from heavy metal are usually having property which strongly binds with water. Mercury, arsenic, cadmium, copper, lead and chromium are some examples of hazardous ion of heavy metal. They are highly resistant to conventional methods of treatment, and are presented in water resources after underwent various scale of wastewater treatment plants and other treatment method. Comparison of heavy metal concentration found in groundwater, soil and river against water quality standard has been reported by previous research in **Table 1** below (Adapted with permission from [7])

Table 1: Some heavy metals. MCL is the maximum concentration (limit) acceptable to humans.

Heavy metal	Description	Effect	MCL (mg/L)
Mercury (Hg)	Volatile, persistent; used in electrical appliances and production of chlorine and caustic soda, etc.	Severe neurological and renal disturbances; toxic effects on organs such as the kidney, immune system, nerves, skin and eyes.	0.002
Arsenic (As)	Naturally occurring in the Earth's crust; makes highly toxic compounds in ground-water and agricultural crops.	Cancer of the bladder, skin and lungs caused by long-term arsenic exposure.	0.01
Lead (Pb)	Highly malleable; widespread use in batteries, ammunition, glazes, alloys, etc.	Affects multiple body systems such as the liver, kidney, brain and bones. Various neurological and behavioural effects, impaired fertility, hypertension, adverse pregnancy outcomes, impaired dental health and delayed sexual maturation.	0.015
Cadmium (Cd)	Present in groundwater because of mining procedures; vast applications in battery manufacturing, pigments, metallurgy and pesticides.	Readily taken up in different parts of the human body such as lungs, liver and heart, where it accumulates and can affect health.	0.003
Chromium (Cr)	One of the most toxic heavy metals, with an extensive distribution in the Earth's crust. Applications in industries such as electroplating, mining, leather and pigment production.	The most toxic and carcinogenic state is Cr (VI); other oxidation species like Cr (III) compounds are generally not carcinogenic to humans. Cr accumulates mainly in the kidneys, liver, spleen and bones.	0.05
Copper (Cu)	Copper is a constituent of many enzymes, like Zn, and is essential at low levels in the body.	Excessive ingestion of copper causes toxicological concerns, e.g. nausea, vomiting, diarrhoea, brain abnormalities and tremors.	0.25
Nickel (Ni)	Toxic ion, often present in wastewater as a result of industrial processes such as battery manufacturing, electroplating, printing and silver refining.	Causes dry cough, chest pain, nausea, cyanosis and possibly lung cancer.	0.07

2. Wastewater treatments

Basically, there are various types of physical, biological, and chemical treatment processes that had been carried out for removal of these hazardous ions such as soil vapor extraction, air stripping, filtration, coagulation, and membrane technology. The goal of all water treatment process is to remove existing contaminants in the water, or reduce the concentration of such contaminants so the water becomes fit for its desired end-use. One such use is returning water that has been used back into the natural environment

without adverse ecological impact. Currently, these treatments have been ineffective in removing hazardous ions and in some cases, they are costly and require high maintenance.

2.1 Chemical precipitation technique

Chemical precipitation is a well-known water processing issue which can be addressed using ion exchange resin to control scale formation, corrosion and growth of microbiological in water treatment system by using a variety of additives or chemical reagents. Early theories of ‘The precipitation law’ published by Weimarn in the past decades states that the supersaturation condition plays an important role in determine the size of particles precipitation [8]. In support of this view, research by Toth et al. report that this famous theory by Weimarn’s is valid [9]. The simple chemical precipitation method has typically been conducted by continuous stirring and in supersaturated solutions usually produces micron size particles [10-11]. The addition of other organic soluble chemicals can also create supersaturation conditions by changing the solubility of the precipitate in the solution. Hence, insoluble complexes can easily separate from water using filtration or sedimentation methods [12]. Even though the precipitation method offers a simple method, involving small quantities of reagents, it can potentially be used to remove a wide range of impurities, including heavy metal elements, and this method can target a specific type of particles, including those that may co-precipitate and so improve the purity of the water. Separation problems can arise from the addition of chemicals leading to acidic conditions which may produce toxic gases as by products, and this process has to be carefully monitored.

2.2 Membrane filtration technique

The reverse osmosis (RO) method is one of the most common membrane processes which is widely used in the water treatment industry to produce high purity water. According to Amjad (1993), RO membranes successfully remove dissolved salts, microorganisms, colloids and organic particles greater than ninety per cent [13]. This process has been considered as a vital process in water treatment systems for over thirty years. This process is also used on ships to convert seawater into drinking water. Today, membrane desalination plants are often used to convert seawater to drinking water on ships and in many arid regions. Besides that, desalination is also used to treat water that is fouled by natural and unnatural contaminants. This method is perhaps one of the most popular water treatment technologies that completely reduces the widest range of drinking water contaminants [14-15]. Shahalam et al. reported that 20% of global desalination capacity has been produced using this method [16]. Thus, many studies have been reported on capability and efficiency of reverse osmosis specifically in water treatment. For example, Zhang et al. and Mohsen-Nia et al. revealed the removal efficiency of heavy metal ions using reverse osmosis

technique [17-18]. However, this technique is threatened by materials left deposited on the membrane surface which creates a 'fouled' membrane. This leads to lower efficiency of the process, high maintenance costs and decrease in the quality of water. These membranes are easily contaminated and the cost of the membrane itself is expensive. Hence, in order to protect the membrane and maintain the efficiency of the process, regular feedwater pretreatment is compulsory. This leads to an increase in the total cost and adds to the complexity of the process [19-20].

2.3 Flotation techniques

Ion flotation is a separation process which uses rising bubbles to remove dissolved ionic species from dilute aqueous solutions [21], whereas froth flotation uses bubbles and a collector, in the aqueous solution, to remove hydrophobic particles collected at the surface of the rising bubbles. In each process ions, surfactant and particles are adsorbed onto the surface of rising bubbles and are carried into a foam on the surface before being removed from the solution [22].

The detailed mechanism behind the successful study of biobased surfactant amino acid of cysteine in removing hazardous ion by using ion flotation are unknown [7].

2.4 Adsorption

Adsorption known as one of the most common treatments in removing various type of hazardous ions and has been used since years ago. This method offers a simple, effective technique in terms of cost, energy demand, and environmental acceptability [23]. Previous studies have explored a variety of adsorbents, such as activated carbon, ion exchange resins, advanced polymers and organic/inorganic composite materials. It has been reported that commonly used activated carbon has unsatisfactory adsorption capacities, due to slow adsorption kinetics and reduced performance in the presence of organic matter [7, 24-27]. Among a variety of inorganic adsorbents, layered double hydroxide (LDH) which are an anionic clay material have gained recent attention due to their structural charge and flexibilities, promising high adsorption capacity [28-29]. Several treatments, such as adsorption, anionic exchange or dissolution precipitation have reported that LDH can successfully remove contaminated ions [30-32].

LDHs are one of the adsorbents that contain 2D anionic clays with positively charged host layers and counter-anion interlayers have taken into significant consideration. Table 2 shows the advantages and disadvantages of different adsorbents.

Table 2: Advantage and disadvantage of different adsorbents

Adsorbent	Advantage	Disadvantage
LDH	Unique 2D structure, excellent chemical and thermal stability, low cost, and high anion-exchange capacity.	Soluble and ineffective in acidic.
Graphite	Large surface area, chemical stability, and strong electrical conductivity.	May experiences degradation, which includes chemical, surface, and morphological alterations.
Activated carbon	Large surface area and excellent resistance.	Low selectivity, efficiency, stability, and sorption kinetics

3. Conclusion

In conclusion, each method described above has been considered as an approach in water treatment process, which can remediate hazardous ions from aqueous solution. In this study, the focus will be on the synthesis and characterization of Ca-Fe and Zn-Fe LDH as the green adsorbents with excellent properties such as a large surface area, easy separation and efficient to be used in removing hazardous ions that exist in water. To our knowledge, no previous research successfully explain the properties and the effectiveness of divalent LDH in removing hazardous ions of heavy metal in aqueous solution. Since the needs of safe and clean water becomes an increasing concern in global water production, and so a scientific research study of this green materials should aim at commercial application and not be limited only to laboratory work.

v) **Related References** / Rujukan berkaitan

1. Faizatulakma Azami, (2011). Adsorption Behavior of Sunset Yellow and Rhodamine-B onto Chemically Treated Sugarcane Bagasse, Universiti Teknologi Malaysia: Bachelor of Science (Industrial Chemistry) Project Report.
2. Russell MH, Berti WR, Szostek B, Buck RC. Investigation of the biodegradation potential of a fluoroacrylate polymer product in aerobic soils. Environ Sci Technol 2008;42(3):800–7.
3. Shaji, E., Santosh, M., Sarath, K.V., Prakash, P., Deepchand, V., Divya, B.V., 2021. Arsenic contamination of groundwater: a global synopsis with focus on the Indian Peninsula. Geosci. Front. 12.
4. Ren, Y.S., Ilyas, M., Xu, R.Z., Ahmad, W., Wang, R.J.A.S., Technology, 2022. Concentrations of Lead in Groundwater and Human Blood in the Population of Palosai, a Rural Area in Pakistan: Human Exposure and Risk Assessment, 2022
5. Abdulkarem, E., Ibrahim, Y., Kumar, M., Arafat, H.A., Naddeo, V., Banat, F., Hasan, S.W., 2021. Polyvinylidene fluoride (PVDF)- α -zirconium phosphate (α -ZrP) nanoparticles based mixed matrix membranes for removal of heavy metal ions. Chemosphere 267,128896.

6. Acosta Rodriguez, I., Martnez-Jurez, V.M., Cardenas-Gonzlez, J.F., Moctezuma-Zrate, M.d.G., 2013. Biosorption of arsenic (III) from aqueous solutions by modified fungal biomass of *paecilomyces* sp. *Bioinorgan. Chem. Appl.* 5
7. Nafi AW, Taseidifar M. Removal of hazardous ions from aqueous solutions: current methods, with a focus on green ion flotation. *J Environ Manag* 2022;319:115666.
8. Von Weimarn, P. P. (1925). The Precipitation Laws. *Chemical Reviews*, 2(2), 217-242.
9. Tóth, J., Kardos-Fodor, A., & Halász-Péterfi, S. (2005). The formation of fine particles by salting-out precipitation. *Chemical Engineering and Processing: Process Intensification*, 44(2), 193-200.
10. Giorgi, R., Bozzi, C., Dei, L., Gabbiani, C., Ninham, B.W. and Baglioni, P., 2005. Nanoparticles of Mg (OH) 2: synthesis and application to paper conservation. *Langmuir*, 21(18), pp.8495-8501.
11. Kawase, M. and Miura, K., 2007. Fine particle synthesis by continuous precipitation using a tubular reactor. *Advanced Powder Technology*, 18(6), 725-738.
12. Ku, Y., & Jung, I. L. (2001). Photocatalytic reduction of Cr (VI) in aqueous solutions by UV irradiation with the presence of titanium dioxide. *Water research*, 35(1), 135-142.
13. Amjad, Z. 1993, 'Reverse osmosis: membrane technology, water chemistry & industrial applications', Chapman & Hall.
14. Kalogirou, S.A., 2005. Seawater desalination using renewable energy sources. *Progress in energy and combustion science*, 31(3), 242-281.
15. Fischetti, M., 2007. Fresh from the sea. *Scientific American*, 297(3), pp.118-119.
16. Shahalam, A. M., Al-Harthy, A., & Al-Zawhry, A. (2002). Feed water pretreatment in RO systems: unit processes in the Middle East. *Desalination*, 150(3), 235-245.
17. Mohsen-Nia, M., Montazeri, P., & Modarress, H. (2007). Removal of Cu²⁺ and Ni²⁺ from wastewater with a chelating agent and reverse osmosis processes. *Desalination*, 217(1-3), 276-281.
18. Zhang, L., Yanjun, W. U., Xiaoyan, Q. U., Zhenshan, L. I., & Jinren, N. I. (2009). Mechanism of combination membrane and electro-winning process on treatment and remediation of Cu²⁺ polluted water body. *Journal of Environmental Sciences*, 21(6), 764-769.
19. Shahid, M., Fan, C. and Pashley, R.M. 2016, 'Insight into the bubble column evaporator and its applications', *International Reviews in Physical Chemistry*, 35(1), 143-185.
20. Gaudlip, A.W., Paugh, L.O. and Hayes, T.D. 2008, 'Marcellus Shale Water Management Challenges in Pennsylvania', *SPE Paper No. SPE-119898-PP*, Society of Petroleum Engineers.
21. Doyle, F.M., 2003. Ion flotation—its potential for hydrometallurgical operations. *International Journal of Mineral Processing*, 72(1-4), 387-399.
22. Polat, H., & Erdogan, D. (2007). Heavy metal removal from waste waters by ion flotation. *Journal of Hazardous Materials*, 148(1-2), 267-273.
23. Wanninayake, D. M. (2021). Comparison of currently available PFAS remediation technologies in water: A review. *Journal of Environmental Management*, 283, 111977.
24. Kucharzyk, K. H., Darlington, R., Benotti, M., Deeb, R., & Hawley, E. (2017). Novel treatment technologies for PFAS compounds: A critical review. *Journal of Environmental Management*, 204, 757-764.
25. Dixit, F., Dutta, R., Barbeau, B., Berube, P., & Mohseni, M. (2021). PFAS removal by ion exchange resins: A review. *Chemosphere*, 272, 129777.
26. Zhang, D. Q., Zhang, W. L., & Liang, Y. N. (2019). Adsorption of perfluoroalkyl and polyfluoroalkyl substances (PFASs) from aqueous solution: A review. *Science of the Total Environment*, 694, 133606.
27. Yu, Q., Zhang, R., Deng, S., Huang, J., & Yu, G. (2009). Sorption of perfluorooctane sulfonate and perfluorooctanoate on activated carbons and resin: Kinetic and isotherm study. *Water Research*, 43(4), 1150-1158.
28. Boumeriame, H., Da Silva, E. S., Cherevan, A. S., Chafik, T., Faria, J. L., & Eder, D. (2022). Layered double hydroxide (LDH)-based materials: A mini-review on strategies to improve the performance for photocatalytic water splitting. *Journal of Energy Chemistry*, 64, 406-431.

29. Nafi, A. W., & Taseidifar, M. (2024). Nucleation of PFAS adsorbents using a bubble column evaporator (BCE). *Journal of the Taiwan Institute of Chemical Engineers*, 155, 105295.
30. Intachai, S., Nakorn, M. N., Kaewnok, A., Pankam, P., Sumanatrakul, P., & Khaorapapong, N. (2022). Versatile inorganic adsorbent for efficient and practical removal of hexavalent chromium in water. *Materials Chemistry and Physics*, 288, 126388.
31. Chen, Y., Jing, C., Zhang, X., Jiang, D., Liu, X., Dong, B., Feng, L., Li, S., & Zhang, Y. (2019). Acid-salt treated CoAl layered double hydroxide nanosheets with enhanced adsorption capacity of methyl orange dye. *Journal of Colloid and Interface Science*, 548, 100-109.
32. Wang, Z., Zhang, L., Fang, P., Wang, L., & Wang, W. (2020). Study on simultaneous removal of dye and heavy metal ions by NiAl-layered double hydroxide films. *ACS Omega*, 5(34), 21805-21814

vi) **Relevance to Government Policy, if any** / *Perkaitan dengan Dasar Kerajaan, jika berkenaan*

Sustainable Development Goals (Environmental & Natural Resources)
 Goal 6 – Clean water and sanitation
 Goal 14 – Life below water

(b) Objective (s) of the Research
Objektif Penyelidikan

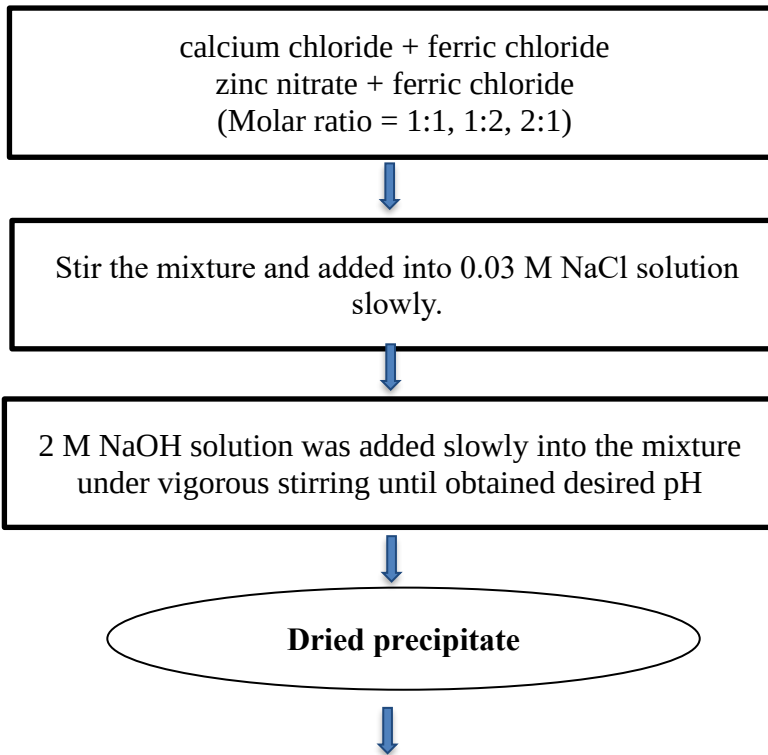
1. To synthesis the green materials of LDH (based of calcium chloride, zinc nitrate and ferric chloride) to remediate emerging contaminants of heavy metal ions from aqueous solution.
2. To evaluate the effect of differents parameters of different ratio of cation, concentration and pH on the removal of heavy metal ions.
3. To further characterize the LDH samples using Fourier transform infrared (FTIR) spectra, scanning electron microscope (SEM), and inductively coupled plasma optical emission spectrophotometer (ICP-OES) and Ultraviolet-visible spectroscopy (UV-Vis).

(c) Methodology
Kaedah penyelidikan

Please state in the form / *Sila nyatakan di borang ini*

Part A: Synthesis of green adsorbent of Ca-Fe and Zn-Fe layered double hydroxide

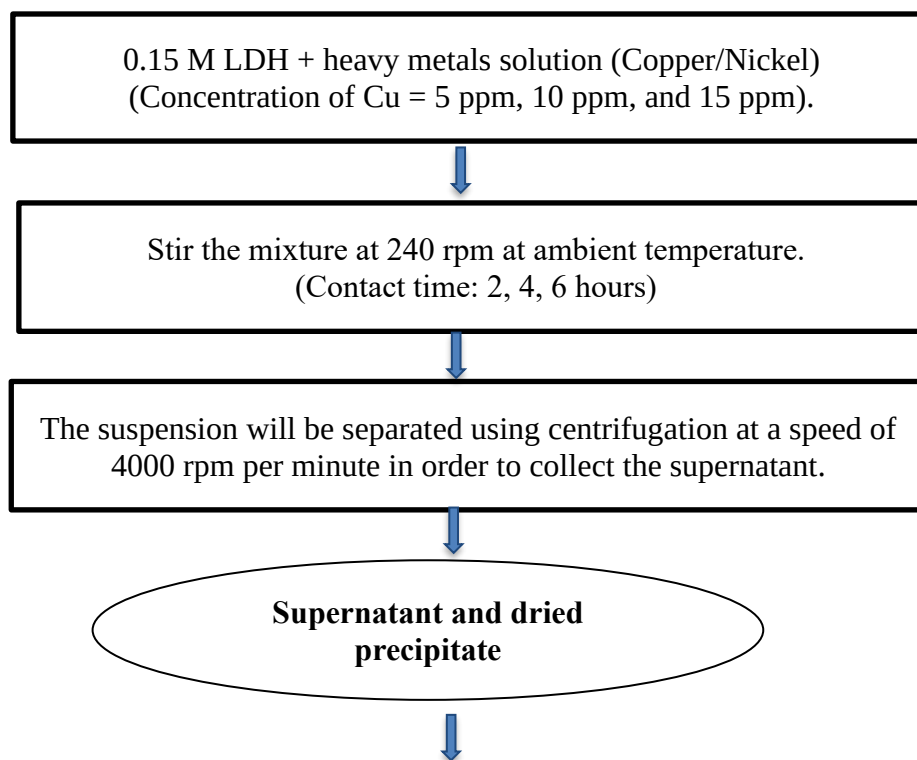
For comparison, the LDHs will be prepared using different parameter of cation ratio (1:1, 1:2, 2:1) and pH (5.5, 7.5, 12.5).



Characterizations

SEM	To obtain the morphology and composition by image
FTIR	To confirm the structure of LDHs
ICP-OES	To further confirm the elemental composition of the samples
XRD	To determine the crystallinity of the samples

Part B: Adsorption test of Ca-Fe and Zn-Fe layered double hydroxide



Characterizations	
UV-VIS	To measure the concentration of Cu/Ni solution
SEM	To obtain the morphology and composition by image
FTIR	To confirm the present of Cu/Ni in the structure of LDHs
ICP-OES	To further confirm the elemental composition of the samples
XRD	To determine the crystallinity of the samples

(d) Expected Results/Benefit

Jangkaan Hasil Penyelidikan

1. ***Novel theories/New findings/Knowledge***

This proposal is seeking to synthesis the green adsorbent of LDHs for the removal of hazardous ions from heavy metals in aqueous solution by applying different parameters. Since the previous study do not explain the efficacy of LDHs, thus this study offer new knowledge on the characterisation properties of LDHs as green adsorbent.

2. ***Research Publications***

- Effect of cation ratio and concentration of layered double hydroxide in removing hazardous ions of heavy metal
- Fabrication of layered double hydroxide (LDH) for removal of heavy metal: A review

3. ***Specific or Potential Grant Applications (please specify targeted grant application)***

FRGS (UM and FRIM Collaboration- PM DR Amalina M. Afifi and DR. NURARIESMAN)

Title: Understanding the Physicochemical Properties of Green Adsorbent Derived from Di/Trivalent Layered Double Hydroxide in the Extraction of Heavy Metal Ions from Aqueous Solutions.

Description: This proposed GSP grant can be further improvised by fabricating LDH with addition metal cation or using another type of cation.

4. ***Number of PhD and Masters (by research) Students (if any)***

5. ***Impact on Society, Economy and Nation***

In this study, the LDH is expected to be obtained which can be potential green adsorbent and to tackle the drawback of current available adsorbents and treatment method in removing hazardous ions of heavy metals from natural water and groundwater. The advantages of LDH such as excellent chemical and thermal stability, low synthesis cost, and high anion-exchange capacity will have great potential to not only as adsorbents for water treatment application but also proving the possibility of using LDH for commercial applications. This eventually support the Sustainable Development Goals (Environmental & Natural Resources).

(e) Research activity & Milestone
Aktiviti penyelidikan & Carta perbatuan

Aktiviti penyelidikan & Carta perbatuan

Activities	Location
Synthesis of green materials ❖ Ca-Fe LDH ❖ Zn-Fe LDH	FACULTY OF APPLIED SCIENCE UITM PERLIS
Characterisation & Performance Test ❖ X-ray Diffractrometer (XRD). ❖ Scanning Electron Microscopic (SEM). ❖ Fourirer Transform Infrared Spectroscopy (FTIR) ❖ Inductively coupled plasma optical emission spectroscopy (ICP-OES)	FACULTY OF APPLIED SCIENCE UITM PERLIS/FACULTY OF ENGINEERING UM

Gantt Chart

[illegible]

D	BUDGET /BELANJAWAN		
	Please indicate your estimated budget for this research and details of expenditure according to the guidelines attached. <i>Sila nyatakan anggaran bajet bagi cadangan penyelidikan ini dan berikan butir – butir perbelanjaan lengkap dengan berpandukan kepada garis panduan yang dilampirkan.</i>		
	Budget details <i>Butiran belanjawan</i>	Amount requested by applicant <i>Jumlah yang dipohon oleh pemohon</i>	
		Year 1 (Tahun 1) (RM)	Year 2 (Tahun 2) (RM)
D(i)	Vote 21000 - Travelling and Transportation/ <i>Perjalanan dan Pengangkutan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>	Transportation to Universiti Malaya from UiTM Perlis (return trip) RM 200 X 1 = RM 200 Total = RM 200	Transportation to Universiti Malaya from UiTM Perlis (return trip) RM 200 X 1 = RM 200 Total = RM 200
D(ii)	Vote 24000 - Rental <i>Vot 24000 - Sewaan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>	NA	NA
D(iii)	Vote 27000 - Research Materials & Supplies <i>Vot 27000 - Bekalan dan Bahan Penyelidikan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>	Chemicals - Calcium chloride (Rm63/500g x 1)	Glassware -Beaker 200 ml (RM15/pcs X 2) - Beaker 100 ml

		-Iron (III) Chloride (RM 83/500g X 1) -Sodium Hydroxide (RM 58/1kg X 1) -Zinc nitrate (RM 88/500g X 1) -PVA (RM470/250g X 1) -Ni standard solution (RM 415/500ml X 1) -Cu solution (RM 270/500ml X 1) -PFOA (RM420/5g X 2) Total = RM 1867	(RM 21/pcs X 2) -Conical flasl 250ml (RM 27/pcs X 1) -Volumetric flask 200ml (RM 47 X 2) -Magnetic stirrer (RM 40/pack X 2) -Vials (12ml) (RM 410/box X 1) -Plastic syringe (RM100/box X 1) RM781 Total = RM 783
D(iv)	Vote 28000 - Maintenance and Minor Repair Services <i>Bvot 28000 - Baik pulih kecil dan ubahsuai</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>	NA	NA

D(v)	Vote 29000 - Professional Services <i>Vot 29000 - Perkhidmatan Ikhtisas</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>	i) Service charge for characterizations SEM – RM50 X 5 samples XRD – RM50 X 5 samples ICP-OES - RM150 X 5 samples Total = RM 1250	i) Publication fee RM 500 X 1 ii) Patent application RM200 X 1 Patent Total = RM 700
D(vi)	Vote 35000 - Accessories and Equipment <i>Vot 35000 - Aksesori dan Peralatan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>	NA	NA
TOTAL AMOUNT JUMLAH BESAR		RM 5000	
E	Declaration by applicant / Akuan Pemohon (Please tick (✓)): / (Sila tanda (✓)):		

I hereby declare that:

Saya dengan ini mengaku bahawa:

- / 1. **All information stated here are accurate, and PJI has right to reject or to cancel the offer without prior notice if there is any inaccurate information given.**
Semua maklumat yang diisi adalah benar, PJIM&A berhak menolak permohonan atau membatalkan tawaran pada bila-bila masa sekiranya keterangan yang dikemukakan adalah tidak benar.
- / 2. **Application of this research is presented for the Geran Semarak Penyelidikan**
Permohonan penyelidikan ini dikemukakan untuk Geran Semarak Penyelidikan.
- / 3. **Application of this research is subject to Ethical Committee approval (if applicable).**
Permohonan penyelidikan ini dimajukan ke Jawatankuasa Etika (jika berkenaan).

Date : 22/11/2024
Tarikh :

Applicant's Signature :
Tandatangan Pemohon :


DR. WAN NUR ATIKAH HJ WAN NAFI
Pensyarah Kanan
Fakulti Sains Gunaan
Universiti Teknologi MARA
Caw. Perlis, Kampus Arau
02600 Arau, Perlis.

Note: APPLICATIONS SUBMITTED WILL BE TREATED IN FULL CONFIDENCE. THE DECISION OF THE INTERNAL RESEARCH ACCULTURATION MAIN COMMITTEE UiTM CAWANGAN PERLIS IS FINAL. Semua permohonan dianggap sulit. Keputusan Jawatankuasa Induk Geran Penyelidikan Pembudayaan Dalam UiTM Cawangan Perlis adalah MUKTAMAD.



Rujukan : 100 UiTMPs(PJIM&A/UPK.15/1)
Tarikh : 1445H جمادي الأول 13
15 November 2024

Dr. Nabilah Akemal Muhd Zailani
Fakulti Sains Gunaan
UiTM Cawangan Perlis
Kampus Arau
02600 Arau
Perlis

ویرگاتة ورحمة الله عليكم dan Salam Sejahtera

Puan,

KELULUSAN PERMOHONAN PENAMBAHAN AHLI PROJEK RESEARCH INTEREST GROUP (RIG)

Dengan hormatnya perkara di atas adalah dirujuk.

2. Adalah dimaklumkan Unit Penerbitan dan Kecemerlangan di bawah RIG Bahagian Penyelidikan & Jaringan Industri, UiTM Cawangan Perlis telah **MELULUSKAN** permohonan penambahan ahli projek berkuatkuasa serta merta. Maklumat terperinci perubahan adalah seperti di bawah:-

Tajuk Projek	: <i>Advanced Material For Energy Storage Research Group</i>
Kod Pendaftaran	: RIG 033/2020
Ketua Projek	: Dr. Nabilah Akemal Muhd Zailani
Ahli Projek	: Dr. Khuzaimah Nazir
	: Dr. Rozilah Rajmi
	: Pn. Madhiyah Yahaya Bermakai
	: Pn. Noorsyam Yusof
	: Pn. Norha Abdul Hadi
Tambahan Ahli	: Pn. Wan. Nur Atikah Hj. Wan Nafi
	: En. Muhammad Zharfan Mohd Halizan
	: Pn. Siti Hajar Mohmad Salleh

3. Walaubagaimana pun pihak kami ingin memaklumkan bahawa semua surat yang terdahulu yang telah didaftarkan sebelum ini adalah **TERBATAL**.

4. Sehubungan dengan itu, diharapkan agar perubahan ini dapat memantapkan lagi Kumpulan RIG ini dalam mengatur sebarang aktiviti atau program yang bermanfaat di masa akan datang.

Sekian.

اوسها، تقوى، مليا

"MALAYSIA MADANI"

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

(PROF. MADYA DR. AHMAD NIZAN MAT NOOR)
Rektor

BORANG PERUBAHAN MAKLUMAN KUMPULAN RIG

Tarikh: 11 NOVEMBER 2024

Bahagian Penyelidikan Jaringan Industri,
Komuniti, Alumni dan Keusahawanan
Unit Perundingan & Kecemerlangan
UiTM cawangan Perlis
Arau Perlis

Nama Kumpulan : Advanced Material for Energy Storage Research Group

No.Pendaftaran : RIG033/2020

Nama CORE :

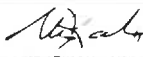
Ketua Projek (Asal) : Dr. Nabilah Akemal Muhd Zailani

Dengan hormatnya perkara di atas adalah dirujuk.

Kami ingin memohon maklumat kumpulan RIG seperti di bawah:

Tandakan (/) pada ruangan yang disediakan:

☐ Pertukaran Nama RIG	☒ Penambahan Ahli Projek	☐ Penggubalan RIG
☐ Pertukaran Ketua Projek	☐ Pengguguran Ahli Projek	

Nama (Ditambah/ ~~Ditukar~~ / ~~Digugur~~) : WAN NUR ATIKAH BINTI HAJI WAN NAFI	
No Staf : 384250	Email : atikahnafi@uitm.edu.my
Tel. Pejabat.:	No. Tel. Bimbit : 013-333 8323
Fakulti/Pusat/Bahagian/Jabatan : ~~Perakutan~~ Fakulti Sains Gunaan (Kimia)	Tandatangan :  DR. WAN NUR ATIKAH HJ WAN NAFI Pensyarah Kanan Fakulti Sains Gunaan Universiti Teknologi MARA Caw. Perlis, Kampus Arau 02600 Arau, Perlis.
Nama (Ditambah) : Muhammad Zharfan bin Mohd. Halizan	
No Staf : 384946	Email : zharfan@uitm.edu.my
Tel. Pejabat.:	No. Tel. Bimbit : 011-35810592
Fakulti/Pusat/Bahagian/Jabatan : Fakulti Sains Gunaan (Fizik)	Tandatangan :  MUHAMMAD ZHARFAN BIN MOHD HALIZAN (DR) PENSYARAH KANAN UITM KAMPUS ARAU CAWANGAN PERLIS

Nama (Ditambah : SITI HAJAR BINTI MOHMAD SALLEH	
No Staf : 290250	Email : sitiha2902@uitm.edu.my
Tel. Pejabat.: 04-9882703	No. Tel. Bimbit : 013-4036385
Fakulti/Pusat/Bahagian/Jabatan : FAKULTI SAINS GUNAAN (FIZIK)	Tandatangan :  SITI HAJAR BINTI MOHMAD SALLEH Pensyarah Fakulti Sains Gunaan Universiti Teknologi MARA Cawangan Perlis, Kampus Arau
Nama (Ditambah/Ditukar/Digugur) :	
No Staf :	Email :
Tel. Pejabat.:	No. Tel. Bimbit :
Fakulti/Pusat/Bahagian/Jabatan :	Tandatangan :
Nama (Ditambah/Ditukar/Digugur) :	
No Staf :	Email :
Tel. Pejabat.:	No. Tel. Bimbit :
Fakulti/Pusat/Bahagian/Jabatan : Perakaunan	Tandatangan :
Nama (Ditambah/Ditukar/Digugur) :	
No Staf :	Email :
Tel. Pejabat.:	No. Tel. Bimbit :
Fakulti/Pusat/Bahagian/Jabatan :	Tandatangan :

Justifikasi / Sebab:

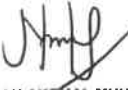
Menambah ahli baru bagi menyemarakkan lagi aktiviti penyelidikan.

.....
.....

Nama ahli projek terkini	Staf ID	Tandatangan
Dr. Nabilah Akemal binti Muhd Zailani	346748	
Dr. Khuzaimah binti Nazir	338798	
Dr. Rozilah binti Rajmi	358752	
Pn. Madhiyah binti Yahaya Bermakai	292559	
Pn. Noorsyam binti Yusof	252256	
Pn. Norha binti Abdul Hadi	282792	

Pengesahan Ketua RIG

Tandatangan & Cop :


DR. NABILAH AKEMAL MUHD ZAILANI
Perisytaroh Kanan
Fakulti Sains Gunaan
Universiti Teknologi MARA
Cawangan Perlis
02600 Arau, Perlis

Tarikh : 11/11/2024

Kelulusan PTJ (Dekan/ Rektor/TDPJI/TRek)

Ulasan :

Permohonan Diwheat

Keputusan :



Diluluskan (Disokong)



Tidak Diluluskan

Tandatangan & Cop :

[Signature]
PROF. Madya DR. WAN IZZAH NAWAWI WAN ISMAIL
Timbalan Rektor
Bahagian Penyelidikan dan Jaringan Industri,
UTM Cawangan Perlis
02600 Arau, Perlis

Tarikh :

15/11/24



**PEJABAT BENDAHARI
BAHAGIAN GAJI & KEMUDAHAN STAF**

JENIS POTONGAN : DANA PENYELIDIKAN (TAPIU)

NO PEKERJA : 384250
NAMA : WAN NUR ATIKAH BINTI HAJI WAN NAFI
NO KAD PENGENALAN : 910211-03-6090
JABATAN/BAHAGIAN : UITM KAMPUS ARAU
JAWATAN : PENSYARAH KANAN
POTONGAN : DANA PENYELIDIKAN (TAPIU)
AMAUN POTONGAN (BARU) : RM 20.00

Tarikh : 25/11/2024

Tandatangan Pemohon : WAN NUR ATIKAH
BINTI HAJI WAN NAFI
(384250)

**Kod
Potongan** : 9142

Dokumen Ini Adalah Cetakan Berkomputer Dan Tidak Memerlukan Tandatangan

Kod Rujukan: (Diisi oleh PJI)	
RIG	
Bukti Kolaborasi	
(Diisi oleh PJI)	

**BORANG PERMOHONAN
GERAN SEMARAK PENYELIDIKAN (GSP) 2024**

**Bahagian Penyelidikan & Jaringan Industri (PJI)
UiTM CAWANGAN PERLIS**

A	TITLE OF PROPOSED RESEARCH: <i>Tajuk penyelidikan yang dicadangkan :</i> TRAVELLING WAVES IN A CUBIC-QUINTIC COMPLEX GINZBURG-LANDAU EQUATION WITH TIMEDELAY FEEDBACK AND STABILITY ANALYSIS EFFECT	
B	DETAILS OF RESEARCHER / MAKLUMAT PENYELIDIK	
B(i)	Name of Project Leader: <i>Nama Ketua Projek:</i> NURIZATUL SYARFINAS BINTI AHMAD BAKHTIAR	IC / Passport Number: <i>No. Kad Pengenalan/ Pasport:</i> 901125-08-5254
B(iii)	Faculty/School/Centre/Unit (Please provide full address): <i>Fakulti/Jabatan /Pusat/Unit (Sila nyatakan Kolej pengasas, UiTM CAWANGAN PERLIS, 02600, ARAU, PERLIS.</i> KOLEJ PENGAJIAN PENGKOMPUTERAN, INFORMATIK DAN MEDIA, UiTM CAWANGAN PERLIS	
B(iv)	Office Telephone No.: <i>No. Telefon Pejabat:</i> 04-9882153	Handphone No.: <i>No. Telefon Bimbit:</i> 019-9010705 -
B(v)	E-mail Address: <i>Alamat e-mel:</i> nurizatul@uitm.edu.my	
B(vi)	Date of first appointment with this University: <i>Tarikh mula berkhidmat dengan Universiti ini:</i> 2 FEBRUARY 2021	

C	RESEARCH INFORMATION / MAKLUMAT PENYELIDIKAN																																	
C(i)	Research Domain (Please tick (✓)): <i>Domain Penyelidikan (Sila tanda (✓)):</i> A. Pure and Applied Sciences (Sains Tulen dan gunaan) <table border="0"> <tr> <td>☐ Chemistry (Kimia)</td> <td>☐ Physic (Fizik)</td> <td>☐ Biology (Biologi)</td> </tr> <tr> <td>☐ Biochemistry (Biokimia)</td> <td>☐ Materials Science (Sains Bahan)</td> <td>☒ Mathematics and Statistics (Matematik dan Statistik)</td> </tr> <tr> <td>☐ Materials Science (Sains Bahan)</td> <td></td> <td></td> </tr> </table> B. Social Sciences (Sains Sosial) <table border="0"> <tr> <td>☐ Anthropology (Antropologi)</td> <td>☐ Psychology (Psikologi)</td> <td>☐ Sociology (Sosiologi)</td> </tr> <tr> <td>☐ Political Science (Sains Politik)</td> <td>☐ Business and Management (Pengurusan dan Perniagaan)</td> <td>☐ Geography (Geografi)</td> </tr> <tr> <td>☐ Economic (Ekonomi)</td> <td>☐ Human Ecology (Ekologi Manusia)</td> <td>☐ Communication (Komunikasi)</td> </tr> </table> C. Arts and Applied Arts (Sastera dan Sastera Ikhtisas) <table border="0"> <tr> <td>☐ Language and Linguistic (Bahasa dan Linguistik)</td> <td>☐ Literature (Kesusasteraan)</td> <td>☐ Religion (Agama)</td> </tr> <tr> <td>☐ Philosophy (Falsafah)</td> <td>☐ Civilization (Tamadun)</td> <td>☐ History (Sejarah)</td> </tr> <tr> <td>☐ Art (Seni)</td> <td>☐ Culture (Budaya)</td> <td>☐ Education (Pendidikan)</td> </tr> <tr> <td>☐ Policies and Law (Dasar dan Undang-undang)</td> <td>☐ Built Environment (Alam Bina-Aspek Kemanusiaan)</td> <td>☐ Environment (Alam Sekitar-Aspek Kemanusiaan)</td> </tr> </table> D. Natural Sciences and National Heritage (Sains Tabii dan Warisan Negara) <table border="0"> <tr> <td>☐ Environment (Alam Sekitar)</td> <td>☐ Forestry (Perhutanan)</td> <td>☐ Agriculture (Pertanian)</td> </tr> </table>	☐ Chemistry (Kimia)	☐ Physic (Fizik)	☐ Biology (Biologi)	☐ Biochemistry (Biokimia)	☐ Materials Science (Sains Bahan)	☒ Mathematics and Statistics (Matematik dan Statistik)	☐ Materials Science (Sains Bahan)			☐ Anthropology (Antropologi)	☐ Psychology (Psikologi)	☐ Sociology (Sosiologi)	☐ Political Science (Sains Politik)	☐ Business and Management (Pengurusan dan Perniagaan)	☐ Geography (Geografi)	☐ Economic (Ekonomi)	☐ Human Ecology (Ekologi Manusia)	☐ Communication (Komunikasi)	☐ Language and Linguistic (Bahasa dan Linguistik)	☐ Literature (Kesusasteraan)	☐ Religion (Agama)	☐ Philosophy (Falsafah)	☐ Civilization (Tamadun)	☐ History (Sejarah)	☐ Art (Seni)	☐ Culture (Budaya)	☐ Education (Pendidikan)	☐ Policies and Law (Dasar dan Undang-undang)	☐ Built Environment (Alam Bina-Aspek Kemanusiaan)	☐ Environment (Alam Sekitar-Aspek Kemanusiaan)	☐ Environment (Alam Sekitar)	☐ Forestry (Perhutanan)	☐ Agriculture (Pertanian)
☐ Chemistry (Kimia)	☐ Physic (Fizik)	☐ Biology (Biologi)																																
☐ Biochemistry (Biokimia)	☐ Materials Science (Sains Bahan)	☒ Mathematics and Statistics (Matematik dan Statistik)																																
☐ Materials Science (Sains Bahan)																																		
☐ Anthropology (Antropologi)	☐ Psychology (Psikologi)	☐ Sociology (Sosiologi)																																
☐ Political Science (Sains Politik)	☐ Business and Management (Pengurusan dan Perniagaan)	☐ Geography (Geografi)																																
☐ Economic (Ekonomi)	☐ Human Ecology (Ekologi Manusia)	☐ Communication (Komunikasi)																																
☐ Language and Linguistic (Bahasa dan Linguistik)	☐ Literature (Kesusasteraan)	☐ Religion (Agama)																																
☐ Philosophy (Falsafah)	☐ Civilization (Tamadun)	☐ History (Sejarah)																																
☐ Art (Seni)	☐ Culture (Budaya)	☐ Education (Pendidikan)																																
☐ Policies and Law (Dasar dan Undang-undang)	☐ Built Environment (Alam Bina-Aspek Kemanusiaan)	☐ Environment (Alam Sekitar-Aspek Kemanusiaan)																																
☐ Environment (Alam Sekitar)	☐ Forestry (Perhutanan)	☐ Agriculture (Pertanian)																																

	☐ Marine (Marin) ☐ Archaeology (Arkeologi) ☐ Geoscience (Geosains) ☐ Ethnography (Etnografi) ☐ Built Environment (Heritage Aspect) Alam Bina (Aspek Warisan) ☐ Culture (Budaya) ☐ Biodiversity (Kepelbagaian Biologi) E. Information and Communication Technology (Teknologi Maklumat dan Komunikasi) ☐ Software and Information System (Perisian dan Sistem Maklumat) ☐ Soft Computing (Pengkomputeran Lembut) ☐ Computer Networking (Rangkaian Komputer) ☐ Information Security (Keselamatan Maklumat) ☐ Multimedia (Multimedia) ☐ Computer Engineering (Kejuruteraan Komputer) ☐ Computer Science (Sains Komputer) F. Health Sciences (Sains Kesihatan) ☐ Basic Medical Sciences (Sains Perubatan Asas) ☐ Pharmacy (Farmasi) ☐ Pharmacology (Farmakologi) ☐ Medical Microbiology (Mikrobiologi Perubatan) ☐ Parasitology (Parasitologi) ☐ Pathology (Pathologi) ☐ Community Medical Prevention (Perubatan Pencegahan Masyarakat) ☐ Clinical Surgical (Klinikal Surgikal) ☐ Clinical Medical (Klinikal Medikal) ☐ Associate Health Science (Sains Kesihatan Bersekutu) ☐ Dental (Pergigian) ☐ Nursing Science (Sains Kejururawatan)
C(ii)	Location of Research: Tempat penyelidikan dijalankan: BIG DATA LAB, UITM CAWANGAN PERLIS, KAMPUS ARAU, 02600, ARAU, PERLIS

C(iii)	Duration of this research (Maximum 24 months): <i>Tempoh masa penyelidikan ini (Maksimum 24 bulan):</i> Duration: 2 years <i>Tempoh :</i> From : 1 Jan 2025 <i>Dari :</i> To : 31 Dec 2026 <i>Hingga :</i>																							
C(iv)	Other Researchers: <i>Ahli-ahli penyelidik yang lain:</i> <table border="1" data-bbox="201 741 1555 1285"> <thead> <tr> <th data-bbox="201 741 269 932">Bil</th><th data-bbox="269 741 574 932">Name <i>Nama</i></th><th data-bbox="574 741 867 932">IC / Staff Number: <i>No. Kad Pengenalan/ No. Pekerja:</i></th><th data-bbox="867 741 1235 932">University / Industry / Agency <i>Fakulti/ P.Pengajian/ Pusat/Unit</i></th><th data-bbox="1235 741 1555 932">Academic Qualification/ Designation <i>Tahap Kelayakan Akademik/Jawatan</i></th></tr> </thead> <tbody> <tr> <td data-bbox="201 932 269 1056">1.</td><td data-bbox="269 932 574 1056">FARAH AINI BINTI ABDULLAH</td><td data-bbox="574 932 867 1056">770615-07-5692</td><td data-bbox="867 932 1235 1056">PUSAT PENGAJIAN SAINS MATEMATIK, UNIVERSITI SAINS MALAYSIA</td><td data-bbox="1235 932 1555 1056">PhD/ PROF. MADYA DR</td></tr> <tr> <td data-bbox="201 1056 269 1178">2.</td><td data-bbox="269 1056 574 1178">NUR FATIAH BINTI FAUZI</td><td data-bbox="574 1056 867 1178">338510</td><td data-bbox="867 1056 1235 1178">PUSAT PENGAJIAN MATEMATIK, KPPIM, UITM CAWANGAN PERLIS</td><td data-bbox="1235 1056 1555 1178">PhD/ DR</td></tr> <tr> <td data-bbox="201 1178 269 1285">3.</td><td data-bbox="269 1178 574 1285">NURUL HIDAYAH AB RAJI</td><td data-bbox="574 1178 867 1285">279417</td><td data-bbox="867 1178 1235 1285">PUSAT PENGAJIAN MATEMATIK, KPPIM, UITM CAWANGAN PERLIS</td><td data-bbox="1235 1178 1555 1285">MSc./ DR</td></tr> </tbody> </table>				Bil	Name <i>Nama</i>	IC / Staff Number: <i>No. Kad Pengenalan/ No. Pekerja:</i>	University / Industry / Agency <i>Fakulti/ P.Pengajian/ Pusat/Unit</i>	Academic Qualification/ Designation <i>Tahap Kelayakan Akademik/Jawatan</i>	1.	FARAH AINI BINTI ABDULLAH	770615-07-5692	PUSAT PENGAJIAN SAINS MATEMATIK, UNIVERSITI SAINS MALAYSIA	PhD/ PROF. MADYA DR	2.	NUR FATIAH BINTI FAUZI	338510	PUSAT PENGAJIAN MATEMATIK, KPPIM, UITM CAWANGAN PERLIS	PhD/ DR	3.	NURUL HIDAYAH AB RAJI	279417	PUSAT PENGAJIAN MATEMATIK, KPPIM, UITM CAWANGAN PERLIS	MSc./ DR
Bil	Name <i>Nama</i>	IC / Staff Number: <i>No. Kad Pengenalan/ No. Pekerja:</i>	University / Industry / Agency <i>Fakulti/ P.Pengajian/ Pusat/Unit</i>	Academic Qualification/ Designation <i>Tahap Kelayakan Akademik/Jawatan</i>																				
1.	FARAH AINI BINTI ABDULLAH	770615-07-5692	PUSAT PENGAJIAN SAINS MATEMATIK, UNIVERSITI SAINS MALAYSIA	PhD/ PROF. MADYA DR																				
2.	NUR FATIAH BINTI FAUZI	338510	PUSAT PENGAJIAN MATEMATIK, KPPIM, UITM CAWANGAN PERLIS	PhD/ DR																				
3.	NURUL HIDAYAH AB RAJI	279417	PUSAT PENGAJIAN MATEMATIK, KPPIM, UITM CAWANGAN PERLIS	MSc./ DR																				
C(vi)	Please provide information on academic publications that has been published by the project leader for the last five (5) years. (Example: Journals, Books, Chapters in books, etc) <i>Sila kemukakan maklumat berkaitan penerbitan akademik yang telah diterbitkan oleh ketua penyelidik dalam tempoh lima (5) tahun terakhir. (Contoh: Jurnal, buku, bab dalam buku, dll)</i> <table border="1" data-bbox="201 1451 1555 1940"> <thead> <tr> <th data-bbox="201 1451 618 1575"></th><th data-bbox="618 1451 906 1575">Title of publication <i>Tajuk penerbitan</i></th><th data-bbox="906 1451 1230 1575">Name of journals/books <i>Nama jurnal/buku</i></th><th data-bbox="1230 1451 1555 1575">Year published <i>Tahun diterbitkan</i></th></tr> </thead> <tbody> <tr> <td data-bbox="201 1575 618 1698">1.</td><td data-bbox="618 1575 906 1698">Comparative Analysis of Euler and Runge-Kutta Fehlberg Methods in Solving theLotka-Volterra Competitive Model</td><td data-bbox="906 1575 1230 1698">Mathematical Sciences and Informatics Journal</td><td data-bbox="1230 1575 1555 1698">2024</td></tr> <tr> <td data-bbox="201 1698 618 1822">2.</td><td data-bbox="618 1698 906 1822">Dissipative solitons in the complex Swift-Hohenberg equation: The stability of ofsnaking solitons</td><td data-bbox="906 1698 1230 1822">AIP Publishing</td><td data-bbox="1230 1698 1555 1822">2024</td></tr> <tr> <td data-bbox="201 1822 618 1940">3.</td><td data-bbox="618 1822 906 1940">An Enhanced Algorithm for Tourist TripDesign Problem with User Preferences andAttraction Popularity</td><td data-bbox="906 1822 1230 1940">AIP Publishing</td><td data-bbox="1230 1822 1555 1940">2024</td></tr> </tbody> </table>					Title of publication <i>Tajuk penerbitan</i>	Name of journals/books <i>Nama jurnal/buku</i>	Year published <i>Tahun diterbitkan</i>	1.	Comparative Analysis of Euler and Runge-Kutta Fehlberg Methods in Solving theLotka-Volterra Competitive Model	Mathematical Sciences and Informatics Journal	2024	2.	Dissipative solitons in the complex Swift-Hohenberg equation: The stability of ofsnaking solitons	AIP Publishing	2024	3.	An Enhanced Algorithm for Tourist TripDesign Problem with User Preferences andAttraction Popularity	AIP Publishing	2024				
	Title of publication <i>Tajuk penerbitan</i>	Name of journals/books <i>Nama jurnal/buku</i>	Year published <i>Tahun diterbitkan</i>																					
1.	Comparative Analysis of Euler and Runge-Kutta Fehlberg Methods in Solving theLotka-Volterra Competitive Model	Mathematical Sciences and Informatics Journal	2024																					
2.	Dissipative solitons in the complex Swift-Hohenberg equation: The stability of ofsnaking solitons	AIP Publishing	2024																					
3.	An Enhanced Algorithm for Tourist TripDesign Problem with User Preferences andAttraction Popularity	AIP Publishing	2024																					

4.	Comparative Analysis of Taylor Series and Runge-Kutta Fehlberg Methods in Solving the Lotka-Volterra Competitive Model	Journal of Applied Mathematics and Computational Intelligence	2023
5.	A Performance of SIR Model in Predicting the Number of COVID-19 Cases in Malaysia based on Different Phase of COVID-19 Outbreak	Journal of Computing Research and Innovation	2023
6.	Covid-19 Simulation in Malaysia Based on Susceptible-Infected-Recovered (SIR) Mathematical Model	Mathematical Sciences and Informatics Journal	2023
7.	Determining the criteria of choosing tour packages in Langkawi Island using FAHP	Journal of Computing Research and Innovation	2022
8.	A Comparison of Fuzzy Time Series and ARIMA to Forecast Tourist Arrivals to Homestay in Pahang	Journal of Computing Research and Innovation	2021
9.	The role of effective communication in enhancing leadership skills among students of Bachelor of Management Mathematics in UiTM Perlis	Journal of Computing Research and Innovation	2021
10.	Implementation of Long-Short Term Memory Neural Network (LSTM) for Predicting The Water Quality Parameters in Sungai Selangor	Journal of Computing Research and Innovation	2021
11.	Green Inventory Routing Problem using Hybrid Genetic Algorithm	Journal of Computing Research and Innovation	2021
12.	Parent Teacher Associations Mobile Application (PTA-MA) to Enhance Communication among PTA Members During COVID-19 Pandemic	International Journal of Academic Research in Business and Social Sciences	2021
13.	The Development of Parent Teacher Associations Mobile Application (PTA-MA) using Minimum Viable Product (MVP) Method	International Journal of Academic Research in Business and Social Sciences	2021
C(vii)	Executive Summary of Research Proposal (maximum 300 words) (Please include the problem statement, objectives, research methodology, expected output/outcomes/implication, and significance of output from the research project) <i>Ringkasan Cadangan Eksekutif Penyelidikan (maksimum 300 patah perkataan)</i> <i>(Meliputi pernyataan masalah, objektif, kaedah penyelidikan, jangkaan hasil penyelidikan/implikasi dan kepentingan output projek penyelidikan)</i> The research explore into the dynamics of dissipative solitons using the cubic-quintic Complex Ginzburg Landau equation (cqCGLE), exploring its applications across physics, biology, and medicine. Using Wolfram Mathematica		

	9.0, the study investigates five new classes of solitary wave solutions and extends its analysis to traveling wave patterns in oscillatory systems. Our objectives are to investigate cqCGLE solutions in the context of spatiotemporal chaos with and without time-delayed feedback, compare analytical solutions with previous studies on the conventional Ginzburg-Landau equation (CGLE), and analyze stability. As a result of equation derivation, hypotheses suggest that stability criteria for plane wave solutions in cqCGLE can be established, indicating a greater stability than CGLE regardless of the presence of time-delayed feedback, and demonstrating stabilization of plane waves depending on parameters. These objectives encompass examining cqCGLE solutions in the realm of spatiotemporal chaos with and without time-delayed feedback, comparing analytical solutions with previous studies on the conventional Ginzburg-Landau equation (CGLE), and conducting stability analysis. Hypotheses propose that stability criteria for plane wave solutions in cqCGLE can be established through equation derivation, indicating greater stability compared to CGLE regardless of time-delayed feedback presence, and demonstrating stabilization of plane waves under specific parameter conditions.
C(viii)	Detailed proposal of research project: <i>Cadangan maklumat penyelidikan secara terperinci:</i> (a) Research background including: / <i>Latarbelakang penyelidikan termasuk:</i> i) Problem Statement / <i>Pernyataan Masalah</i> Nowadays, the study of the dissipative soliton receives much attention by researcher. One of the most popular approaches to study dissipative solitons is based on the cubic-quintic Complex Ginzburg Landau equation (cqCGLE). In this research, the study of the five new classes of solitary waves solutions are very important to analyze the pattern of the soliton behaviors. The present result in this study became clearer that the concept of the dissipative soliton could be applied not only in physics (optics) but also in biology and medicine (Akhmediev and Ankiewicz, 2005, 2008). Furthermore, this study can be extended by applying the cqCGLE in the travelling wave patterns in a generic oscillatory system. It has been shown that (Mancas and Choudhury, 2007) were using a variational approach as one of the method to retrieve the stability of plane wave solutions in cqCGLE. Yet, because of the complexity of the equation, this research represents a delayed feedback term as another method to resolve the stability of plane wave solutions. It has been done by Puzyrev et al. (2014), but not in this particular area which is involve in a reaction-diffusion systems. Therefore, the importance of these main problem statement addressed by this research leads to the objectives of this study as the specified in the following section. ii) Hypothesis / <i>Hipotesis</i> 1. Criteria of the stability of plane wave solutions in the cqCGLE without the time delayed feedback is achieved by gaining the equation. 2. When cqCGLE exhibits greater stability compared to CGLE, regardless of the presence or absence of time-delayed feedback based on the derivation equation. 3. Stabilization of plane waves was achieved for the parameter used. iii) Research Questions / <i>Persoalan Penyelidikan</i> This study will explore the following questions: 1. How does the introduction of time-delayed feedback influence the behavior of chaotic solutions in the complex quadratic-cubic Ginzburg-Landau equation (cqCGLE) within the spatiotemporal chaos regime, particularly regarding the dynamics of travelling plane waves? 2. What are the similarities and differences between the analytical solutions obtained for the complex quadratic-cubic Ginzburg-Landau equation (cqCGLE) in the present study and those reported in previous papers for the conventional Ginzburg-Landau equation (CGLE)? 3. How do these findings contribute to understanding the overall dynamics and behavior of the system?

iv) **Literature Reviews / Kajian Literatur**

Reaction-diffusion models are formulated to describe the spatiotemporal dynamics (i.e. of patterns) of many systems. Its applications in various fields from chemical and biological phenomena to medicine (physiology, diseases, etc.), genetics, physics, social science, finance, economics, weather prediction, and astrophysics (Hodgkin and Huxley, 1952; Volpert and Petrovskii, 2009; Ji and Fenton, 2016; Kuttler, 2017). It is important to introduce the concept of bifurcation before elaborate any further. Bifurcation is a complex field of study and is currently heavily researched. Bifurcation theory is based on how a slight variation in a parameter may lead to significant impact on the solution.

Ordinary and partial differential equations works are familiar to model many systems as these models assist researcher to grasp a better understanding of complicated phenomena. Yet, these systems are unable to capture the various key dynamics observed in some systems, namely when the evolution of a variable depends not only on its current value (at the time t) but also on its value at a past time, where τ is the time delay. This class of differential equations mathematically are called the delay differential equations (DDE) (Erneux, 2009).

These equations have an extra element of time involved and although they may appear to look very similar to ordinary differential equations, yet they consist of many features which makes their analysis more complex. Delay differential equations are used in many fields of study including, mathematical biology, chemistry, mechanical vibrations and many more (Erneux, 2009). Systems consisting of a feedback control may involve time delays. The initial condition is now be replaced by an initial function defined on a finite interval of time. DDE must not only provide the value of the solution at the initial point but also the solution of y at times prior to the initial point (Erneux, 2009).

The model that had been studied in this research contains a time-delay feedback. A feedback loop is an ordinary and powerful tool in manipulating a system (Schöll and Schuster, 2007; Mikhailov and Showalter, 2006). The major purpose of a feedback loop is to take the system output into a desired output response. By introducing a delayed global feedback (Battogtokh, Preusser and Mikahilov, 1997) turbulence in oscillatory distributed systems can be controlled shown by previous work. Elements of a distributed oscillatory system collectively produce a control signal that is applied back to each of them after adding a certain delay under the influence of a delayed global feedback.

In control theory (Schöll and Schuster, 2007), it was stated that while controlling some solution of the original equation, the feedback term should be equal to zero in the moment of control. A non-invasive control is by considering a feedback F non-zero while approaching the real solution the feedback signal decays to zero. Initially, in order to be able to control a system, it is required the control force to be non-zero but when control is successful, the stabilizing feedback vanishes and all the desirable features of the uncontrolled system are retained (Schöll and Schuster, 2007; Bleich et al., 1997). An invasive system in the moment of control will occurred when F is non-zero. It is desirable to design the feedback such that the magnitude of the control signal decreases for many applications as the system approaches the desired state (Bleich et al., 1997).

Jin and Meng (2020) analyze the dynamical behavior of an optimal velocity (OV) model incorporating time-delayed feedback control, a technique widely used to stabilize traffic flow. The study extends classical OV models by considering the effects of delay, reflecting real-world driver response times. Through analytical and numerical methods, the authors demonstrate how delays influence traffic stability and lead to complex phenomena such as Hopf bifurcations and oscillatory behavior. Their findings highlight the critical role of feedback control in mitigating traffic instabilities, providing insights for traffic flow optimization and control system design.

Kyrychko, Blyuss, Hogan and Schöll (2009) studied the effects of a time-delayed feedback control on the appearance and development of spatiotemporal patterns in a reaction diffusion system. In their study they investigated various types of control schemes and this approach exposed different dynamical regimes, which arise from chaotic state or from travelling waves. In each case of their study the stability boundary was found in the parameter space of the control strength and the time delay, and numerical simulations suggest that diagonal control fails to control the spatiotemporal chaos.

The suppression of spatiotemporal chaos in the CGLE by a combined global and local time-delay feedback was studied further by Stich and Beta (2010). Linear stability analysis was performed for two cases. Firstly for uniform oscillations and then secondly, for the fixed point solution that corresponds to amplitude death in the spatially extended systems. Both performed with respect to space-dependent perturbations and then complemented with numerical simulations (Stich and Beta, 2010). This research are using a similar approach and ansatz but focusing on studying travelling waves. Our model is different as this study is using both global and local feedback terms.

Advancing from this study, later in 2013 Stich collaborated with Casal and Beta (Stitch, Casal and Beta, 2013), studying standing waves as solutions of the model studied before (Stitch, Casal and Diaz, 2007; Stich and Beta, 2010). The onset is described as instability of the uniform oscillations with respect to spatially periodic perturbations. The solution of the standing wave pattern was firstly given analytically and then studied through simulations. Gurevich and Friedrich report on a novel behaviour of solitary localized structures in a real Swift-Hohenberg equation also subjected to a delayed feedback (Gurevich and Friedrich, 2013). Their study consisted of a bifurcation analysis of the delayed system and also the derivation of a system of order parameter equations explicitly describing the temporal behaviour of the localized structure in the vicinity of the bifurcation point.

Research by Puzyrev, Yanchuk, Vladimirov and Gurevich focused on the stability of plane wave solutions in complex Ginzburg–Landau equation with delayed feedback (Puzyrev et al., 2014). They performed bifurcation analysis of plane wave solutions in a one-dimensional complex cubic-quintic Ginzburg–Landau equation with delayed feedback. As a result of their study they discovered how multistability and snaking behaviour of plane waves emerge as time delay is introduced.

In recent years, researchers have time-delayed feedback control methods offer a powerful tool for stabilizing unstable systems and controllers. The literature reviewed here underscores the importance of understanding the underlying dynamics and control strategies associated with TDFC. Further research in this domain holds promise for addressing critical challenges in control theory and advancing our ability to regulate complex dynamical systems effectively (Moatimid, Amer and Ellabban, 2024).

Lavrova and Kudryashov (2023) claims that the suppression of chaos in systems governed by the generalized complex Ginzburg–Landau equation through parametric excitation represents an important area of research within nonlinear dynamics and applied mathematics. By leveraging insights from existing studies and addressing key challenges, researchers can continue to advance our understanding of chaos control mechanisms and their implications for practical applications in science and engineering.

According to Kashchenko (2023) by studying the Van der Pol equation with a large feedback delay represents an intriguing avenue of research within nonlinear dynamics and delay differential equations. By building upon foundational concepts and addressing contemporary challenges, this research contributes to our understanding of time-delayed systems and their implications for various scientific and engineering disciplines. Future investigations in this area hold promise for uncovering new insights into the interplay between nonlinearity, delay, and oscillatory behavior in dynamical systems.

v) **Related References / Rujukan berkaitan**

Ahlers, G., Grossmann, S. and Lohse, D. (2009). Heat Transfer and large scale dynamics in turbulent Rayleigh-Bénard convection. *Rev. Mod. Phys.* 81.

Akhmediev, N. and Ankiewicz, A. (2005). Dissipative solitons in the complex Ginzburg-Landau and Swift-Hohenberg equations. In *Dissipative Solitons* (Vol. 661, pp 1-7). Springer, Berlin Heidelberg.

Akhmediev, N. and Ankiewicz, A. (2008). Three sources and three component parts of the concept of dissipative soliton. In *Dissipative Solitons: From Optics to Biology and Medicine* (Vol. 751, pp. 1-28). Springer-Verlag Berlin Heidelberg.

Battogtokh, D., Preusser, A. and Mikhailov, A. (1997). Controlling turbulence in the complex Ginzburg-Landau equation in two dimensional systems. *Physica D* 106, 327.

Beta, C. and Mikhailov, A. S. (2004). Controlling spatiotemporal chaos in oscillatory reaction-diffusion systems by time-delay auto synchronization. *Physica D* 199, 173-184.

Bleich, M. E., Hochheiser, D., Moloney, J. V. and Socolar, J. E. (1997). Controlling extended systems with spatially filtered, time-delayed feedback. *Phys. Rev. E* 55, 2119.

Erneux, T. (2009). *Applied delay differential equations*. Springer, New York.

Gurevich, S. V., and Friedrich, R. (2013). Instabilities of localized structures in dissipative systems with delayed feedback. *Phys. Rev. Lett.* 110, 014101.

Hodgkin, A. L. and Huxley, A. F. (1952). A quantitative description of membrane current and its application to conduction and excitation in nerve. *J. Physiol.* 117, 500-544.

Ji, Y. C. and Fenton, F. H. (2016). Numerical simulations of reaction-diffusion equations: Application to neural and cardiac models. *American Journal of Phys.* 84, 626.

Jin, Y., & Meng, J. (2020). Dynamical analysis of an optimal velocity model with time-delayed feedback control. *Communications in Nonlinear Science and Numerical Simulation*, 90, 105333.

Kuttler, C. (2017). Chapter 4: Reaction-diffusion equations and their application on bacterial communication. *Handbook of Statistics*.37, 55-91.

Kashchenko, S. (2023). Van der Pol equation with a large feedback delay. *Mathematics*, 11(6), 1301.

Kyrychko, Y. N., Blyuss, K. B., Hogan, S. J. and Schöll, E. (2009). Control of spatiotemporal patterns in the gray-scott model. *Chaos* 19, 043126.

Lavrova, S., & Kudryashov, N. (2023). Suppression of chaos in the periodically perturbed generalized complex Ginzburg–Landau equation by means of parametric excitation. *Optical and Quantum Electronics*, 55(10), 903.

Mancas, S. C. and Choudhury, S. R. (2007). A novel variational approach to pulsating solitons in the cubic-quintic Ginzburg-Landau equation. *Theoretical and Mathematical Physics*, 152(2), 1160-1172.

Mikhailov, A. S. and Showalter, K. (2006). Control of waves, patterns and turbulence in chemical systems. *Phys. Rep.* 425, 79.

Moatimid, G. M., Amer, T. S., & Ellabban, Y. Y. (2024). A novel methodology for a time-delayed controller to prevent nonlinear system oscillations. *Journal of Low Frequency Noise, Vibration and Active Control*, 43(1), 525-542.

Murray, J. D. (2003). In *Mathematical Biology II : Spatial Models and Biomedical Applications*. Springer.

Puzyrev, D., Yanchuk, S., Vladimirov, A. G. and Gurevich, S. V. (2014). Stability of plane wave solutions in complex Ginzburg-Landau equation with delayed feedback. *SIAM J. Appl. Dyn. Syst.* 13(2), 986-1009.

Stitch, M. (2003). Target patterns and pacemaker in reaction-diffusion systems. PhD thesis, Technical University Berlin.

Stitch, M. and Beta, C. (2010). Control of pattern formation by time-delayed feedback with global and local contributions. *Physica* , 239, 1681.

Stitch, M., Casal, A. and Beta, C. (2013). Stabilization of standing waves through time-delayed feedback. *Phys. Rev. E*, 88, 042910.

Volpert, V. and Petrovskii, S. (2009). Reaction-diffusion waves in Biology. *Phys. of Life Rev.* 6, 267-310.

vi) **Relevance to Government Policy, if any / Perkaitan dengan Dasar Kerajaan, jika berkenaan**

The development of the mathematical models in this research is one of a key roles in ensuring the growth and development of a country's economy as well as in improving the quality of life for citizens within the country especially in the engineering industry to support the component of all economies and manufacturing. This research project is parallel to the National Policy on Science, Technology, and Innovation (NPSTI) where the government motivating Malaysians to advance towards a more progressive in creating a scientifically advanced nation for socioeconomic transformation and inclusive growth. Research on traveling wave time-delayed feedback can have several relevant implications for Malaysia's government policies and initiatives:

1. Infrastructure and Transportation: Malaysia's government is continually investing in improving transportation infrastructure. Understanding the dynamics of traffic flow, for example, which can be modeled using traveling wave concepts, can lead to more efficient traffic management strategies and

infrastructure planning. This research can inform policies related to road construction, traffic signal optimization, and public transportation development.

2. **Energy Management and Sustainability:** Malaysia is increasingly focusing on renewable energy sources and energy efficiency initiatives. Research on time-delayed feedback in power grid dynamics can help optimize energy distribution, mitigate fluctuations in renewable energy sources like solar and wind, and improve overall grid stability. Insights from this research can inform policies related to energy management, grid modernization, and sustainable development goals.
3. **Healthcare and Disease Management:** Malaysia's healthcare system faces challenges related to disease surveillance, outbreak prediction, and healthcare resource allocation. Modeling disease spread using traveling wave dynamics and time-delayed feedback can aid in understanding epidemic patterns, optimizing healthcare resource deployment, and implementing effective public health interventions. This research can inform policies related to disease prevention, healthcare infrastructure planning, and emergency response strategies.
4. **Technology Innovation and Economic Development:** Malaysia aims to strengthen its position as a hub for technology innovation and economic development. Research on traveling wave time-delayed feedback can drive innovation in areas such as telecommunications, control systems, and information technology. Government policies supporting research and development in these fields can stimulate economic growth, attract investment, and foster a culture of innovation and entrepreneurship.

(b) Objective (s) of the Research

Objektif Penyelidikan

The main objective of this thesis is to study on the dynamical behaviour of cqCGLE. The result is simulated using Wolfram Mathematica 9.0. The objectives can be divided into three areas:

1. To examine solution of cqCGLE in the regime of spatiotemporal chaos and in the presence and absence of time-delayed feedback, which represents travelling plane waves.
2. To compare and analyze the analytical solution of the current study (cqCGLE) with the analytical solution.
3. To perform the stability analysis from the derived equation.

(c) Methodology

Kaedah penyelidikan

Please state in the form / Sila nyatakan di borang ini

1. Developing the mathematical models consisting of the cubic-quintic Ginzburg-Landau equation with and without time delayed feedback by considering local and global feedback.

-The cqCGLE for a one dimensional medium with a combination of local and global time delayed feedback is achieved by separating the global and local part. The model of cqCGLE for one dimensional medium is develop the combination of these two global and local parts.

$$\frac{\partial A}{\partial t}(\vec{x}, t) = (1 - i\omega)A(\vec{x}, t) + (1 + ic_1)\nabla^2 A(\vec{x}, t) - (1 + ic_3)|A|^2 A(\vec{x}, t) - (1 + ic_5)|A|^4 A(\vec{x}, t),$$

2. The basic solution is achieved through the examination of uniform oscillations and standing (stationary) waves.
 - There are two important solutions of this system which are uniform oscillation and standing waves. Uniform oscillations are the type of oscillation where the amplitude and frequency are both constant. They represent an elementary solution of spatially extended oscillatory systems where in time of the quantity they having a sinusoidal behavior. The sinusoidal is seen in the real or imaginary part of the complex oscillation amplitude A in this case. The modulus remains constant in time. The amplitude A does not show any space dependence. Generally,

standing waves which also known as stationary waves are the result of the overlapping of two waves. It consist of the same amplitude and frequency. These waves travelling in the same speed although comes from the opposite directions. Whilst the waves are moving, at various locations the waves consist of a very large amplitude oscillation while others have zero amplitude and continuous destructive interference. Standing waves refer to a spatial pattern and in one dimension it is sinusoidal function which is constant in time.

3. Plane wave solutions were established by identifying the homogeneous solution while accounting for the presence or absence of time-delayed feedback.

- A wave is a disturbance that is created by a vibrating object and subsequently travels through a medium from one location to another, whilst transferring energy. The mechanism by which a mechanical wave propagates itself through a medium involves

particle interaction. One particle applies a force on its neighbouring element from its state of equilibrium or rest position. This type of wave that is seen travelling through a medium is sometimes referred to as a travelling wave. A plane wave is a wave whose wavefronts surfaces of constant phases are infinite parallel planes. Plane wave is a special kind of travelling wave and play a fundamental role in the theory of linear wave equation.

4. Solving the eigenvalues from the equation to get the linear stability analysis by using Mathematica or Matlab software.

- A mode separation was performed as we want to separate parts which are unperturbed since the study was interested in the stability of plane waves with respect to perturbation of wavenumber q . Then, perturbations and were applied in our finding.

5. Comparison of the finding between the present results to the previous literature.

6. The existence and stability of a specific travelling wave solution in the cqCGLE subjected to time-delay feedback were investigated.

(d) Expected Results/Benefit

Jangkaan Hasil Penyelidikan

1. Novel theories/New findings/Knowledge

1. The properties of plane wave solutions of cqCGLE with the presence and absence of the time delayed feedback. Criteria of the stability of plane wave solutions in the cqCGLE without the time delayed feedback are briefly described where the solution of plane waves for the standard cqCGLE is given by deriving the equation.

2. The stability of of plane waves in a time-delay cqCGLE with combined local and global time-delayed feedback. The analytical solution of plane waves was derived.

3. A linear stability analysis of plane waves with the respect to perturbations of wave number q had performed. As a consequence of this analysis, the eigenvalues was obtained.

4. Stabilization of plane waves was achieved for the parameter used.

5. Similar work has been done previously but using different scheme and not aiming at stabilizing the same solution. This method also had been used but using complex Ginzburg-Landau equation and yet did not achieved the stability of plane waves.

2. Research Publications

AIP Publishing

Journal of Applied Mathematics and Computational Intelligence

3. Specific or Potential Grant Applications (please specify targeted grant application)

Fundamental Research Grant Scheme (FRGS)

4. Number of PhD and Masters (by research) Students (if any)

N/A

5. Impact on Society, Economy and Nation

1. Understanding Complex Systems - Time-delayed feedback is a common feature in many natural and engineered systems, including biological networks, chemical reactions, and communication systems. Investigating traveling waves in such systems provides insights into their dynamic behavior and the underlying mechanisms governing their evolution.

2. Predictive Modeling - By studying traveling waves with time delayed feedback, researchers can develop mathematical models to predict and control the behavior of dynamic systems. These models contribute to improving system performance, stability, and reliability in real-world applications.

3. Emergent Properties - Research on traveling waves with time delayed feedback helps uncover emergent properties and collective behaviors that arise from the interactions between system components. These emergent properties can lead to novel functionalities and applications in diverse fields, including robotics, materials science, and ecology.

4. Technological Innovations - Insights gained from studying traveling waves with time delayed feedback often drive technological innovations in areas such as signal processing, control systems, and information theory. These innovations contribute to the development of advanced technologies with applications in communication networks, medical devices, and renewable energy systems.

5. Interdisciplinary Collaboration - Research on traveling waves with time delayed feedback fosters interdisciplinary collaboration among scientists, engineers, mathematicians, and practitioners from various fields. Collaborative efforts facilitate the exchange of knowledge, methodologies, and perspectives, leading to comprehensive solutions to complex scientific and engineering challenges.

(e) Research activity & Milestone

Aktiviti penyelidikan & Carta perbatuan

Gantt Chart of Research Activities

No.	Activities	Year 1				Year 2			
		1/1/25 - 31/3/25	1/4/25 - 30/6/25	1/7/25 - 30/9/25	1/10/25 - 31/12/25	1/1/26 - 31/3/26	1/4/26 - 30/6/26	1/7/26 - 30/9/26	1/10/26 - 31/12/26
1	Literature review and preliminary study.								
2	Developing the mathematical model consisting of the time-delayed feedback by considering two boundary conditions (no flux and periodic).								
3	Deriving the mathematical model for the problem considered local and global feedback.								
4	Basic stable solution which <u>corresponding</u> to uniform oscillations by splitting the real and imaginary parts is obtained.								
5	Basic solution is achieved through the examination of uniform oscillations and standing (stationary) waves.								
6	Plane wave solutions are established by doing analytical <u>solution</u> , mode separation and linear stability analysis.								
7	Comparing the analytical solution of the present study (<u>ccCGLE</u>) with the previous papers (CGLE).								
8	Analyzing the analytical solution and mode separation by considering the presence and absence of time-delayed feedback.								
9	Performing the stability analysis from the <u>derive</u> equation.								
10	Obtaining the eigenvalues by using Mathematica and <u>Matlab</u> .								
11	Determining the existence and stability of a specific traveling wave solution in the <u>ccCGLE</u> subjected to time-delayed feedback.								
12	Analyzing and recording the obtained results.								
13	Preparing a journal publication or conference proceeding.								

* Milestones

	Flow Chart of Research Activities <pre> graph TD A[Literature review: Waves and Pattern Formation in Oscillatory Systems, Travelling Waves, Time-Delayed Feedback] --> B[Developing the mathematical models consisting of the cubic-quintic Ginzburg-Landau equation with and without time delayed feedback by considering local and global feedback] B --> C[The basic solution is achieved through the examination of uniform oscillations and standing (stationary) waves] C --> D[Plane wave solutions were established by identifying the homogeneous solution while accounting for the presence or absence of time-delayed feedback] D --> E[Solving the eigenvalues from the equation to get the linear stability analysis by using Mathematica or Matlab software] E --> F[Comparison of the finding between the present results to the previous literature] F --> G[The existence and stability of a specific travelling wave solution in the cqCGLE subjected to time-delay feedback were investigated] G --> H[Report the all the research outputs of the proposed models as a journal publication. Evaluate the strengths, weaknesses, and future works of the research.] </pre>
D	BUDGET /BELANJAWAN
	Please indicate your estimated budget for this research and details of expenditure according to the guidelines attached. <i>Sila nyatakan anggaran bajet bagi cadangan penyelidikan ini dan berikan butir – butir perbelanjaan lengkap dengan berpandukan kepada garis panduan yang dilampirkan.</i>

	Budget details <i>Butiran belanjawan</i>	Amount requested by applicant <i>Jumlah yang dipohon oleh pemohon</i>	
		Year 1 (Tahun 1) (RM)	Year 2 (Tahun 2) (RM)
D(i)	Vote 21000 - Travelling and Transportation/ <i>Perjalanan dan Pengangkutan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali</i> . Pengangkutan untuk menghadiri konferens/seminar/consultant	RM200.00	RM200.00
D(ii)	Vote 24000 - Rental <i>Vot 24000 - Sewaan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>		
D(iii)	Vote 27000 - Research Materials & Supplies <i>Vot 27000 - Bekalan dan Bahan Penyelidikan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>		
D(iv)	Vote 28000 - Maintenance and Minor Repair Services <i>Bvot 28000 - Baik pulih kecil dan ubahsuai</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>		

D(v)	Vote 29000 - Professional Services <i>Vot 29000 - Perkhidmatan Ikhtisas</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i> Perkhidmatan Proofreading Konferens/Jurnal Honorium pelajar (RM400 x 3 bulan)	 RM300.00 RM1400.00 RM1200.00	 RM300.00 RM1400.00
D(vi)	Vote 35000 - Accessories and Equipment <i>Vot 35000 - Aksesori dan Peralatan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>		
TOTAL AMOUNT JUMLAH BESAR		RM5000.00	
E	Declaration by applicant / Akuan Pemohon (Please tick (√)): / (Sila tanda (√)):		

I hereby declare that:

Saya dengan ini mengaku bahawa:



- 1. All information stated here are accurate, and PJI has right to reject or to cancel the offer without prior notice if there is any inaccurate information given.**

Semua maklumat yang diisi adalah benar, PJIM&A berhak menolak permohonan atau membatalkan tawaran pada bila-bila masa sekiranya keterangan yang dikemukakan adalah tidak benar.



- 2. Application of this research is presented for the Geran Semarak Penyelidikan**

Permohonan penyelidikan ini dikemukakan untuk Geran Semarak Penyelidikan.



- 3. Application of this research is subject to Ethical Committee approval (if applicable).**

Permohonan penyelidikan ini dimajukan ke Jawatankuasa Etika (jika berkenaan).

Date : 20/11/2024

Tarikh :

Applicant's Signature :

Tandatangan Pemohon :



Note: APPLICATIONS SUBMITTED WILL BE TREATED IN FULL CONFIDENCE. THE DECISION OF THE INTERNAL RESEARCH ACCULTURATION MAIN COMMITTEE UiTM CAWANGAN PERLIS IS FINAL. Semua permohonan dianggap sulit. Keputusan Jawatankuasa Induk Geran Penyelidikan Pembudayaan Dalam UiTM Cawangan Perlis adalah MUKTAMAD.

Bahagian Penyelidikan, Jaringan Industri
Masyarakat, Alumni & Keusahawanan
Universiti Teknologi MARA Cawangan Perlis
Kampus Arau, 02600 Arau, Perlis
Tel: (+604) 988 2017 / 2028 / 2029 / 2080 / 2302 / 2308
Emel: pjimaperlis@uitm.edu.my



UNIVERSITI
TEKNOLOGI
MARA

Cawangan Perlis
Kampus Arau

Our Ref : 100 UiTMPs(PJIM&A/UPK.15/1)
Date : 1445H ذوالقعدة 27
: 4 Jun 2024

Dr. Nur Fazliana Rahim
Kolej Pengajian Pengkomputeran, Informatik dan Matematik
UiTM Perlis Branch
Arau Campus
Perlis.

وَبَرَكَاتُهُ dan Salam Sejahtera

Puan

PENDAFTARAN RESEARCH INTEREST GROUP (RIG)

Tajuk Projek : *Interdisciplinary Research Alliance (iRA)*
Kod Pendaftaran : RIG 063/2024
Ketua Projek : Dr. Nur Fazliana Rahim
Ahli Projek : Dr. Nur Izzati Khairudin
: Dr. Nur Fatimah Fauzi
: Dr. Nurizatul Syarfinas Ahmad Bakhtiar
: Dr. Huda Zuhrah Ab. Halim
: Dr. Nurtihah Mohamed Noor

Dengan hormatnya perkara di atas adalah dirujuk.

2. Untuk makluman 'Research Interest Group' – *Interdisciplinary Research Alliance(iRA)* telah didaftarkan di bawah PJIM&A UiTM Cawangan Perlis dengan Kod Pendaftaran RIG 063/2024.

3. Sehubungan dengan itu, kumpulan RIG ini adalah digalakkan untuk mengatur sebarang aktiviti atau program yang bermanfaat untuk perkembangan kumpulan RIG tersebut. Di samping itu, kumpulan RIG ini hendaklah menghantar sesalinan laporan aktiviti yang dilaksanakan untuk direkodkan oleh pihak PJIM&A.

4. Segala sumbangan dan sokongan daripada pihak tuan didahului dengan ucapan ribuan terima kasih.

Sekian.

اوسها، تقوى، مليا

"MALAYSIA MADANI"

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan Amanah,

PROF. MADYA DR. SHUKOR SANIM MOHD FAUZI
Menjalankan Fungsi Rektor

Universiti Teknologi MARA Cawangan Perlis
Kampus Arau
02600 Arau, Perlis, MALAYSIA
Tel: (+604) 988 2000 Faks: (+604) 988 2019
e-mel: korporatperlis@uitm.edu.my



BORANG GSP 2024

Kod Rujukan: (Diisi oleh PJI)	
RIG	
Bukti Kolaborasi	

(Diisi oleh PJI)

**BORANG PERMOHONAN
GERAN SEMARAK PENYELIDIKAN (GSP) 2024****Bahagian Penyelidikan & Jaringan Industri (PJI)
UiTM CAWANGAN PERLIS**

A	TITLE OF PROPOSED RESEARCH: <i>Tajuk penyelidikan yang dicadangkan :</i> Physicochemical properties and active compound profiling of Annona-based biopesticide repellent against aphids	
B	DETAILS OF RESEARCHER / MAKLUMAT PENYELIDIK	
B(i)	Name of Project Leader: <i>Nama Ketua Projek:</i> Nazalyyusma Yusop	IC / Passport Number: <i>No. Kad Pengenalan/ Pasport:</i> 761022085014
B(iii)	Faculty/School/Centre/Unit (Please provide full address): <i>Fakulti/Jabatan /Pusat/Unit (Sila nyatakan)</i> Fakulti Perladangan dan Agroteknologi, UiTM Cawangan Perlis	
B(iv)	Office Telephone No.: <i>No. Telefon Pejabat:</i> 04 - 988 2297	Handphone No.: <i>No. Telefon Bimbit:</i> 019 – 570 1165
B(v)	E-mail Address: <i>Alamat e-mel:</i> nazalyyusma@uitm.edu.my	

B(vi)	Date of first appointment with this University: <i>Tarikh mula berkhidmat dengan Universiti ini:</i> 01 November 2006																														
C	RESEARCH INFORMATION / MAKLUMAT PENYELIDIKAN																														
C(i)	Research Domain (Please tick (✓)): <i>Domain Penyelidikan (Sila tanda (✓)):</i> Pure and Applied Sciences (Sains Tulen dan gunaan) <table border="0"> <tr> <td>☐ Chemistry (Kimia)</td> <td>☐ Physic (Fizik)</td> <td>☐ Biology (Biologi)</td> </tr> <tr> <td>☐ Biochemistry (Biokimia)</td> <td>☐ Materials Science (Sains Bahan)</td> <td>☐ Mathematics and Statistics (Matematik dan Statistik)</td> </tr> <tr> <td>☐ Materials Science (Sains Bahan)</td> <td></td> <td></td> </tr> </table> B. Social Sciences (Sains Sosial) <table border="0"> <tr> <td>☐ Anthropology (Antropologi)</td> <td>☐ Psychology (Psikologi)</td> <td>☐ Sociology (Sosiologi)</td> </tr> <tr> <td>☐ Political Science (Sains Politik)</td> <td>☐ Business and Management (Pengurusan dan Perniagaan)</td> <td>☐ Geography (Geografi)</td> </tr> <tr> <td>☐ Economic (Ekonomi)</td> <td>☐ Human Ecology (Ekologi Manusia)</td> <td>☐ Communication (Komunikasi)</td> </tr> </table> C. Arts and Applied Arts (Sastera dan Sastera Ikhtisas) <table border="0"> <tr> <td>☐ Language and Linguistic (Bahasa dan Linguistik)</td> <td>☐ Literature (Kesusasteraan)</td> <td>☐ Religion (Agama)</td> </tr> <tr> <td>☐ Philosophy (Falsafah)</td> <td>☐ Civilization (Tamadun)</td> <td>☐ History (Sejarah)</td> </tr> <tr> <td>☐ Art (Seni)</td> <td>☐ Culture (Budaya)</td> <td>☐ Education (Pendidikan)</td> </tr> <tr> <td>☐ Policies and Law (Dasar dan Undang-undang)</td> <td>☐ Built Environment (Alam Bina-Aspek Kemanusiaan)</td> <td>☐ Environment (Alam Sekitar-Aspek Kemanusiaan)</td> </tr> </table>	☐ Chemistry (Kimia)	☐ Physic (Fizik)	☐ Biology (Biologi)	☐ Biochemistry (Biokimia)	☐ Materials Science (Sains Bahan)	☐ Mathematics and Statistics (Matematik dan Statistik)	☐ Materials Science (Sains Bahan)			☐ Anthropology (Antropologi)	☐ Psychology (Psikologi)	☐ Sociology (Sosiologi)	☐ Political Science (Sains Politik)	☐ Business and Management (Pengurusan dan Perniagaan)	☐ Geography (Geografi)	☐ Economic (Ekonomi)	☐ Human Ecology (Ekologi Manusia)	☐ Communication (Komunikasi)	☐ Language and Linguistic (Bahasa dan Linguistik)	☐ Literature (Kesusasteraan)	☐ Religion (Agama)	☐ Philosophy (Falsafah)	☐ Civilization (Tamadun)	☐ History (Sejarah)	☐ Art (Seni)	☐ Culture (Budaya)	☐ Education (Pendidikan)	☐ Policies and Law (Dasar dan Undang-undang)	☐ Built Environment (Alam Bina-Aspek Kemanusiaan)	☐ Environment (Alam Sekitar-Aspek Kemanusiaan)
☐ Chemistry (Kimia)	☐ Physic (Fizik)	☐ Biology (Biologi)																													
☐ Biochemistry (Biokimia)	☐ Materials Science (Sains Bahan)	☐ Mathematics and Statistics (Matematik dan Statistik)																													
☐ Materials Science (Sains Bahan)																															
☐ Anthropology (Antropologi)	☐ Psychology (Psikologi)	☐ Sociology (Sosiologi)																													
☐ Political Science (Sains Politik)	☐ Business and Management (Pengurusan dan Perniagaan)	☐ Geography (Geografi)																													
☐ Economic (Ekonomi)	☐ Human Ecology (Ekologi Manusia)	☐ Communication (Komunikasi)																													
☐ Language and Linguistic (Bahasa dan Linguistik)	☐ Literature (Kesusasteraan)	☐ Religion (Agama)																													
☐ Philosophy (Falsafah)	☐ Civilization (Tamadun)	☐ History (Sejarah)																													
☐ Art (Seni)	☐ Culture (Budaya)	☐ Education (Pendidikan)																													
☐ Policies and Law (Dasar dan Undang-undang)	☐ Built Environment (Alam Bina-Aspek Kemanusiaan)	☐ Environment (Alam Sekitar-Aspek Kemanusiaan)																													

D. Natural Sciences and National Heritage (*Sains Tabii dan Warisan Negara*)

☐ Environment
(*Alam Sekitar*)

☐ Forestry
(*Perhutanan*)

☒ Agriculture
(*Pertanian*)

☐ Marine
(*Marin*)

☐ Archaeology
(*Arkeologi*)

☐ Geoscience
(*Geosains*)

☐ Ethnography
(*Etnografi*)

☐ Built Environment
(*Heritage Aspect*)
Alam Bina (Aspek Warisan)

☐ Culture
(*Budaya*)

☐ Biodiversity
(*Kepelbagaian Biologi*)

E. Information and Communication Technology (*Teknologi Maklumat dan Komunikasi*)

☐ Software and Information System
(*Perisian dan Sistem Maklumat*)

☐ Soft Computing
(*Pengkomputeran Lembut*)

☐ Computer Networking
(*Rangkaian Komputer*)

☐ Information Security
(*Keselamatan Maklumat*)

☐ Multimedia
(*Multimedia*)

☐ Computer Engineering
(*Kejuruteraan Komputer*)

☐ Computer Science
(*Sains Komputer*)

F. Health Sciences (*Sains Kesihatan*)

☐ Basic Medical Sciences
(*Sains Perubatan Asas*)

☐ Pharmacy
(*Farmasi*)

☐ Pharmacology
(*Farmakologi*)

☐ Medical Microbiology
(*Mikrobiologi Perubatan*)

☐ Parasitology
(*Parasitologi*)

☐ Pathology
(*Pathologi*)

☐ Community Medical Prevention
(*Perubatan Pencegahan Masyarakat*)

☐ Clinical Surgical
(*Klinikal Surgikal*)

☐ Clinical Medical
(*Klinikal Medikal*)

☐ Associate Health Science
(*Sains Kesihatan Bersekutu*)

☐ Dental
(*Pergigian*)

☐ Nursing Science
(*Sains Kejururawatan*)

C(ii)

Location of Research:

Tempat penyelidikan dijalankan:

UiTM Cawangan Perlis

C(iii)	Duration of this research (Maximum 12 months): <i>Tempoh masa penyelidikan ini (Maksimum 12 bulan):</i> Duration: 1 year <i>Tempoh :</i> From : 1 Jan 2025 <i>Dari :</i> To : 31 Dec 2025 <i>Hingga :</i>																																	
C(iv)	Other Researchers: <i>Ahli-ahli penyelidik yang lain:</i> <table border="1"> <thead> <tr> <th>Bil</th> <th>Name <i>Nama</i></th> <th>IC / Staff Number: <i>No. Kad Pengenalan/ No. Pekerja:</i></th> <th>University / Industry / Agency <i>Fakulti/ P.Pengajian/ Pusat/Unit</i></th> <th>Academic Qualification/ Designation <i>Tahap Kelayakan Akademik/Jawatan</i></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>Dr. Najihah Farhan Sabri</td> <td>257785</td> <td>Faculty of Plantation and Agrotechnology, UiTM Perlis</td> <td>PhD (Plant Pathology, USM)</td> </tr> <tr> <td>2</td> <td>Prof. Dr. Chuah Tse Seng</td> <td>336839</td> <td>Faculty of Plantation and Agrotechnology, UiTM Perlis</td> <td>PhD (Environmental Science, UKM)</td> </tr> <tr> <td>3</td> <td>Noor Zuhairah Samsuddin</td> <td>304489</td> <td>Faculty of Plantation and Agrotechnology, UiTM Perlis</td> <td>MSc. (Plant Biotechnology, UKM)</td> </tr> <tr> <td>4</td> <td>Dr. Non Daina Masdar</td> <td>195973</td> <td>Faculty of Applied Science, UiTM Perlis</td> <td>PhD</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> </tbody> </table>				Bil	Name <i>Nama</i>	IC / Staff Number: <i>No. Kad Pengenalan/ No. Pekerja:</i>	University / Industry / Agency <i>Fakulti/ P.Pengajian/ Pusat/Unit</i>	Academic Qualification/ Designation <i>Tahap Kelayakan Akademik/Jawatan</i>	1	Dr. Najihah Farhan Sabri	257785	Faculty of Plantation and Agrotechnology, UiTM Perlis	PhD (Plant Pathology, USM)	2	Prof. Dr. Chuah Tse Seng	336839	Faculty of Plantation and Agrotechnology, UiTM Perlis	PhD (Environmental Science, UKM)	3	Noor Zuhairah Samsuddin	304489	Faculty of Plantation and Agrotechnology, UiTM Perlis	MSc. (Plant Biotechnology, UKM)	4	Dr. Non Daina Masdar	195973	Faculty of Applied Science, UiTM Perlis	PhD					
Bil	Name <i>Nama</i>	IC / Staff Number: <i>No. Kad Pengenalan/ No. Pekerja:</i>	University / Industry / Agency <i>Fakulti/ P.Pengajian/ Pusat/Unit</i>	Academic Qualification/ Designation <i>Tahap Kelayakan Akademik/Jawatan</i>																														
1	Dr. Najihah Farhan Sabri	257785	Faculty of Plantation and Agrotechnology, UiTM Perlis	PhD (Plant Pathology, USM)																														
2	Prof. Dr. Chuah Tse Seng	336839	Faculty of Plantation and Agrotechnology, UiTM Perlis	PhD (Environmental Science, UKM)																														
3	Noor Zuhairah Samsuddin	304489	Faculty of Plantation and Agrotechnology, UiTM Perlis	MSc. (Plant Biotechnology, UKM)																														
4	Dr. Non Daina Masdar	195973	Faculty of Applied Science, UiTM Perlis	PhD																														
C(vi)	Please provide information on academic publications that has been published by the project leader for the last five (5) years. (Example: Journals, Books, Chapters in books, etc) <i>Sila kemukakan maklumat berkaitan penerbitan akademik yang telah diterbitkan oleh ketua penyelidik dalam tempoh lima (5) tahun terakhir. (Contoh: Jurnal, buku, bab dalam buku, dll)</i> <table border="1"> <thead> <tr> <th>Title of publication <i>Tajuk penerbitan</i></th> <th>Name of journals/books <i>Nama jurnal/buku</i></th> <th>Year published <i>Tahun diterbitkan</i></th> </tr> </thead> <tbody> <tr> <td></td> <td></td> <td></td> </tr> </tbody> </table>				Title of publication <i>Tajuk penerbitan</i>	Name of journals/books <i>Nama jurnal/buku</i>	Year published <i>Tahun diterbitkan</i>																											
Title of publication <i>Tajuk penerbitan</i>	Name of journals/books <i>Nama jurnal/buku</i>	Year published <i>Tahun diterbitkan</i>																																

1.	Bab 3: Penggalak Tanaman Meningkatkan Jambak Bunga dan Set Buah	Terokai Ilmu Harumanis Raja Mangga Malaysia (Chapters in Book)	2024
2.	Survey of herbicide-resistant weed management in oil palm estates from Peninsular Malaysia and Indonesia	Advances in Weed Science	2024
3.	Projek CBF-Peranan Dan Cabaran Dalam Peningkatan Produktiviti Dan Sosio Ekonomi Pengusaha Mangga Harumanis	Abstrak Persidangan Harumanis Kebangsaan 2024	2024
C(vii)	Executive Summary of Research Proposal (maximum 300 words) (Please include the problem statement, objectives, research methodology, expected output/outcomes/implication, and significance of output from the research project) <i>Ringkasan Cadangan Eksekutif Penyelidikan (maksimum 300 patah perkataan)</i> <i>(Meliputi pernyataan masalah, objektif, kaedah penyelidikan, jangkaan hasil penyelidikan/implikasi dan kepentingan output projek penyelidikan)</i> Executive summary The aim of this study is to evaluate efficacy of Emulsifiable Concentrate (EC) formulations of Annona-based biopesticide repellent against aphids. This work is required to isolate the active compound and prepare a potentials extract and establish formulation profiling of EC formulations of Annona-based biopesticide. A leaves of <i>Annona squamosa</i> L. will be prepare using EC formulations comprising of leaves extract (40%) by using organic solvents (50%) and emulsifier blends (10%). Physical properties such as pH, solubility, contact angle and etc while chemical properties of <i>Annona squamosa</i> L extract will be determine using FTIR, HPLC and GC-MS. Additionally, in-vitro bioassays test will be conduct to evaluate the repellent's effectiveness against aphids. Approximately, 5 samples of EC formulations will be prepare from leaves and determination of emulsion stability, cold test, accelerated storage and flash point test will be carry out to indicate feasibility for their commercial production. Besides, all the EC formulation will be determine using several test for profiling of active compound by GC-MS, using FTIR and HPLC to reveal some bioactive constituents belonging to Annona-based biopesticide. The profiling of EC formulations of Annona-based biopesticide repellent against aphids outcomes will be use for further study. In addition, this study is significance in developing biopesticide repellent formulations as an alternative to harmful synthetic chemical and a step forward towards development of a promising eco-friendly technology in crop protection.		
C(viii)	Detailed proposal of research project: <i>Cadangan maklumat penyelidikan secara terperinci:</i> (a) Research background including: / <i>Latarbelakang penyelidikan termasuk:</i> i) Problem Statement / <i>Pernyataan Masalah</i> ii) Hypothesis / <i>Hipotesis</i> iii) Research Questions / <i>Persoalan Penyelidikan</i> iv) Literature Reviews / <i>Kajian Literatur</i> v) Related References / <i>Rujukan berkaitan</i> vi) Relevance to Government Policy, if any / <i>Perkaitan dengan Dasar Kerajaan, jika berkenaan</i> i) Problem Statement:		

The primary obstacle in utilising *Annona squamosa* extracts as a biopesticide repellent is their inadequate physicochemical stability, adversely affecting both efficacy and shelf life. Current formulations often encounter problems like phase separation, degradation of active compounds, and inconsistent repellent efficacy in different environmental conditions. These issues limit the practical application and commercial viability of Annona-based biopesticides, as they may lose potency before use or necessitate frequent reapplication in the field. Addressing these stability problems is essential for creating a dependable, durable biopesticide that may efficiently repel pests while reducing dependence on synthetic chemical pesticides.

ii) Hypothesis

The study suggests that enhancing the physicochemical properties of the Annona biopesticide repellent by adding stabilizers and emulsifiers will improve its stability and effectiveness. By creating the biopesticide in the oil phase, it is expected that the bioactive compounds will have better solubility and stability, which will lower degradation rates and improve their adherence to plant surfaces. This oil-based formulation is likely to allow for a sustained release of active compounds, leading to longer-lasting repellent effects against agricultural pests and minimizing the need for frequent reapplication.

iii) Research Questions

The research aims to address the following key questions:

1. What are the physicochemical properties of *Annona squamosa* leaves extract and bioactive properties against aphids.
2. What is the efficacy of Emulsifiable Concentrate (EC) formulations of Annona-based biopesticide repellent against aphids.
3. What is a detail profiling of Emulsifiable Concentrate (EC) formulations of Annona-based biopesticide repellent against aphids

iv) Literature review

Annona squamosa, commonly known as sugar apple, contains bioactive compounds such as acetogenins, flavonoids (including quercetin), tannins, and alkaloids, which exhibit notable pesticidal properties. These phytochemicals have proven effective against a range of agricultural pests, making them promising candidates for the development of biopesticides. Notably, acetogenins play a key role in delivering potent insecticidal effects by targeting the nervous systems of pests and disrupting ATP production, essential for cellular energy Behera & Sahoo (2017). However, a significant challenge in utilizing Annona-based biopesticides is enhancing their physicochemical stability to ensure reliable performance during storage and application.

To improve the efficacy of these bio-pesticides, it is vital to enhance their physicochemical properties, such as solubility and emulsification. This is especially critical when shifting formulations to an oil-based phase, as the hydrophobic characteristics of most active compounds in *Annona squamosa* can create challenges with dispersion and stability. Furthermore, research indicates that oil-based formulations may offer better protection for bioactive compounds against environmental degradation, thereby extending the product's shelf life and effectiveness in the field. Investigating ways to optimize these formulations could lead to a stable and effective natural alternative to synthetic pesticides in the pomology sector, targeting pests like flea beetles while reducing harm to non-target beneficial insects and the environment.

The formulation process is crucial in reducing potential risks. Switching to oil-based formulations can improve the controlled release of active compounds, which may lower the required dosage and frequency of application. This controlled release could help decrease the exposure of non-target species to harmful levels of bioactive compounds. Investigating ways to enhance formulation stability, such as using emulsifiers or encapsulation techniques, can further boost the safety and effectiveness of Annona-based bio-pesticides, positioning them as a viable, eco-friendly option for integrated pest management in the pomology sector.

v) Related References

- Alva, A., Kaushik, G., & Puri, A. (2018). Formulation and stability of plant-based pesticides. *Journal of Agricultural and Food Chemistry*, 66(34), 9014-9025.
- Behera, S., & Sahoo, S. (2017). Phytochemical properties of *Annona squamosa* and its role in bio-pesticides. *International Journal of Research in Biosciences*, 6(2), 45-54. Retrieved from <https://www.researchgate.net>
- Eze, P. N., et al. (2021). Pesticide residue concerns in agricultural exports from Malaysia. *International Journal of Environmental Research and Public Health*, 18(10), 5327.
- Liu, Y., Wang, Y., & Wang, Z. (2020). Stability and bioactivity of plant-based insecticides: A review. *Pesticide Biochemistry and Physiology*, 164, 38-44.
- Lim, L. S., Tan, S. S., & Tan, W. L. (2020). Biotechnology in Malaysia: Towards a knowledge-based economy. *Malaysian Journal of Biotechnology*, 12(3), 63-75.
- Ma, C., Chen, Y., Chen, J., Li, X., & Chen, Y. (2017). A review on *Annona squamosa* L.: Phytochemicals and biological activities. *The American Journal of Chinese Medicine*, 45(5), 1-32. <https://doi.org/10.1142/S0192415X17500501>
- N'Guessan, R., Traore, M., & Kone, S. (2019). Evaluation of the environmental impact of bio-pesticides on non-target species in agricultural ecosystems. *Environmental Toxicology and Chemistry*, 38(2), 299-308.
- Perez, A., Hernandez, A., & Sanchez, L. (2016). Shelf life and stability testing for natural pesticide formulations. *Pesticide Science and Technology*, 22(1), 1-10.
- Sciepub. (2020). Phytochemicals and potential use of *Annona squamosa* for pest management. Retrieved from <https://www.sciepub.com>
- Sullivan, C., et al. (2017). Market trends and the impact of sustainable farming practices in Southeast Asia. *Asia-Pacific Journal of Agribusiness*, 5(1), 45-58.
- IOSR Journals. (n.d.). Phytochemical analysis and anti-cancer properties of *Annona squamosa* seed extract. Retrieved from www.iosrjournals.org
- Sciepub. (2020). Phytochemicals and potential use of *Annona squamosa* for pest management. Retrieved from www.sciepub.com

vi) Relevance to Government Policy:

The development of biopesticides from *Annona squamosa* fits well with key government policies in Malaysia, particularly those aimed at promoting sustainable agricultural practices and decreasing reliance on synthetic chemicals. Initiatives like the National Agro-Food Policy (2011–2020) and the Malaysian Palm Oil Green Certification Standard have been introduced to boost agricultural productivity and sustainability. These policies focus on minimizing the environmental impact of farming, encouraging organic farming methods, and increasing the use of biopesticides within integrated pest management (IPM) systems.

By promoting biopesticides derived from *Annona squamosa*, the government supports its goal of shifting towards more environmentally friendly agricultural practices. This commitment to sustainability is also reflected in the Eleventh Malaysia Plan (2016–2020), which advocates for the development of sustainable agricultural technologies that reduce harmful chemical usage, benefiting both the environment and public health. Biopesticides play a crucial role in this effort by offering safer alternatives to synthetic pesticides, which have raised concerns about food residues and negative effects on non-target species.

Moreover, the government's policies on environmental protection and biodiversity conservation, such as the Environmental Quality Act and the National Biodiversity Policy, align with the objectives of utilizing naturally derived pesticides. Developing products based on *Annona* would help decrease chemical

contamination in ecosystems and protect biodiversity, which is a national priority. Additionally, fostering local research and development in biopesticides could stimulate Malaysia's economic growth by creating new green technologies and markets for sustainable agricultural products.

(b) Objective (s) of the Research

Objektif Penyelidikan

Objectives research

1. To evaluate a potential of *Annona squamosa* leaves extract and bioactive properties against aphids.
2. To evaluate efficacy of Emulsifiable Concentrate (EC) formulations of Annona-based biopesticide repellent against aphids.
3. To develop profiling of Emulsifiable Concentrate (EC) formulations of Annona-based biopesticide repellent against aphids

(c) Methodology

Kaedah penyelidikan

Please state in the form / Sila nyatakan di borang ini

This study will employ both laboratory and field-based approaches to develop and evaluate the effectiveness and stability of Annona based bio-pesticides, focusing on their physicochemical properties, formulation stability, and environmental impact.

1. Collection of Plant Material

Annona squamosa leaves and seeds will be sourced from local farms and orchards. Fresh, healthy plant material will be collected and cleaned to remove any debris or contaminants. The leaves and seeds will be dried at room temperature, ground into fine powder, and stored in airtight containers to maintain quality before extraction.

2. Extraction of Bioactive Compounds

The bioactive compounds will be extracted from the leaves of *Annona squamosa* using solvents such as ethanol or methanol through a maceration process. The solvents will be selected based on their ability to extract a broad range of phytochemicals, including acetogenins, alkaloids, and flavonoids. The extraction will be performed in a temperature-controlled environment to optimize compound yield. The extracts will be concentrated using rotary evaporation to remove excess solvents.

3. Physicochemical Characterization of the leaves extracts will undergo detailed analysis to determine key properties such as:

- i) pH: The pH of the formulation will be measured to ensure that it is within an optimal range for stability and safety.
- ii) Chemical Characterization of bioactive compound will be measure by using FTIR, HPLC and GC-MS.

4. Physicochemical Characterization and biological test of the Emulsifiable Concentrate (EC) formulations

- iii) Solubility: To assess the ability of the active compounds to dissolve in various solvent systems (e.g., water, oil, ethanol).
- iv) Emulsification: The emulsifying properties will be evaluated using surfactants to prepare an oil-based formulation.
- v) Viscosity: The viscosity of the final formulation will be measured using a viscometer to ensure easy application.
- vi) pH: The pH of the formulation will be measured to ensure that it is within an optimal range for stability and safety.
- vii) These tests are crucial for determining the feasibility of scaling up the formulation and ensuring that the product is stable during storage and application (Liu et al., 2020; Alva et al., 2018).
- viii) Temperature: The formulations will be stored at different temperatures (e.g., 4°C, 25°C, and

40°C) and monitored over time to observe any physical changes, such as phase separation or precipitation.

- ix) Light Exposure: The formulations will be tested under exposure to different light conditions (dark vs. light) to simulate real-world storage conditions and assess the degradation of bioactive compounds (Ma et al., 2017).
- x) Shelf-Life Testing: Long-term shelf-life testing will be conducted for a minimum of 6 months to monitor any reduction in effectiveness or changes in physical properties (Perez et al., 2016).
- xi) Biological test: In-vitro bioassay of aphids
- xii) Chemical Characterization will be measure by using FTIR, HPLC and GC-MS,

Data Analysis

Data will be analyzed using statistical tools such as Analysis of Variance (ANOVA) to compare the effectiveness of different Emulsifiable Concentrate (EC) formulations and determine the statistical significance of the results. The results will be used to optimize the formulation and determine the optimal conditions for stability and efficacy.

(d) Expected Results/Benefit

Jangkaan Hasil Penyelidikan

1. ***Novel theories/New findings/Knowledge***

This study could provide new insights into creating bio-pesticides that are both effective and stable for commercial applications. Furthermore, it may enhance our understanding of how plant-based compounds, particularly those from *Annona squamosa*, can be used in aphids management while minimizing harm to beneficial organisms. Integrating these naturally derived solutions into pest management systems could also open up new avenues for policy development in sustainable agriculture, especially in Malaysia, where there is a significant emphasis on decreasing the use of synthetic pesticides.

2. ***Research Publications***

Journal of index publication

3. ***Specific or Potential Grant Applications (please specify targeted grant application)***

4. ***Number of PhD and Masters (by research) Students (if any)***

5. ***Impact on Society, Economy and Nation***

The use of bio-pesticides from *Annona squamosa* can promote healthier agricultural practices by decreasing dependence on chemical pesticides. This shift would lead to safer food production and lower health risks for both farmers and consumers (Alva et al., 2018). Moreover, developing natural pest control solutions could encourage sustainable agricultural communities, fostering environmentally friendly farming practices that benefit society in the long run (N'Guessan et al., 2019).

Economically, the transition to bio-pesticides could create new opportunities in Malaysia's agricultural and biotechnology sectors. By cutting costs related to synthetic pesticides and enhancing the quality of agricultural products, Malaysian farmers could see improved productivity and profitability. Additionally, exporting *Annona squamosa*-derived bio-pesticides could enhance Malaysia's competitiveness in global markets, particularly in areas that prioritize organic and eco-friendly agricultural products (Eze et al., 2021). This industry could also invigorate local economies by supporting the development of small and medium-sized enterprises (SMEs) focused on biotechnology and agrochemical production (Lim et al., 2020).

On a national scale, embracing bio-pesticides could help Malaysia achieve its ambition of becoming a leader in sustainable agriculture and biotechnology innovation. This aligns with national policies like the Malaysia Plan and National Agrofood Policy, which advocate for sustainable farming and a

In conclusion, the commercialization of *Annona squamosa*-based bio-pesticides holds significant potential for societal benefits and economic growth.

Aktiviti penyelidikan & Carta perbatuan

No	Project activity description	Date	Completion project progress
1	Collection of Plant Material	1/1/2025	20
2	Extraction of Bioactive Compounds	1/2/2025	40
3	Physicochemical Characterization (Extraction)	1/6/2025	60
4	Physicochemical Characterization (Oil-Based) Stability Evaluation	1/9/2025	80
5	Data Analysis and Writing	1/12/2025	100%

Gantt Chart

[illegible]

D	BUDGET /BELANJAWAN	
	Please indicate your estimated budget for this research and details of expenditure according to the guidelines attached. <i>Sila nyatakan anggaran bajet bagi cadangan penyelidikan ini dan berikan butir – butir perbelanjaan lengkap dengan berpandukan kepada garis panduan yang dilampirkan.</i>	
	Budget details <i>Butiran belanjawan</i>	Amount requested by applicant <i>Jumlah yang dipohon oleh pemohon</i>
		Year 1 Tahun 1 (RM)
D(i)	Vote 21000 - Travelling and Transportation/ <i>Perjalanan dan Pengangkutan</i> Please specify 1. <i>Traveling for leaves /material collection at Kedah - Perlis</i> 2. <i>Attending local conference/seminar/workshop</i>	RM200 RM300
D(ii)	Vote 24000 - Rental <i>Vot 24000 - Sewaan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>	
D(iii)	Vote 27000 - Research Materials & Supplies <i>Vot 27000 - Bekalan dan Bahan Penyelidikan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i> 1. Consumable material 2 Chemical 3 Analysis	RM1200 RM1200 RM1200

D(iv)	Vote 28000 - Maintenance and Minor Repair Services <i>Bvot 28000 - Baik pulih kecil dan ubahsuai</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>	
D(v)	Vote 29000 - Professional Services <i>Vot 29000 - Perkhidmatan Ikhtisas</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i> Saguhati/honorarium	RM800
D(vi)	Vote 35000 - Accessories and Equipment <i>Vot 35000 - Aksesori dan Peralatan</i> Please specify <i>Sila nyatakan secara lengkap dengan pecahannya sekali.</i>	
TOTAL AMOUNT JUMLAH BESAR		RM5000
E	Declaration by applicant / Akuan Pemohon (Please tick (✓)): / (Sila tanda (✓)):	

I hereby declare that:

Saya dengan ini mengaku bahawa:



All information stated here are accurate, and PJI has right to reject or to cancel the offer without prior notice if there is any inaccurate information given.

Semua maklumat yang diisi adalah benar, PJIM&A berhak menolak permohonan atau membatalkan tawaran pada bila-bila masa sekiranya keterangan yang dikemukakan adalah tidak benar.



Application of this research is presented for the Geran Semarak Penyelidikan

Permohonan penyelidikan ini dikemukakan untuk Geran Semarak Penyelidikan.



Application of this research is subject to Ethical Committee approval (if applicable).

Permohonan penyelidikan ini dimajukan ke Jawatankuasa Etika (jika berkenaan).

Date : 18 November 2024
Tarikh :

Applicant's Signature :
Tandatangan Pemohon :



Note: APPLICATIONS SUBMITTED WILL BE TREATED IN FULL CONFIDENCE. THE DECISION OF THE INTERNAL RESEARCH ACCULTURATION MAIN COMMITTEE UiTM CAWANGAN PERLIS IS FINAL.
Semua permohonan dianggap sulit. Keputusan Jawatankuasa Induk Geran Penyelidikan Pembudayaan Dalaman UiTM Cawangan Perlis adalah MUKTAMAD.