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	Student	USD 200	USD 250	USD 150
PARTICIPANT	Local	RM100		
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IMPORTANT DATES

Abstract Submission Dateline

1 April 2022

Notification of Abstract Acceptance

15 April 2022

Early bird Registration & Payment

2 May 2022

Full Paper Submission Dateline

3 June 2022

Normal Registration & Payment

1 August 2022

ICoAIMS 2022

24 – 26 August 2022



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Extending Generalised Leland Option Pricing Models: Simulation Using Monte Carlo

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Abstract. To explain option pricing movements, most studies modify the Black-Scholes model by adding other factors. The parametric generalisation, on the other hand, frequently leads to an over-parametrisation problem in the model being constructed. The model's high constraints frequently resulted in considerable underpricing of the option. The nonparametric generalisation of the Black-Scholes-Merton (BSM) model, on the other hand, is prone to both discretisation and truncation issues in pricing options. Thus, this study extends the existing option pricing models by developing Extended Generalised Leland (EGL) models based on the implied adjusted volatility introduced in Leland models. The integrated framework ensures a model-free modelling while conforming to the conventional parametric option pricing. The proposed semiparametric models are developed to incorporate the transaction costs rate factor in the intermediated model-free framework to assure realistic pricing of options. The main focus of this study is to document by simulation that the EGL models deliver option pricing outperformance compared to the benchmark model. The simulation of the EGL models is conducted to investigate whether the proposed models are practical to be applied in a real financial system. Superior option pricing accuracy was observed in the EGL models based on the simulation results. This finding is grounded on the RMSE values as well on pairwise percentage difference values.

INTRODUCTION

Limited by the assumption, the Black-Scholes-Merton (BSM) model was perceived to be in disadvantage especially in handling extreme conditions, particularly after the October 1987 market crash. The volatility smile phenomenon, which causes a significant variation in the pricing of BSM options, serves as clear evidence of this. The failure of the BSM model to produce accurate option pricing is recognised in many studies to be correctible [1]-[3]. This leads to significant evolution in the modern parametric option pricing models in attempt to generalising the BSM model [4]. Regardless the improvement, the parametric generalisation often results in overparametrisation problem to the model being developed.

The parametric option pricing models rely on paper-designed assumptions that somehow are quite astringent and unrealistic to the real financial derivative market dynamics. The parametric option pricing models often impose complex assumptions, which are too ideal to reflect the real-world market and often not valid in reality. Plentiful studies have acknowledged the severe downside introduced in the parametric models. Among them are Jankova [5], who highlighted the constant volatility assumption problem.

The generalisation of the BSM model has also inspired the development of model-free pricing framework. Model-free or nonparametric models are built based on the minimal theoretical finance assumptions to defy the pricing bias introduced in parametric restrictive models. With minimal reliance on finance theory, the model-free

framework is somehow perceived to be groundless. The lack of dependency on finance theory in model-free framework tends to develop infeasible pricing of options [6]. This study differs from other existing studies by having a model that employs non-parametric mechanism while still conforms the parametric framework.

Interestingly, the BSM framework is shared by the Leland models. The Leland models are developed to consider realistic transaction costs which is relaxed in the BSM models. For that reason, this research extends the Leland ([7]-[8]) models within non-parametric framework used in Bakshi *et al.* [9] in estimating the adjusted option-implied information. This semiparametric framework is referred to as Extended Generalised Leland (EGL) models. It is anticipated in the first place that the EGL models able to solve both the model misspecification problem introduced by the Leland models and the infeasible pricing problem in Bakshi *et al.* [9].

On top of that, simulation using the Monte Carlo approach is done to assess the performance of the EGL models. Similar study which utilised Monte Carlo in option pricing includes Bayer *et al.* [10], Capuozzo *et al.* [11], Liang and Xu [12], Jeong *et al.* [13], Xiao and Wang [14], Yamada and Yamamoto [15], Bormetti *et al.* [16], Boyarchenko and Levendorskiĭ [17] as well as Sodhi [18]. Even though this paper considers basic Monte Carlo, without further adjustment on the method, it is sufficient for this paper since the main objective is to investigate the behaviour of the integrated option pricing model, i.e., the EGL model in pricing the options.

The benchmark model is fixed to be the fully-implied Model-Free Bakshi-Kapadia-Madan (MFBKM) model. Using three pricing error measures, both proposed models are compared against the benchmark model of MFBKM. The primary aim of this study is to assess theoretically whether the proposed EGL models can lead to an improvement in option valuation accuracy. We test the approaches used in estimating integrals, i.e., the basic, adapted, and advanced approaches, proposed at the beginning of the research. Different rebalancing intervals are manipulated.

Four sections are formed in this study. The first section (Section 1) describes brief overview of this study. The respective model and methodology is explained in Section 2. The main findings of this study are recorded in following Section 3. Finally, this study is concluded in Section 4.

METHODOLOGY

Developing the Extended Generalised Leland models

The effectiveness of option pricing for EGL models—which encompass both the model-free implied Leland (MFIL) and the Generalized Leland-Infused (GLI) model—is examined in this work. Only the transaction costs rate and the rebalancing interval are taken into account by the EGL model. The initial cost of trading was implicitly taken into account by the GLI model, nevertheless. The initial portfolio assumptions are taken into consideration by the MFIL model in addition to the transaction costs rate and the rebalancing interval variables. The beginning cost of trading is taken into account by the new MFIL models when they make the assumption that the initial portfolio is made up entirely of cash and stock holdings.

A cross-section of the call and put option prices are first extracted from the Leland models in order to calculate the option-implied adjusted volatility values using the MFIL model. By employing the three approaches—Basic (trapezoidal-rule), Adapted (single-combined), and Advanced (single-combined, cubic-spline)—programmed in MatLab, it is possible to acquire the option-implied information.

The new GLI model is derived from the fact that the model-free option-implied volatility is only the square-root of the Bakshi *et al.* [9] variance contract. In Bakshi *et al.* [9], they defined the risk-neutral variance, $VAR(t, \tau)$, as:

$$VAR(t, \tau) \equiv E^q\{(R_{t,\tau} - E^q[R_{t,\tau}])^2\}, \quad (1)$$

or

$$VAR(t, \tau) = e^{r\tau}V(t, \tau) - \mu(t, \tau)^2. \quad (2)$$

$E^q\{\}$ is the expectation under q where $q[S]$ is the risk-neutral pricing density. S is the stock price, $R(t, \tau)$ is defined as the τ -period return, r is the risk-free rate, $V(t, \tau)$ is the variance contract. The μ -expectation is:

$$\mu(t, \tau) = e^{r\tau} - 1 - \frac{e^{r\tau}}{2}V(t, \tau) - \frac{e^{r\tau}}{6}W(t, \tau) - \frac{e^{r\tau}}{24}X(t, \tau), \quad (3)$$

where V , W and X represent the variance, cubic and quartic contracts, respectively.

It is assumed that the variance contract defined in Bakshi *et al.* [9] produces equivalent adjusted variance in Leland [7] model. If the assumption holds to be true, then a function can be created by merging both variance functions.

By equating the variance contract (left-hand-side) with the square of the adjusted volatility introduced in Leland [7] (right-hand-side), we obtain:

$$e^{r\tau}V(t, \tau) - \mu(t, \tau)^2 = \sigma^2 \left(1 + \frac{k\sqrt{\frac{2}{\pi}}}{\sigma\sqrt{\delta\tau}} \right), \quad (4)$$

where σ is the volatility, k is the round-trip transaction cost rate per unit dollar of transaction and $\delta\tau$ is the time between hedging adjustment. An equation can be obtained by solving eq. (4).

The new equation then can be written as:

$$\sigma^2 + \sigma \cdot \frac{k}{\sqrt{\frac{2}{\pi}}} \cdot \sqrt{\frac{2}{\pi}} - e^{r\tau}V(t, \tau) + \mu(t, \tau)^2 = 0. \quad (5)$$

The extended generalised Leland function is as follows:

$$EGL = \frac{-k}{\sqrt{2\pi \cdot \Delta\tau}} + \sqrt{\frac{k^2}{\pi \cdot \Delta\tau} - 2(\mu^2 - e^{r\tau} \cdot V)}, \quad (6)$$

where V represents the variance contract, k is the round-trip transaction cost rate per unit dollar of transaction and $\Delta\tau$ is the time between hedging adjustment, i.e., the rebalancing interval. This model assumes proportional transaction costs, asset price dynamics governed under the lognormal distribution, constant volatility, no dividend included throughout the option's life, etc.

Simulation using Monte Carlo

Using Monte Carlo simulation process, we simulate the option prices for both call and put options. The simulation is done using MatLab software for 10,000 iterations. We allow for different risk assumptions under all parameters. The simulation follows the following equation:

$$P_t = P_{t-1} e^{(U+SE*\sigma)} \quad (7)$$

P_t is the periodic daily stock return based on natural logarithm; U is the drift constant obtained from linear regression; σ is the standard deviation (indicating the random shock); and SE is standard error, in which the term $SE * \sigma$ indicates the random walk (or Wiener process).

An array of 51 by 10,000 is obtained for both call and put options. Using the simulated random path of option prices, we generate the implied volatility. A range of possible outcomes is modeled using Leland models.

The Generalised Leland-Infused (GLI) is retrieved by infusing the Leland's adjusted volatility implied on the model-free volatility. The interest rate is set to be 10 per cent. In order to compare the relative pricing performance, we utilise RMSE. Pricing performance of options retrieved from the GLI models are compared against the benchmark model, MFBKM. We take into account the daily and weekly rebalancing intervals to access whether the rebalancing factor affects the results. The steps are summarised as follows:

- Step 1: Generate 10,000 random stock price path for the underlying
- Step 2: Calculate the payoff or the option prices using Leland models
- Step 3: Average the payoff
- Step 4: Discount the averaged payoff
- Step 5: Obtain the adjusted implied volatility
- Step 6: Input the implied volatility in GLI model under risk-neutral measure
- Step 7: Compare pricing performance of GLI (EGL) against benchmark model
- Step 8: Investigate which manipulating parameter contributes to the model outperformance

In short, this study mainly investigates the pricing performance of the EGL model (guided by the GLI model) using the simulation and based on the simulation results, we examine which manipulating parameter contributes to the model outperformance.

RESULTS AND DISCUSSION

At first, we randomly simulate payoff for 1,000 iterations. Figure 1 illustrates the random distribution retrieved out of 1,000 iterations. For 10,000 iterations, somewhat different results are obtained. The payoff which exceeds \$100 fluctuates much blatantly compared to those that fall below \$100 (see Figure 2).

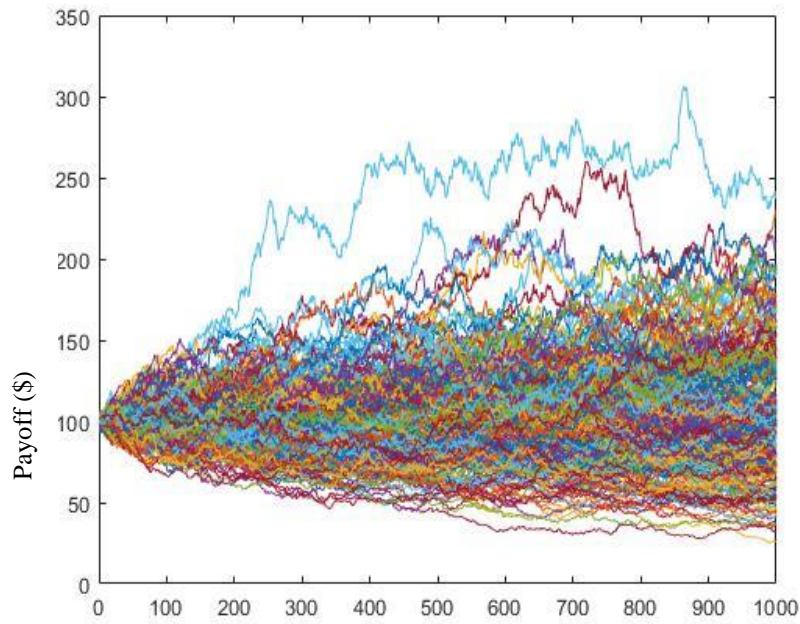


FIGURE 1. Random distributi Iterations

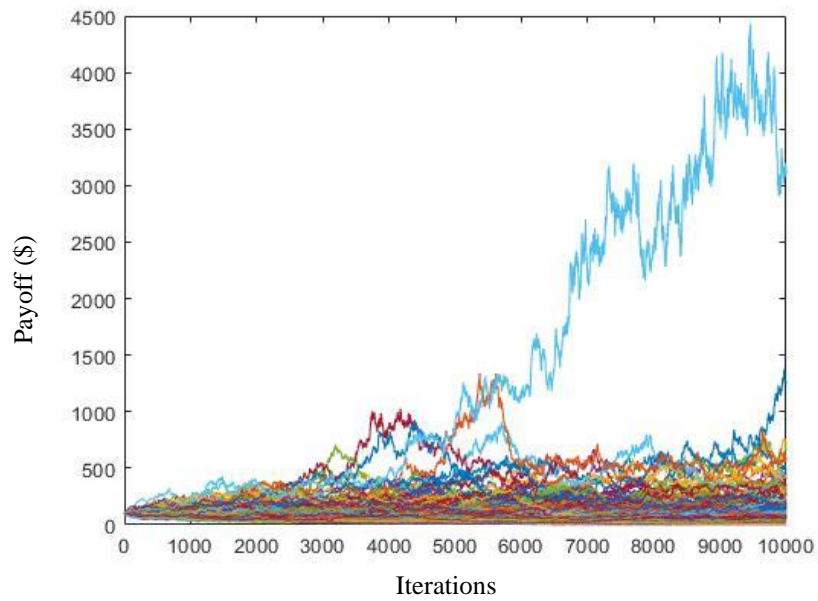


FIGURE 2. Random distribution of stock prices for 10,000 iterations.

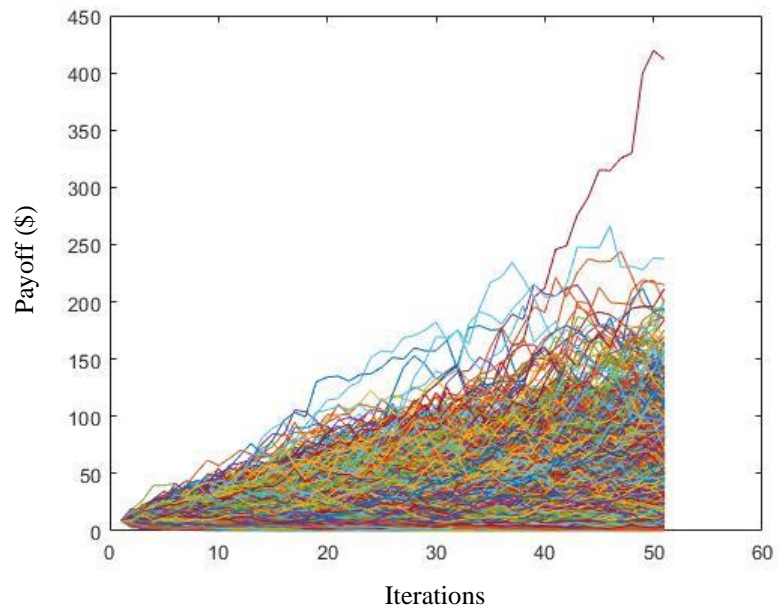


FIGURE 3. Random distribution of Call Option Prices.

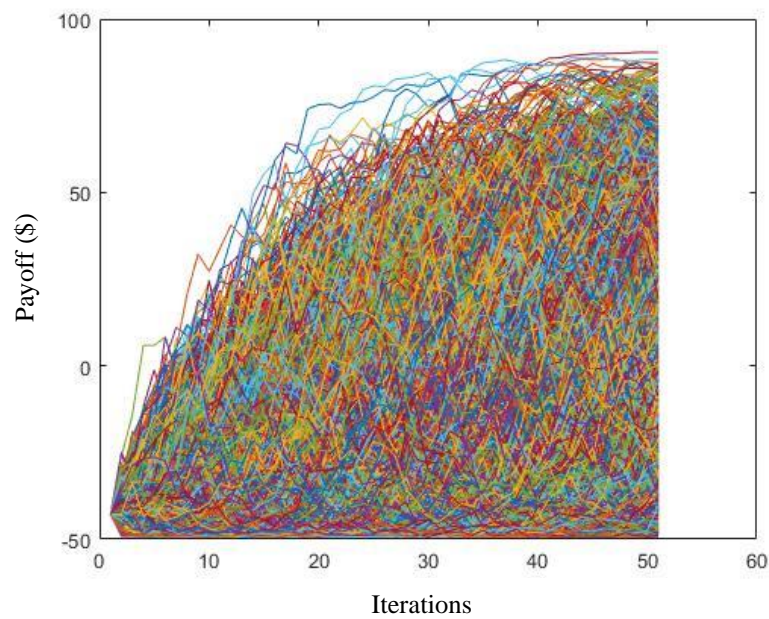


FIGURE 4. Random distribution of Put Option Prices.

In another case, we perform the simulation in an exclusive manner for each call and put options. Again, the number of iterations is maintained to be 10,000. The option prices are generated from the Black-Scholes-Merton option pricing model. Figure 3 and Figure 4 show the 10,000 samples generated based on the simulation process conducted on both call and put options, correspondingly.

In a similar mode, we compare the implied volatility adjusted using the GLI model obtained from the simulated data of both call and put options against the fully-implied model-free model. The summary of model pricing is expressed in terms of both mean and standard deviation (SD) in Table 1.

TABLE 1. Statistic of different option pricing models.

Model	Approach	MEAN	SD
Generalised Leland-Infused (GLI) Model	Basic	0.5681	0.0247
	Adapted	0.5718	0.0244
	Advanced	0.6486	0.0266
Model-Free Model (MFBKM)	Basic	0.1931	0.0162
	Adapted	0.1954	0.0161
	Advanced	0.2467	0.0197

TABLE 2. Summary of model pricing performance with daily rebalancing.

Model	Approach	RMSE (pts)	SD	MRPE (%)	SD (%)	MARPE (%)	SD (%)
PANEL A: True Value = Average of Realised Volatility							
GLI	Basic	0.1610	0.0255	32.3771	37.4673	37.8892	31.3252
	Adapted	0.1635	0.0263	33.2570	37.7519	38.5242	31.8236
	Advanced	0.2212	0.0439	51.2639	43.1891	52.2353	41.9001
MFBKM	Basic	0.3018	0.0844	-55.3396	11.8262	55.3396	11.8262
	Adapted	0.2998	0.0839	-54.7917	11.9926	54.7917	11.9926
	Advanced	0.2536	0.0684	-42.8288	15.3910	42.8288	15.3910
PANEL B: True Value = 0.1							
GLI	Basic	0.4687	0.0246	468.1121	24.6765	468.1121	24.6765
	Adapted	0.4724	0.0245	471.8142	24.3754	471.8142	24.3754
	Advanced	0.5492	0.0310	548.5785	26.5553	548.5785	26.5553
MFBKM	Basic	0.0943	0.0037	93.0578	16.2112	93.0578	16.2112
	Adapted	0.0966	0.0037	95.3767	16.0936	95.3767	16.0936
	Advanced	0.1479	0.0068	146.7415	19.6879	146.7415	19.6879

The error analysis of the simulated option-implied volatility is conducted based on RMSE, MRPE and MARPE. The results are tabulated in Table 2 and Table 3 with regard to the daily and weekly rebalancing, respectively. Based on the table, both GLI and model-free models fail to obey proposition fixed in this study, i.e. the RMSE: *advanced* \leq *adapted* \leq *basic*. In fact, the outcome is somehow reversed in order for both models. The propositions are only complied by MFBKM when the analysis is carried out based on average of realised volatility.

Looking at the RMSE figure, it is found that the GLI model significantly surpasses the performance of the Model-Free model, consistently in all three approaches considered. This signifies the significant performance of the GLI model compared to the other model in generating implied volatility. However, the finding is only evident in the case of when the error analysis is based on the average of realised volatility.

When the RMSE is compared across the different rebalancing basis, the option pricing error is reported to be smaller in the case of daily rebalancing, compared to the case of weekly rebalancing. The results suggest the reduced pricing error when more frequent rebalancing is considered.

TABLE 3. Summary of model pricing performance with weekly rebalancing.

Model	Approach	RMSE (pts)	SD	MRPE (%)	SD (%)	MARPE (%)	SD (%)
PANEL A: True Value = Average of Realised Volatility							
GLI	Basic	0.1797	0.0315	38.8232	39.4081	42.2603	35.3408
	Adapted	0.1826	0.0323	39.7094	39.6949	42.8999	35.8909
	Advanced	0.2448	0.0508	57.8279	45.1696	58.1896	44.6599
MFBKM	Basic	0.3018	0.0844	-55.3396	11.8262	55.3396	11.8262
	Adapted	0.2998	0.0839	-54.7917	11.9926	54.7917	11.9926
	Advanced	0.2536	0.0684	-42.8288	15.3910	42.8288	15.3910
PANEL B: True Value = 0.1							
GLI	Basic	0.4962	0.0261	495.5873	24.8328	495.5873	24.8328
	Adapted	0.4999	0.0260	499.3152	24.5282	499.3152	24.5282
	Advanced	0.5771	0.0326	576.5491	26.6870	576.5491	26.6870
MFBKM	Basic	0.0943	0.0037	93.0578	16.2112	93.0578	16.2112
	Adapted	0.0966	0.0037	95.3767	16.0936	95.3767	16.0936
	Advanced	0.1479	0.0068	146.7415	19.6879	146.7415	19.6879

Another note to mark is the piece of information given by the MRPE values, as given in Table 2 and Table 3. The MFBKM model tends to underprice both call and put options, regardless of any account for different rebalancing intervals. Instead, the option-implied volatility which is produced by the GLI model is greater than that of the MFBKM. The GLI model corrects the underpricing of the MFBKM model. This can be explained from the fact that the adjusted option-implied volatility involves the incorporation of the initial trading costs. This gives greater value than the original variance contract, defined in the MFBKM.

By comparing the MRPE across the different approaches, we found that there exists a systematic and consistent underpricing pattern. The volatility given by all models is underestimated in an orderly manner. In both models, the advanced method has the highest MRPE, while the basic account for the smallest MRPE value, compared with others.

To answer the manipulating factors which drive the outperformance of the EGL model, we identify two manipulating parameters: the estimation approaches – basic, adapted or advanced; and rebalancing frequency basis – daily or weekly. We verify that the option pricing abilities of the models estimated based on advanced approach with daily rebalancing to be statistically significantly superior (Refer Table 4 in Appendix).

CONCLUSION

In summary, the GLI models produce significantly outperformed option-implied adjusted moments compared to the MFBKM model based on the RMSE values, consistently across all three approaches considered. This finding is further supported by the statistically significant positive results in pairwise percentage difference. This signifies the notability performance of the GLI model compared to the other model in generating the option-implied information.

This study only considers the simulation of the GLI model against the MFBKM. The simulation of MFIL models is reserved for further analysis if the results fail to show the outperformance of the GLI against the MFBKM. The error analysis results show improved pricing produced by the GLI model, especially in the case of when the model estimation is performed using advanced approach with daily rebalancing.

The inconsistent option pricing results produced in this part of study compared to the empirical part may be attributed using wavelet transform. The simulated data are generated without considering wavelet transform process. Hence, it can be suggested that for the models to perform well, the use of wavelet transform is crucial to produce an accurate option pricing. Further study can include other modification of Monte Carlo in simulating option pricing using the EGL model.

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APPENDIX

TABLE 4. Summary of Study

ISSUES	RESEARCH OBJECTIVE	RESEARCH QUESTIONS	OBJECTIVE SETTINGS	INPUT	METHODOLOGY	OUTCOME
<p>The modern parametric approaches often lead to poorly and extremely constrained models. Rational and realistic option pricing, in spite of that, is not assured in nonparametric method.</p>	<p>To examine the option pricing performance of the Extended Generalised Leland (EGL) models using simulation;</p>	<p>Does the EGL model improve option valuation accuracy?</p>	<p>To compare the option pricing performance of the EGL models against the benchmark model.</p>	<p>The parameter is based on option implied volatility</p> <p>Option Pricing Models</p> <ul style="list-style-type: none"> a. MFBKM – benchmark b. EGL <p>Estimation approaches:</p> <ul style="list-style-type: none"> a. Basic b. Adapted c. Advanced <p>Rebalancing frequency basis:</p> <ul style="list-style-type: none"> a. Daily b. Weekly 	<p>Test:</p> <ul style="list-style-type: none"> a. T-test b. Analysis of Variance (ANOVA) single-factor with post-hoc analysis c. Pairwise statistic difference test <p>Evaluating Performance:</p> <ul style="list-style-type: none"> a. RMSE b. MRPE c. MARPE 	<p>The EGL models produce significantly outperformed option-implied adjusted moments compared to the Model-Free Bakshi-Kapadia Madan (MFBKM) model</p> <p>MFBKM model tends to underprice both call and put options</p> <p>EGL corrects the underpricing of the MFBKM model</p>
			<p>To investigate which manipulating parameter contributes to the model out-performance.</p>	<p>We verified the option pricing abilities of the models estimated based on advanced approach with daily rebalancing to be statistically significantly superior.</p>		

WEDNESDAY, AUGUST 24

SESSION 1: 11:00 – 13:00

ROOM 1 – APPLIED MATHEMATICS

Time	Presenter	Paper ID	Title
11:00	Mohd Anuar Jamaludin INVITED SPEAKER	A166	The Effects of Buoyancy, Magnetic Field and Thermal Radiation on The Flow and Heat Transfer Due to an Exponentially Stretching Sheet
11:25	Noor Amalina Nisa Ariffin	A006	Numerical Solutions on Reiner–Philippoff Fluid Model with Velocity and Thermal Slip Boundary Condition
11:45	Wan Faezah Wan Azmi	A065	Free Convection Caputo-Fabrizio Casson Blood Flow in the Cylinder with Slip Velocity Cylinder with Slip Velocity
12:05	Noraihan Afiqah Rawi	A134	The Effect of Non-Uniform Heat Source/Sink on Mixed Convection Flow of Hybrid Nanofluid Over a Stretching Sheet
12.25	Wan Muhammad Hilmi Wan Rosli	A087	Boundary Layer Flow of Non-Newtonian Williamson Hybrid Ferrofluid Over a Permeable Stretching Sheet with Thermal Radiation Effects

ROOM 2 – STATISTICS

Time	Presenter	Paper ID	Title
11:00	Siti Mariam Norrulashikin	S067	Data Fitting Distribution for Wind Speed in Mersing, Johor
11:20	Nadzira Aina Mohamad	S122	Assessing Monthly Wind Energy Potential of Three Wind Stations in Malaysia using Statistical Modelling
11:40	Siti Rohani Mohd Nor	S057	Wind Speed Forecasting with ARIMA Fourier Time Series Model
12:00	Nur Arina Bazilah Kamisan	S068	Forecasting Rainfall of Senai, Johor with Time Series Models
12:20	Nadiatul Adilah binti Ahmad Abdul Ghani	S202	An Assessment of Rainfall Distribution in Kuantan River Basin Using Generalized Extreme Value Distribution and Gamma Distribution

ROOM 3 – DATA SCIENCE

Time	Presenter	Paper ID	Title
11:00	Chen Ju	D015	Special Major 2 Satisfiability Logic in Discrete Hopfield Neural Network
11:20	Mohd Aftar Abu Bakar	D047	Forecasting the Air Quality Time Series Data Using Univariate and Multivariate Convolutional Neural Network Models
11:40	Syed Anayet Karim	D020	A Socio-inspired Hybrid Election Algorithm for Random k Satisfiability in Discrete Hopfield Neural Network
12:00	Gaeithry Manoharam	D017	Analysis of Horn 3-Satisfiability Logical Structure in Hopfield Neural Network
12:20	Manal Mohammed Othman Farea Asaad	D121	Employing Artificial Bee Colony Algorithm to Optimize the Artificial Neural Network in Heart Disease Prediction

ROOM 4 – PURE MATHEMATICS

Time	Presenter	Paper ID	Title
11:00	Aini Janteng	P160	Coefficient Estimates for Certain Subclasses of Analytic Functions Involving q -Analogue of Ruscheweyh Operator
11:20	Nooradelena Mohd Ruslim	P103	The Representation of n -Cutting Site Splicing Languages for a Single String with Palindromic Rule via de Bruijn Graph
11:40	Diviekga Nair Madhavan	P168	The Existence and Uniqueness of the Solution of an Infinite 3-system of Differential Equations in L_2 Space
12:00	Aini Janteng	P039	Certain Properties of a New Subclass of Analytic Functions with Negative Coefficients Involving q -Derivative Operator
12.20	Mark L. Loyola	P064	Geometric Realizations of the Abstract Platonic Polyhedra

ROOM 5 – OPERATIONAL RESEARCH

Time	Presenter	Paper ID	Title
11:00	Zalina Zahid	O132	Technical Efficiency Analysis of Paddy Farming under the Northwest Selangor Integrated Agricultural Development Area (IADA) of Malaysia Using Data Envelopment Analysis (DEA)
11:20	Preeti Shrivastava	O111	Blockchain Technology Adoption for Risk Management: Case of Operations and Supply Chain Management in Oman
11:40	Zati Aqmar Zaharudin	O005	A Preliminary Model for Recycling Facility Location- Allocation Problem
12:00	Norhaslinda Zullpakkal	O185	The Improvement of LAMR+ Method for Estimating the COVID-19 Outbreak in Terengganu
12.20	Mark Anthony C. Tolentino	O054	Insights on Scrabble Using Cosine Similarity, Minimum Spanning Tree, and Centrality Analysis

ROOM 6 – COMPUTATIONAL MATHEMATICS

Time	Presenter	Paper ID	Title
11:00	Jumat Sulaiman INVITED SPEAKER	C161	Numerical Solution of Nonlinear Fredholm Integral Equations using Newton-PKSOR with Simpson's 1/3
11:25	Faieza Samat	C012	Zero Dissipative Modified Explicit Hybrid Method for Linear Second Order Ordinary Differential Equations
11:45	Jackel Vui Lung Chew	C193	Half-Sweep Modified SOR Approximation of a Two-Dimensional Nonlinear Parabolic Partial Differential Equation
12:05	Hafizah Farhah Saipan Saipol	C113	Generalization of Parallel Performance for Multidimensional Finite Difference Method of PDE Problem
12.25	Arina Nabilah Jifrin	C171	B-Spline Curve Interpolation Modeling using Intuitionistic Alpha Cut for Uncertainty Data

ROOM 7 – APPLIED MATHEMATICS

Time	Presenter	Paper ID	Title
11:00	Ang Tau Keong	A164	Modelling of the Spread of Ebola Virus Disease using SEIR Model
11:20	Fahad Al-Abri	A101	Combined Influences of Distinct Epidemiological Factors and Governmental-Individual Reactions in Determining the Transmission Dynamics of COVID-19
11:40	Muhammad Fahmi Ahmad Zuber	A036	Estimation of the Epidemiological Parameter for the COVID-19 Outbreak
12:00	Shabana Tabassum	A026	Stochastic Gompertz Model for the Oral Cancer Cell Line of HSC-3 Response to an Anticancer Thymoquinone
12.20	Sarinah Banu Mohamed Siddik	A192	Optimal Control for Dengue Dynamics; Antibody and Wolbachia

SESSION 2: 15:30 – 17:00

ROOM 1 – APPLIED MATHEMATICS

Time	Presenter	Paper ID	Title
15:30	Najiyah Safwa Khashi'ie	A009	Radiative Hybrid Ferrofluid Flow Over A Permeable Shrinking Sheet In A Three-Dimensional System
15:50	Ridhwan Reyaz	A130	Analytical Treatment for Accelerated Riga Plate on Fractional Caputo-Fabrizio Casson Fluid
16:10	Kho Yap Bing	A091	Magnetohydrodynamic Ag-Fe ₃ O ₄ -Ethylene Glycol Hybrid Nanofluid Flow and Heat Transfer with Thermal Radiation
16:30	Marjan Mohd Daud	A082	Fractional Casson Fluid Flow via Oscillating Motion of Plate and Microchannel

ROOM 2 – STATISTICS

Time	Presenter	Paper ID	Title
15:30	Har Wai Mun	S213	The Role of Islamic Insurance in Financial Inclusion Index in Malaysia: a conceptual framework
15:50	Siti Aida Sheikh Hussin	S117	Volatility Modelling of Malaysia Islamic and Conventional Stock Prices by Using GARCH and EGARCH Model
16:10	Khuneswari Gopal Pillay	S040	Prediction of KLCI Index Through Economic LASSO Regression Model and Model Averaging
16:30	Shyafina Soleha Mohd Afendi	S159	Macroeconomic Factors and Household Savings: A Case Study in Malaysia

ROOM 3 – PURE MATHEMATICS

Time	Presenter	Paper ID	Title
15:30	Norlyda Mohamed	P211	On the Deep Enhanced Power Graph of Dihedral Group
15:50	Daisy A. Romeo	P095	Quantization of Time of Arrival Functions via Harmonic Analysis on the Euclidean Motion Group on the Plane
16:10	Fatin Hanani Hasan	P106	Automorphisms of Cyclic Groups of 3-Power Order
16:30	Raja Mohammad Latif	P220	$\pi\text{g}^*\beta\text{-T}_0\text{-T}_1\text{-T}_2\text{-Separation Axioms in Nano Topological Spaces}$

ROOM 4 – OPERATIONAL RESEARCH

Time	Presenter	Paper ID	Title
15:30	Wan Khadijah Wan Sulaiman	O194	A Modification of Spectral Conjugate Gradient Method (MSM-2) for Unconstrained Optimization
15:50	Norrlaili Shapiee	O183	Comparison Between FMAR SD Method and NRMI CG Method by Using Exact Line Search
16:10	Ummi Humairah Mohd Isnin	O221	Review on Mathematical Model, Artificial Intelligence and Challenges to Logistics and Supply Chain Management
16:30	Nur Atikah Salahudin	O186	Multi-Channel Assignment Using Improved Greedy Algorithm in Wireless Mesh Networks

ROOM 5 – STATISTICS

Time	Presenter	Paper ID	Title
15:30	Ummul Fahri Abdul Rauf INVITED SPEAKER	S133	The Exploratory Factor Analysis (EFA) of DASS-21 Index: A Case Study of UiTM Student
15:55	Nurul Syuhada Samsudin	S094	An Analysis of Cohort-Based Mortality Model with ARIMA Model
16:15	Anis Suraiya Mat Naji	S107	Gold Price Forecasting using ARIMA-GARCH Model During COVID-19 Pandemic Outbreak
16:35	Siti Aishah Tsamienah Taib	S167	The Implementation of Data Mining Technology in Tourism Industry

ROOM 6 – DATA SCIENCE

Time	Presenter	Paper ID	Title
15:30	Mohd Aftar Abu Bakar	D047	Forecasting the Air Quality Time Series Data Using Univariate and Multivariate Convolutional Neural Network Model
15:50	Guo Yueling	D019	Flexible Random Satisfiability in Discrete Hopfield Neural Network
16:10	Gao Yuan	D016	The Effects of Learning Mechanism on a Special Satisfiability Logic in Discrete Hopfield Neural Network
16:30	Suad Abdeen	D018	S-Type Random 2 Satisfiability Logic integrated Discrete Hopfield Neural Network

ROOM 7 – MATHEMATICS EDUCATION

Time	Presenter	Paper ID	Title
15:30	Adina Najwa Kamarudin	E144	Students' Performance on Statistics Course Through Online Learning
15:50	Betty Wan Niu Voon	E096	Design of E-Advanced Calculus
16:10	Fadila Amira Razali	E066	Validation of Students' Anxiety and Attitudes Towards Statistical Concepts Questionnaire: An Exploratory Factor Analysis Procedure
16:30	Nurul Habibah Abdul Rahman	E078	Development of a Predictive Model for Students' Final Grades Using Machine Learning Techniques
16:50	Borboeva Gulnisa Mamatkanovna	E124	Organization of Learning Activities in the Formation of Spatial Thinking

THURSDAY, AUGUST 25

SESSION 3: 09:00 – 10:20

ROOM 1 – APPLIED MATHEMATICS

Time	Presenter	Paper ID	Title
09:00	Mohamad Hidayad Ahmad Kamal	A147	Stagnation Point Flow of g-Jitter Nanofluid Induced by Natural Convection with Newtonian Heating Thermal Condition
09:20	Siti Farah Haryatie Mohd Kanafiah	A148	Flow Analysis of Brinkman-Viscoelastic Fluid in Boundary Layer Region of Horizontal Circular Cylinder
9:40	Laila Amera Aziz	A207	Flow of Viscoelastic Fluid with Microrotation at a Boundary Layer of a Horizontal Circular Cylinder Flow of Viscoelastic Fluid with Microrotation at a Boundary Layer of a Horizontal Circular Cylinder
10:00	Syazwani Mohd Zokri	A046	Carboxymethyl Cellulose-Based Second Grade Nanofluid around a Horizontal Circular Cylinder

ROOM 2 – STATISTICS

Time	Presenter	Paper ID	Title
09:00	Nur Aliyah Jazuli Wilaksono	S116	Evaluating the Factors Affecting the Disease Progress of Ganoderma Basal Stem Rot Disease in Oil Palm Using OLS Regression Model and Wild Bootstrap Multiple Regression
09:20	Noryanti Muhammad	S044	Identifying Risk Factors of Cardiovascular Diseases Through Generalized Linear Model
09:40	Noratiqah Mohd Ariff	S045	Dissimilarity Measures for Hierarchical Clustering of Air Pollutants in Peninsular Malaysia
10:00	Yumn Suhaylah Yusoff	S112	The Relationship of Mortality with Obesity in Malaysia
10:20	Norhana Abd. Rahim	S038	The Effect of Inflation and Interest Rate on Private Pension Benefits in Malaysia

ROOM 3 – PURE MATHEMATICS

Time	Presenter	Paper ID	Title
09:00	Wong Koon Sang	P080	Fixed point results via β -admissibility in fuzzy extended rectangular b-metric spaces
09:20	Nor Kamariah Kasmin@Bajuri	P139	A Short Review on Multidigraph
09:40	Bryan Ceasar L. Felipe	P092	A Construction of Two-Dimensional Symbolic Random Substitution Systems
10:00	Suzila Mohd Kasim	P204	Construction of the AA44 Graph of Mathieu Group MM1111

ROOM 4 – STATISTICS

Time	Presenter	Paper ID	Title
09:00	Sharainie Sahrin	S037	Identifying factors that influence students' performance through generalized linear model
09:20	Nurain Ibrahim	S060	Determination Factors of Internet Advertising Affecting Internet Users' Behavior Using Canonical Correlation Analysis
09:40	Nurain Ibrahim	S059	Determination of Risk Factors Influencing Binge Eating Behaviour Among University Students
10:00	Siti Wafiah Hanin Mohd Zulkifli	S190	Length of Hospital stay for Elderly Patients with Respiratory Diseases until recovery in Malaysia: Comparison of Cox Proportional Hazard Model and Parametric Models
10:20	Nurulhaida Zakaria	S035	A Comparative Study of Classical and Robust Principal Component Analysis

ROOM 5 – ENGINEERING & INDUSTRIAL APPLICATIONS

Time	Presenter	Paper ID	Title
09:25	Nornabila Abu	G154	Forecasting of Hydropower Production Using Box-Jenkins Model at Tasik Kenyir, Terengganu
09:45	Lee Siang Chuah	G027	Improved Light Management of Si Thin-Film Solar Cells with ZnO:Al Back Reflector
10:05	Nor Syaza Farhana Mohamad Murad	G053	Rotor Angle Stability of a Linearized Synchronous Generator

ROOM 6 – DATA SCIENCE

Time	Presenter	Paper ID	Title
09:00	Gobithaasan Rudrusamy INVITED SPEAKER	D120	Exploring Selected Terengganu's Rainfall Time Series Using TDA Mapper
09:25	Ruksana Banu. A	D135	Impact of Modality on Cognitive Load and Data-Driven Decisions as Perceived by Novice Users
09:45	Arnold Dela Cruz Jr	D105	Using Machine Learning Algorithms to Determine the Food Insecurity Level of Households of Public School Children
10:05	Mohd Syafiq Asyraf Suhaimi	D033	Heart Disease Prediction using Ensemble of k -Nearest Neighbour, Random Forest and Logistic Regression Method

ROOM 7 – MATHEMATICS EDUCATION

Time	Presenter	Paper ID	Title
09:00	Durrani Aimi Abdul Malik	E181	Determination STEM (Mathematics) Blended Learning Criteria via Fuzzy AHP method
09:20	Adie Safian Ton Mohamed	E169	Application of R Programming in Education: Logistic Regression Approach
09:40	Dg Siti Nurisya Sahirah Ag Isha	E076	Determinants of Students' Academic Performance among Undergraduate Students in Universiti Malaysia Sabah: A Structural Equation Modelling Approach
10:00	Mohd Shafie Rosli	E153	The Framework for Enhancing Mathematical Higher Order Thinking Skills Using Technology Enhanced Learning Environment and Learning Analytics

SESSION 4: 11:45 – 13:00

ROOM 1 – APPLIED MATHEMATICS

Time	Presenter	Paper ID	Title
11:45	Siti Hanani Mat Yasin	A146	Theoretical Study on Thermal Conductivity, Thermal Diffusivity and Nusselt Number of Magnetite Water Based Ferrofluid at Sphere Surface Under Magnetic Field and Thermal Radiation
12:05	Intan Diyana Munir	A175	Effect of Catheter and Stenosis on Solute Diffusion in Non-Newtonian Blood Flow through a Catheterized Stenosed Artery
12:25	Nur Syamilah Arifin	C004	Dusty Casson Fluid Flow containing CNTs over a Stretching Sheet with Aligned Magnetic Field Effect

ROOM 2 – STATISTICS

Time	Presenter	Paper ID	Title
11:45	Ruzaini Zulhusni Puslan	S177	The Application of Geographically Weighted Logistic Regression to Model the Spread of COVID-19 in Peninsular Malaysia.
12:05	Lay Guat Chan	S090	Mortality Fitting and Forecasting Using Hyndman-Ullah Model and Lee-Carter Model: A Study on Malaysia's Ethnic Groups
12:25	Azuraini Mohd Arif	S156	Slope Estimation in Replicated Linear Functional Relationship Model via Trimmed Mean: A Simulation Study
12:45	Nashirah Abu Bakar	S178	Application of Generalized Auto-Regressive Conditional Heteroskedasticity (GARCH) for modeling volatility of share price during the COVID-19 outbreak

ROOM 3 – PURE MATHEMATICS

Time	Presenter	Paper ID	Title
11:45	Muhammad Azrin Ahmad	P195	Pattern of the Strings of the n -th Order Limit Language
12:05	Jim Ralphealo Mijares	P097	Topological Mixing of Random n -Bonacci Substitutions
12:25	Laarni B. Natividad	P098	Fundamental Phase Space Formula for the Similitude Group

ROOM 4 – COMPUTATIONAL MATHEMATICS / DATA SCIENCE

Time	Presenter	Paper ID	Title
11:45	Mohd Shareduwan Mohd Kasihmuddin INVITED SPEAKER	C025	Analysis of Logic Satisfiability in Energy Based Discrete Hopfield Neural Network
12:05	Siti Syatirah Muhammad Sidik	C013	Non-systematic Weighted Random Satisfiability in Discrete Hopfield Neural Network using Binary Artificial Bee Colony
12:25	Nurul Atiqah Romli	D014	Log Linear in 2 Satisfiability Based Reverse Analysis Method

ROOM 5 – COMPUTATIONAL MATHEMATICS / DATA SCIENCE

Time	Presenter	Paper ID	Title
11:45	Noor Julailah Abd Mutalib	C110	Adaptive Step Size Stochastic Runge-Kutta Method of Order 1.5(1.0) for Stochastic Differential Equations (SDEs)
12:05	Nur Idalisa Norddin	C191	Analysis on RMIL Conjugate Gradient Method and Its Variants under Exact Line Search
12:25	Muhammad Haikal Aminuddin	D201	Predictive Model of Car Price based on Customers' Purchasing Decision

ROOM 6 – STATISTICS

Time	Presenter	Paper ID	Title
11:45	Idari Ismail	S199	Interval Estimations for Parameters of Bathtub Hazard Model with Fixed Covariate in the Presence of Right and Interval Censored Data
12:05	Siti Afiqah Muhamad Jamil	S062	Exponential Survival Analysis with Partly-Interval Censored in Measuring the Covariates of Simulation Data
12:25	Norazliani Md Lazam	S197	Modelling New Mortality Rates with Income Inequality Variable

ROOM 7 – APPLIED MATHEMATICS

Time	Presenter	Paper ID	Title
11:45	Ahmad Izul Fakhruddin Azimi	A114	Neural Ordinary Differential Equations for Solving Nonlinear System of Ethanol Fermentation in Bioreactor
12:05	Salvador V. Briones	A152	Ethnomathematics: Linking Mathematics and Cultural Practices of the Agta Tabangnon in the Upland Communities of Goa, Camarines Sur, Philippines
12:25	Clark Kendrick Go	A104	Topological Data Analysis of Collective Behavior in Public Transportation
12:45	Nur Umaisara Rashid	A173	Topological Studies on Public Transport Network in Different Network Spaces and Their Significance

SESSION 5: 15:30 – 17:00

ROOM 1 – APPLIED MATHEMATICS

Time	Presenter	Paper ID	Title
15:30	Mwaffag Sharadga	A089	B-spline method for solving fractional delay differential equations
15:50	Siti NurulAifa Mohd ZainulAbidin	A151	Exact Analysis of Unsteady Convective Diffusion in Herschel-Bulkley Fluid Flow- Application to Catheterised Stenosed Artery
16:10	Muhammad Amsyar Hamidi	A222	Mathematical Modelling and Simulation of Invadopodia Formation Due to Ligand and Transmembrane Protein Binding
16:30	Khalid Hammood Al-Jizani	A010	An Analytic Delayed Solution for generalized Non-linear pantograph Differential Equation Via Coupled Taylor-Homotopy Technique
16:50	Abdulkasim Akhmedov	A100	The Approximation of the Solution of Heat Conduction Problem in Circular Plate with Concentrated Initial Heat

ROOM 2 – COMPUTATIONAL MATHEMATICS / DATA SCIENCE

Time	Presenter	Paper ID	Title
15:30	Rozaimi Zakaria	C170	B-Spline Curve Modeling of Z-Number Triangular Fuzzy Data
15:50	Suzelawati Zenian	C182	Flat EEG Image Enhancement using Type-2 Fuzzy Set
16:10	Noor Jamalina Mohd Jamal	C174	Application of Fuzzy Z-Hesitant Data Information in Fuzzy C-Means Clustering Analysis
16:30	Chengfeng Zheng	D011	A Modified Fuzzy k-Nearest Neighbor using Sine Cosine Algorithm for Two Classes and Multi-Class Datasets

ROOM 3 – APPLIED MATHEMATICS

Time	Presenter	Paper ID	Title
15:30	Zainor Ridzuan Yahya INVITED SPEAKER	A187	Curve Reconstruction using Soft Computing Techniques
15:55	Cheng-Wen Liu	A196	A Modified Gauss-Seidel Method to Balance Chemical Equations
16:15	Saidatul Nur Aisyah Sakinah Ahmad Jamal	A142	Method of Line Technique to Solve the Drift Diffusion Equation for Perovskite Solar Cell
16.35	Syafina Ahmad	A028	The Unique Eccentricity of a Prolate Spheroid Based on its Depolarization Factors
16:55	Nur Faiqah 'Aqilah	A155	Rough Set Model for Component Extraction

ROOM 4 – OPERATIONAL RESEARCH

Time	Presenter	Paper ID	Title
15:30	Set Foong Ng	O024	Analyse Bun Nutrient Contents using TOPSIS Analysis: A Case Study of Commercial Sweet Buns in Malaysia
15:55	Koko Hermanto	O145	Evaluation of The Queue System of a Driving License Application at Kepolisian Resor Sumbawa Besar
16:15	Fazillah Bosli	O108	The Efficiency of Zakat Outreach in Time of COVID-19 Pandemic
16.35	Syarifah Zyurina Nordin	O158	Comparison of MCDM Methods for Priorities in Selecting Patent
16.55	Rozieana Khairuddin	O228	Development of Multi-start Simulated Annealing for Redesigning Warehouse Network Problem

ROOM 5 – STATISTICS

Time	Presenter	Paper ID	Title
15:30	Nik Muhammad Farhan Hakim Nik Badrul Alam	S150	Integration of 4253HT Smoother with Intuitionistic Fuzzy Time Series Forecasting Model
15:50	Shahidah Othman	S180	Triangular and Trapezoidal Intuitionistic Fuzzy Set for Time Series Forecasting model towards Energy-Water Efficiency
16:10	Nik Muhammad Farhan Hakim Nik Badrul Alam	S081	Comparison of Intuitionistic Fuzzy Time Series Forecasting Models Using Different Interval Lengths in Predicting Malaysian Crude Palm Oil Prices
16:30	Nor Sofiza Abu Salleh	S188	Optimization of Rain Gauge Network Using Geostatistics and Artificial Bee Colony Optimization Approaches in The Pahang Riverbasin: A Preliminary Study
16:50	Nur Alia Aziz	S203	An Assessment of Rainfall Distribution at Kuantan River Basin Using Log-Normal and Log-Pearson Type III Distribution

ROOM 6 – DATA SCIENCE

Time	Presenter	Paper ID	Title
15:30	Nordiana Mukahar	D041	Performance Comparison of K Nearest Neighbor Classifier with Different Distance Functions
15:50	Piau Phang	D051	Geo-visualization of Sarawak COVID-19 publicly available data employing open-source geospatial software
16:10	Sri Nur Areena Mohd Zaini	D118	Implementation of Mahalanobis-Taguchi System to Evaluate the Normal and Abnormal Samples in Academic Faculties
16:30	Sri Nur Areena Mohd Zaini	D119	Application of Mahalanobis-Taguchi System in Key Performance Indicator Analysis of Academic Staffs with Grade DS51/52
16:50	Nur Atiqah Mustapa	D206	Optimized Number of Bats for Binary Bat Algorithm Parameter Setting

ROOM 7 – APPLIED MATHEMATICS

Time	Presenter	Paper ID	Title
15:30	Hanani Farhah Harun	A042	Extending Generalised Leland Option Pricing Models: Simulation Using Monte Carlo
15:50	Rabiatul Adawiah Fadzar	A049	Brachistochrone Curve Representation via Transition Curve
16:10	Izzatul Nabila Sarbini	A056	The Security Analysis of GCD Attack on LUCELG, LUC(3)ELG and LUC(4,6)ELG
16.30	Hanani Farhah Harun	A043	Implied Volatility Functions of BS versus Leland: Empirical Evidence from Australian Index Option Market
16:50	Nor Aida Zuraimi Md Noar	A034	A Comparative Study of Taylor Method, Fourth Order Runge-Kutta Method and Runge-Kutta Fehlberg Method to Solve Ordinary Differential Equations

FRIDAY, AUGUST 26

SESSION 6: 11:30 – 12:45

ROOM 1 – APPLIED MATHEMATICS

Time	Presenter	Paper ID	Title
11:30	Zulhibri Ismail INVITED SPEAKER	A189	Generalized Cattaneo's Law over a Vertical Cylinder on Casson Fluids
11:55	Lim Yeou Jiann	A149	Liquid Coating with Variable Thermal Conductivity on a Pipe under Influence of Thermal Radiation and Heat Generation
12:15	Mohd Khairul Hafiz Khairuldin	A109	Application of Risk-Based Inspection using API 581 Methodology to a Pressure Vessel in Petrochemical Plant

ROOM 2 – COMPUTATIONAL MATHEMATICS

Time	Presenter	Paper ID	Title
11:30	Siti Nasyitah Binti Jaman	C086	Interpolation Rational Bezier Curve Modeling Through Fuzzy Intuitionistic Alpha-cut for Uncertainty Data Visualization
11:50	Nur Batrisyia Ahmad Azmi1	C083	Type-2 Intuitionistic Interpolation Fuzzy Bezier Curve Modeling of Complex Uncertainty Data
12:10	M. V. Chakradhara Rao	C157	Minimum Absolute Deviation Covering Partition Energy of Graphs

ROOM 3 – PURE MATHEMATICS

Time	Presenter	Paper ID	Title
11:30	Abdullayeva Cholpon	P123	Necessary and sufficient conditions of the existence of quazudouble lines of the partial mapping of space E_n
11:55	Raja Mohammad Latif	P205	Nano $\pi g^* \beta$ -Normal Spaces and Almost Nano $\pi g^* \beta$ -Normal Spaces
12:15	Mohammad Younus Bhat	P007	A Look at Bell Labs Inequality for M-band Wavelets

ROOM 4 – OPERATIONAL RESEARCH

Time	Presenter	Paper ID	Title
11:30	Noor Hafizah Zainal Aznam	O029	Container Handling Operations using Data Envelopment Analysis: A Systematic Review
11:50	Anis Mardiana Ahmad	O031	A Systematic Review on Data Envelopment Analysis Application in Higher Education
12:10	Raed Hameed Mahdi	O176	Estimating the Parameters of the Two-Parameter Weibull Distribution and Their Impact on the Performance Measures of the M/G/1 Queuing System - A Case Study
12.30	Najihah Mohamed	O229	A Scalability Study and Parameters Effect of The Modified Harmony Search Algorithms

ROOM 5 – ENGINEERING AND INDUSTRIAL APPLICATIONS

Time	Presenter	Paper ID	Title
11:30	Shafini Mohd Shafie	G077	Economic and environmental aspects of electricity generation based on biogas feed fuel cell: A multi criteria analyze (MCA) approach
11:50	Hussain A. Younis	G141	A Review on Integration of Blockchain Technology in IoT Applications
12:10	Mohd Azimin Elias	G074	Wind Speed Interpolation Methodologies for Wind Energy Mapping in Malaysia – A Review
12.30	Nurul Hudaningsih	G171	The Influence of Driving Duration and Driving Shift on Changes in Sleepiness And Fatigue Level On The Taruna Jaya Bus Driver The Sumbawa-Taliwang Route

ROOM 6 – MATHEMATICS EDUCATION

Time	Presenter	Paper ID	Title
11:30	Frankie A. Fran	E099	Developing a Game-Based Instructional Manipulative for Permutation and Combination
11:50	Meike Wigati	E115	Analysis of the Ability to Understand Mathematical Concepts Based on Brain Domination
12:10	Topchybai Isakov	E131	The Role of Online Platforms in Distance Learning
12:30	Isakov Topchubai	E126	The Role of Information and Communication Technologies in Distance Learning

ROOM 7 – STATISTICS

Time	Presenter	Paper ID	Title
11:30	Tan Wai Hong	S075	On the Choice of Functionals Obtained from the Predictive Distribution of Future Retweet Counts
11:50	Sharifah Sakinah Syed Abd Mutalib	S021	Comparative Study of Test on Covariance Performance in Two Outlier Scenarios
12:10	Nur Syahirah Zulkipli	S048	The Multiple Outliers Detection for Circular Univariate Data Using Different Agglomerative Clustering Algorithms