



UNIVERSITI
TEKNOLOGI
MARA

ISETC2025

2ND INTERNATIONAL SCIENCE,
ENGINEERING AND TECHNOLOGY
COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A
SUSTAINABLE WORLD

ORGANIZED BY:
FACULTY OF APPLIED SCIENCES
UNIVERSITI TEKNOLOGI MARA
PERAK BRANCH, TAPAH CAMPUS
MALAYSIA

CO-ORGANIZED BY:



**2nd International Science, Engineering and Technology Colloquium
(ISETC 2025)**

Faculty of Applied Sciences,
Universiti Teknologi MARA,
Perak Branch, Tapah Campus,
35400 Tapah Road, Perak, Malaysia.

Colloquium date: 9th July 2025

Publication date: 9th September 2025

Proceedings of Extended Abstracts

EDITORS

Dr. Emi Norzehan Mohamad Mahbob

Dr. Saiyidah Nafisah Hashim

Ms. Lili Widarti Zainuddin

Ms. Nurul Nazwa Mohammad

Ms. Rozaina Saleh

e-ISBN: 978-629-97630-5-5

Copyright © 2025 ISETC

Published by Faculty of Applied Sciences, Universiti Teknologi MARA,
Perak Branch, Tapah Campus, 35400 Tapah Road, Perak, Malaysia.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, 35400 Tapah Road, Perak, Malaysia.

PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob

Dr. Saiyidah Nafisah Hashim

Ms. Lili Widarti Zainuddin

Ms. Nurul Nazwa Mohammad

Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

SURVEILLANCE OF MICROBIAL CONTAMINANTS ON ELECTRONIC DEVICES IN A LEARNING ENVIRONMENT

Kiroshana Sivanyanam, Khomaizon A.K. Pahirulzaman*

Faculty of Agro-Based Industry, Universiti Malaysia Kelantan, Jeli Campus, 17600 Jeli, Kelantan, Malaysia

**Corresponding author: khomaizon@umk.edu.my*

Abstract: With the increased integration of electronic devices in teaching and learning environments, concerns arising microbial contamination and potential hygiene practices on the electronic devices escalated. This study investigates the microbial communities on electronic devices used for teaching and learning at the Universiti Malaysia Kelantan, Jeli Campus. A surveillance study was employed, involving the collection of microbial swab samples from various electronic devices such as microphone, remote controller, computer screen and keyboards utilised by students and faculty within the university. Selective media such as MacConkey agar, Baird Parker agar, Xylose Lysine Deoxycholate (XLD) agar was used to isolate the commonly encountered pathogens. The isolates were identified by Gram staining, biochemical test, catalase test and triple sugar iron (TSI) test. *Escherichia* spp. and *Staphylococcus* spp., were successfully isolated from the electronic devices used for teaching and learning. These results contribute valuable insights into the microbes associated with electronic learning tools. The findings also contribute to establishing a safer learning environment and reducing the risk of disease transmission through frequently used electronic devices for both students and faculty members.

Keywords: *Microbial contamination, electronic devices, teaching and learning tools, university environment, hygiene practices*

INTRODUCTION

In recent years, electronic devices have become indispensable tools in education, transforming how students and staff engage in teaching and learning. From lecture halls to laboratories, devices such as microphones, keyboards, mice, and remote controls are constantly in use. At the Faculty of Agro-Based Industry, Universiti Malaysia Kelantan Jeli Campus (UMKJC), the integration of technology has facilitated more interactive and flexible learning environments. However, this widespread usage also raises important health concerns particularly regarding microbial contamination. The very tools that enhance the learning experience may also serve as vectors for the transmission of harmful microorganisms.

With an increase in device sharing among staff and students, especially in multi-user environments such as teaching laboratories and computer labs, the potential for microbial transfer is heightened. A lack of routine sanitization and poor hygiene practices further compound this issue. Previous studies have shown that electronic devices can harbor pathogenic microbes, including *Staphylococcus aureus* and *Escherichia coli*, both of which pose significant risks to individuals with compromised immunity. Additionally, as much as 80% of infectious diseases are believed to be spread by hand-to-surface contact or physical interaction with contaminated objects (Olsen, 2020).

This research focuses on identifying and analyzing the microbes present on electronic devices commonly used in lecture rooms and teaching laboratories at UMKJC. It is driven by the hypothesis that these devices, often overlooked during routine cleaning, may serve as reservoirs for microbial contaminants, potentially facilitating cross-contamination among users. The study aims to provide data on the microbial distribution on these devices and highlight the need for improved hygiene practices within academic settings. The use of technology in education is only expected to increase, especially post-pandemic, where digital tools have become even more embedded in daily academic activities (Fatima, 2019). As students and lecturers rely more heavily on mobile phones, laptops, and other devices for communication, research, and classroom interaction, the risk of microbial contamination becomes more pressing. Furthermore, shared environments like libraries, labs, and lecture rooms witness frequent contact with shared devices, making them high-risk areas for microbial transmission (Yong & Calautit, 2023).

Despite the critical role of electronic devices in education, there is a lack of awareness and research about their potential to act as vectors for microbes in academic settings. Most hygiene practices focus on personal sanitation, neglecting the cleanliness of the devices themselves. This study addresses this gap by systematically collecting samples from selected devices and analyzing them to identify the types and distribution of microorganisms present. By investigating microbial presence on electronic teaching tools, this research not only raises awareness of an overlooked issue but also promotes the implementation of preventive measures. These may include regular disinfection routines, awareness campaigns, and recommendations for best practices in device hygiene. Ultimately, this study contributes to a healthier academic environment and aligns with public health efforts to reduce the spread of infectious diseases in shared spaces.

MATERIALS AND METHODS

Sample Collection for Microbial Growth Analysis

This study was conducted at 40 sites within the Faculty of Agro-Based Industry, Universiti Malaysia Kelantan Jeli Campus (UMKJC), including teaching laboratories, lecture rooms, and the library. Samples were collected from the exposed outer surfaces of frequently used electronic devices such as keyboards, computer mice, remote controls, and microphones using sterile cotton swabs pre-moistened with sterile distilled water. After swabbing, each swab was immediately placed into a sterile test tube containing 1 mL of sterile distilled water to maintain microbial viability during transport. All samples were promptly transferred to the Biology Laboratory, where the swabs were aseptically streaked onto pre-prepared growth media to encourage microbial growth for subsequent identification and characterization.

Bacterial Identification

Bacteria isolated from electronic devices in teaching laboratories, lecture rooms, and the library were identified using selective media, Gram staining, and biochemical tests. All tests were performed after incubating cultures for 24 hours at 37 °C.

a. Identification using Selective Media

Isolated bacterial strains were streaked onto the selective media; MacConkey Agar for the detection of *E. coli*, Xylose Lysine Deoxycholate (XLD) Agar for *Salmonella* spp. and Baird Parker Agar for *S. aureus*. Plates were incubated overnight at 37 °C. Colony morphology was recorded as pink colonies on MacConkey agar indicated *E. coli*, yellow colonies on XLD agar indicated *Salmonella* spp. and pale yellow colonies on Baird Parker agar indicated *S. aureus*.

b. Identification by Gram Staining

A sterile wire loop was used to place a drop of sterile distilled water on a clean glass slide. A small amount of bacterial cells was then added, spread into a thin smear, and left to air-dry. The smear was stained with crystal violet for one minute and rinsed with distilled water, followed by iodine solution for another minute and rinsing. Acetone was applied for 15 seconds as a decolorizing agent and rinsed off, then safranin was added as a counterstain for 30 seconds before the final rinse. The slide was examined under a brightfield microscope at 100× magnification, where Gram-positive bacteria appeared purple and Gram-negative bacteria appeared pink.

c. Catalase Test

A small amount of bacterial colony was placed on a clean glass slide, and a few drops of 30% hydrogen peroxide (H₂O₂) were added. The presence of catalase enzyme was indicated by rapid bubble formation, while the absence of bubbles or only minimal bubbling indicated a negative result.

d. Triple Sugar Iron (TSI) Agar Test

Using a sterile wire loop, the isolated bacterial colony was inoculated into Triple Sugar Iron (TSI) agar by stabbing the butt of the medium and then streaking the slant. The tubes were incubated at 37 °C, and the results were interpreted based on the color changes in the medium. A yellow slant and butt indicated the fermentation of both glucose and lactose, resulting in acid production. A red slant with a yellow butt showed that only glucose was fermented, while a red slant and butt indicated that neither glucose nor lactose was fermented.

RESULTS AND DISCUSSION

A total of 63 morphologically distinct bacterial colonies were isolated from 40 swab samples collected across 15 locations at UMK Jeli Campus (UMKJC), focusing on electronic devices used in teaching and learning. The highest number of colonies appeared on Baird-Parker agar, while only a single colony grew on MacConkey agar. No bacterial growth was observed on XLD agar. Control strains confirmed the media specificity: *E. coli* ATCC 8739 grew as pink colonies on MacConkey agar, *S. aureus* ATCC 6538 as white colonies on Baird-Parker agar, and *S. typhi* ATCC 14028 as white colonies with or without black centers on XLD agar. All tested samples showed positive growth on Baird-Parker agar, indicating the widespread presence of *S. aureus*. This suggests poor hygiene practices in the environment, as *S. aureus* is a common human pathogen linked to various infections, from minor skin issues to severe conditions like bloodstream infections and pneumonia (Al-Dhabaan, 2019; Touaitia, 2025). Only one sample from Lecture Room 7 (LR7) showed *E. coli* growth on MacConkey agar, pointing to limited Gram-negative bacterial diversity and highlighting a specific contamination incident. The *E. coli* was isolated from a remote control an object often shared in lecture rooms, meeting rooms, and common areas. Frequent handling increases the risk of microbial transfer, particularly in environments with inadequate hygiene practices (Van Teeseling et al., 2017). As *E. coli* is commonly found in the intestines of humans and animals, its presence on surfaces like remote controls may stem from poor sanitation or lack of regular cleaning (Alemu et al., 2015). Mueller & Tainter, 2019 emphasized that *E. coli* infections are often transmitted through person-to-person contact rather than contaminated food. No bacterial growth was detected on XLD agar, suggesting the absence of *Salmonella* spp. in the tested samples. However, this result is specific to *Salmonella* and does not exclude the possibility of other microbial contaminants (Oludairo et al., 2022).

Based on observations, only the bacteria isolated from LR7 showed morphological characteristics similar to the *E. coli* control—rod-shaped (bacilli) cells (Figure 1). This suggests that the isolate is likely *E. coli*. After Gram staining, the bacteria appeared pink or red under the microscope, indicating they are Gram-negative. This is due to their inability to retain the crystal violet dye, as their cell wall contains an outer membrane rich in lipopolysaccharides. This structure contributes not only to their staining behavior but also to their adaptability and antibiotic resistance (Ruhail & Kataria, 2021). In contrast, Gram-positive bacteria retain the crystal violet stain and appear purple under the microscope (Nikaido, 2016). Isolates from the Postgraduate Laboratory (PGL), Biology Laboratory (BL) and Lecture Hall 2 (LH2), along with the *S. aureus* control, exhibited similar characteristics—purple coloration and spherical (cocci) shape suggesting they are likely *S. aureus* (Figure 1). Gram-positive bacteria have thick peptidoglycan layers that hold the stain even after solvent treatment (Tripathi et al., 2022). Most of the isolates from laboratories, lecture rooms and library were found to be Gram-positive. Among the electronic devices tested, microphones had the highest concentration of Gram-positive bacteria. This suggests that microphones are significant reservoirs of bacterial contamination. *S. aureus*, a common component of the human skin and nasal microbiota (Dias, 2022), can easily be transferred onto microphones through direct contact by speakers or users. In educational settings, these devices may not be cleaned regularly due to time or resource constraints, creating a favorable environment for bacterial survival (Holding, 2017). This highlights the importance of improved hygiene practices for shared electronic devices.

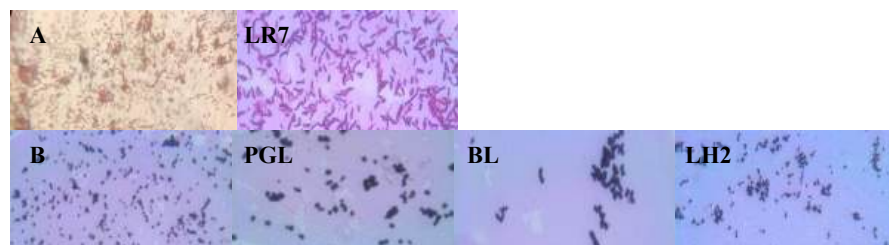


Figure 1. Gram staining results show that the isolate from LR7 appears pink, indicating a Gram-negative bacterium, likely *E. coli*, as seen in the control strain (A). In contrast, isolates from PGL, BL and LH2, appear purple, consistent with Gram-positive *S. aureus*, as shown by the control (B).

The catalase test is used to detect the presence of the catalase enzyme, which breaks down hydrogen peroxide (H_2O_2) into water and oxygen. The release of oxygen is observed as visible bubbling. This test is commonly used to differentiate between catalase-positive *Staphylococcus* species and catalase-negative *Streptococcus* species (Moraes et al., 2021). In this study, most isolates exhibited rapid and vigorous bubbling upon exposure to H_2O_2 , indicating a strong positive catalase reaction. This suggests that these isolates are likely *Staphylococcus* species, particularly *S. aureus*, which is known for its robust catalase activity (Kaushal et al., 2018). The immediate bubbling observed confirms the bacteria's ability to produce the catalase enzyme, classifying them as catalase-positive (Fung et al., 2018). The LR7 isolate also showed bubbling, consistent with the *E. coli* control, suggesting a catalase-positive *E. coli* strain. This is further supported by Gram staining, which showed LR7 as pink rod-shaped cells, characteristic of *E. coli*. In contrast, the isolate from PGL showed no bubble formation, indicating a negative catalase reaction. The isolate from LH2 exhibited only minimal bubbling (Figure 2), which was slower and less vigorous than the strongly positive reactions, suggesting weak catalase activity. A negative or weak catalase reaction typically indicates *Streptococcus* species or other non-staphylococcal genera. Not all *Staphylococcus* species exhibit the same level of catalase activity; for example, *Staphylococcus saprophyticus* can show weaker reactions. Additionally, catalase expression can vary depending on environmental factors such as oxygen levels, temperature, and nutrient availability (Moraes et al., 2021). Therefore, isolates from PGL and LH2 may be non-staphylococcal bacteria with low catalase activity, possibly belonging to genera like *Micrococcus*.



Figure 2. Catalase test results showing different levels of bubble formation among bacterial isolates. Most showed strong bubbling, indicating catalase-positive *Staphylococcus* spp., such as *S. aureus* (B). The LR7 isolate produced similar bubbling to the *E. coli* control (A), confirming it as catalase-positive *E. coli*, supported by Gram staining. The PGL isolate showed no bubbling (catalase-negative), while the LH2 isolate showed weak bubbling, indicating low catalase activity.

The isolated strains were proceeded with TSI test. Results show the colour of TSI slant changed after 24 hours incubation of the strains. The test indicates color changes (red arrows) and gas production (yellow arrows), shown by cracks or displacement of the agar (Figure 1). The *E. coli* control showed a yellow color in both the slant and the butt of the TSI agar, indicating fermentation of glucose, lactose, and sucrose. Gas production, seen as bubbles or cracks in the agar, suggests active metabolism releasing gases like CO_2 and H_2 (Hajna, 2015). Similar results were observed in isolates from PGL, lecture rooms and library, suggesting these isolates are likely *E. coli*, which is known to ferment sugars and produce gas (Selman et al., 2020). The *S. aureus* control also showed a yellow slant and butt, indicating acid production from sugar fermentation, including glucose and lactose (Fung et al., 2018).

Isolates from Chemistry Laboratory (CL), Biology Laboratory (BL), Food Laboratory (FL), LR8, and LR9 displayed a red slant and yellow butt, different from the controls. This pattern indicates fermentation of glucose only (alkaline/acid reaction), with no lactose or sucrose fermentation. The absence of gas or H₂S production suggests these may be *Shigella* species, which typically produce acid without gas (Selman et al., 2020). Gas production was more evident in samples from LR1, LR6, LR8, LR9, LH1, and Learning Block (LB) compared to those from CL, BL, and FL. This may be due to higher human activity in lecture rooms and learning block, which increases microbial presence and diversity. Frequent contact with surfaces and electronic devices in these areas may lead to higher levels of bacterial contamination and fermentation activity (Fatima, 2019). Additionally, environmental factors like temperature and air circulation in lecture rooms and learning blocks may promote microbial growth and gas production (El Zakfaly, 2016).

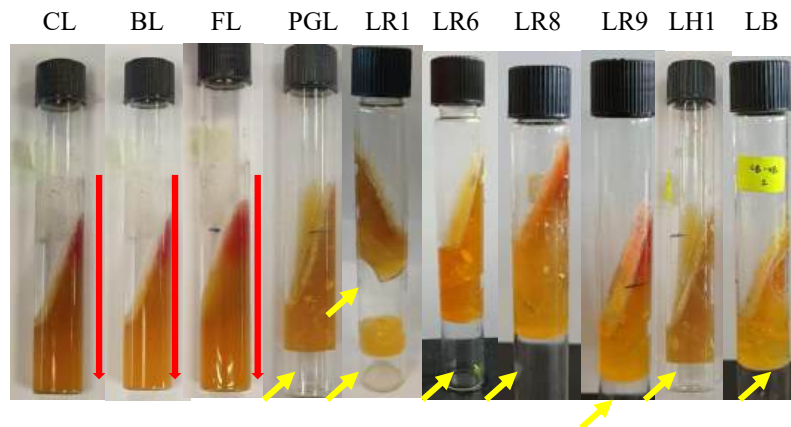


Figure 3. Isolates from different locations exhibit distinct characteristics on TSI agar. Color changes are indicated by red arrows, while gas production—evident from cracks or displacement of the agar—is marked by yellow arrows.

CONCLUSIONS

This study provides valuable insights into microbial contamination on electronic devices used in academic settings. The findings reveal that these devices can harbor a diverse range of microbial species. The main objective was to assess the abundance and types of microbes present on commonly used electronic surfaces in teaching and learning environments. Through the use of selective media and biochemical tests, *E. coli* and *S. aureus* were identified as the two key bacterial species isolated. The presence of these potential pathogens highlights the importance of implementing regular cleaning and disinfection protocols to reduce health risks. Promoting proper hygiene practices for shared electronic devices is essential in maintaining a cleaner, safer academic environment, ultimately supporting the health and well-being of students, educators, and staff.

REFERENCES

- Al-Dhabaan, F. A. (2019). Morphological, biochemical, and molecular identification of petroleum hydrocarbons biodegradation bacteria isolated from oil polluted soil in Dhahran, Saud Arabia. *Saudi Journal of Biological Sciences*, 26(6), 1247–1252.
- Alemu, A., Misganaw, D., & Wondimeneh, Y. (2015). Bacterial profile and their antimicrobial susceptibility patterns of computer keyboards and mice at Gondar University Hospital, Northwest Ethiopia. *Biomed Biotechnol*, 3(1), 1-7.
- Dias, L., & Victor, A. (2022). Teaching and learning with mobile devices in the 21st century digital world: Benefits and challenges. *European Journal of Multidisciplinary Studies*, 7(1), 26-34.

- El-Zakfaly, H. T., & Kassim, E. A. (2016). Effects of storage temperature, light, and time on stability of triple sugar iron agar and its productivity for *Escherichia coli* and *Salmonella typhimurium*. *Folia microbiologica*, 28, 446-451.
- Fatima, A., Ansari, S. K., Waqar, H., & Jameel, A. (2021). Determine augmented risk association between health problems and screen exposure to electronic gadgets in university students, Islamabad during COVID-19 pandemic. *Innovation*, 2(2), 22-26.
- Fung, F., Wang, H. S., & Menon, S. (2018). Food safety in the 21st century. *Biomedical Journal*, 41(2), 88–95.
- Hajna, A. A. (2015). Triple-Sugar iron agar medium for the identification of the intestinal group of bacteria. *Journal of Bacteriology*, 49(5), 516–517.
- Holding, A. J., & Collee, J. G. (2017). Chapter I Routine biochemical tests. In *Methods in microbiology* (Vol. 6, pp. 1-32). Academic Press.
- Kaushal, J., Mehandia, S., Singh, G., Raina, A. K., & Arya, S. K. (2018). Catalase enzyme: Application in bioremediation and food industry. *Biocatalysis and Agricultural Biotechnology*, 16, 192–199.
- Moraes, G. F. Q., Cordeiro, L. V., & De Andrade Júnior, F. P. (2021). Main laboratory methods used for the isolation and identification of *Staphylococcus* spp. *Revista Colombiana De Ciencias Químico - Farmacéuticas*, 50(1).
- Mueller, M & Tainter C. R. *Escherichia coli* Infection. [Updated 2023 Jul 13]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK564298/>
- Olsen, M., Campos, M., Lohning, A., Jones, P., Legget, J., Bannach-Brown, A., McKirdy, S., Alghafri, R., & Tajouri, L. (2020). Mobile phones represent a pathway for microbial transmission: A scoping review. *Travel Medicine and Infectious Disease*, 35, 101704.
- Oludairo, O. O., Kwaga, J. K. P., Kabir, J., Abdu, P., Arya, G., Perets, A., Cibin, V., Lettini, A., & Aiyedun, J. (2022). A review of the International Organization for Standardization (ISO) guidelines for the detection of *Salmonella* from faeces. *Journal of Applied Veterinary Sciences*, 7(4), 14-22.
- Ruhal, R., & Kataria, R. (2021). Biofilm patterns in gram-positive and gram-negative bacteria. *Microbiological Research*, 251, 126829.
- Selman, H. M., Mahdi, A. A., Abugroun, H. A., & Mutwali, E. M. (2020). Isolation and identification of microorganisms in processed meats in Khartoum state. *SSRG International Journal of Agriculture & Environment Science*, 7(5), 7–13.
- Touaitia, R., Mairi, A., Ibrahim, N. A., Basher, N. S., Idres, T., & Touati, A. (2025). *Staphylococcus aureus*: A Review of the Pathogenesis and Virulence Mechanisms. *Antibiotics*, 14(5), 470. <https://doi.org/10.3390/antibiotics14050470>.
- Van Teeseling, M. C. F., De Pedro, M. A., & Cava, F. (2017). Determinants of Bacterial morphology: From fundamentals to possibilities for antimicrobial targeting. *Frontiers in Microbiology*, 8.
- Yong, L. X., & Calautit, J. K. (2023). A Comprehensive Review on the Integration of Antimicrobial Technologies onto Various Surfaces of the Built Environment. *Sustainability*, 15(4), 3394. <https://doi.org/10.3390/su15043394>



Surat kami : 700-KPK (PRP.UP.1/20/1)
Tarikh : 20 Januari 2023



Prof. Madya Dr. Nur Hisham Ibrahim
Rektor
Universiti Teknologi MARA
Cawangan Perak

Tuan,

**PERMOHONAN KELULUSAN MEMUAT NAIK PENERBITAN UiTM CAWANGAN PERAK
MELALUI REPOSITORI INSTITUSI UiTM (IR)**

Perkara di atas adalah dirujuk.

2. Adalah dimaklumkan bahawa pihak kami ingin memohon kelulusan tuan untuk mengimbas (*digitize*) dan memuat naik semua jenis penerbitan di bawah UiTM Cawangan Perak melalui Repositori Institusi UiTM, PTAR.

3. Tujuan permohonan ini adalah bagi membolehkan akses yang lebih meluas oleh pengguna perpustakaan terhadap semua maklumat yang terkandung di dalam penerbitan melalui laman Web PTAR UiTM Cawangan Perak.

Kelulusan daripada pihak tuan dalam perkara ini amat dihargai.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Setuju.

27.1.2023

SITI BASRIYAH SHAIK BAHARUDIN
Timbalan Ketua Pustakawan

PROF. MADYA DR. NUR HISHAM IBRAHIM
REKTOR
UNIVERSITI TEKNOLOGI MARA
CAWANGAN PERAK
KAMPUS SERI ISKANDAR

nar