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FACULTY OF MATHEMATICS & SCIENCES
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CONTENT IN A BRIEF.....	i
EDITORIAL BOARD.....	ii
FOREWORD.....	iii
WELCOME MESSAGE.....	iv
TABLE OF CONTENTS.....	v
A. Abstract of Keynote and Invited Speaker.....	1
B. Material Science and Technology.....	10
C. Science and Technology Education.....	66
D. Environmental Science and Technology.....	124
E. Molecular and Health Science.....	222
F. Mathematics, Statistics, and Modeling.....	300
G. Instrumentation and Measurement.....	481
H. Energy.....	507

PROCEEDINGS OF THE 6th ANNUAL BASIC SCIENCE INTERNATIONAL CONFERENCE

“Enhancing Innovation in Science for Sustainable Development”

ATRIA HOTEL AND CONFERENCE, MALANG, INDONESIA

March, 2nd – 3rd 2016

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FOREWORD

The 6th Annual Basic Science International Conference (BaSIC 2016) had been successfully held on 2 – 3 March 2016 at Atria Hotel, in Malang, Indonesia. The conference theme this year is "*Enhancing Innovation in Science for Sustainable Development*". The conference is aimed at promoting scientific research activities by fellow scientists in Indonesia and overseas, in the hope of building and strengthening networks and collaborations. Additionally, the conference is also designed to bring experts as well as students together from different disciplines related to basic sciences, to stimulate the formation of new collaborations. So, it is an event where new generation of scientists will coalesce with the senior and experienced ones.

We do thank all participants for their contributed talks, the keynote speakers, as well as the invited speakers for coming and sharing their knowledge with us. The presenters actively contributed in sending their articles to be published in this proceeding. We also thank Brawijaya University and Faculty of Sciences in particular, the organizing team from the Department of Mathematics, Faculty of Sciences, Brawijaya University, as well as all members of the scientific committee.

We are delighted that the proceeding of the 6th Annual Basic Science International Conference (BaSIC 2016) had been completed. It is a book containing papers that had been presented in the BaSIC conference. Moreover, the articles in this proceeding are divided into a breath of the conference subjects of Material Science and technology, Science and Technology Education, Environmental Science and Technology, Molecular and Health Science, Mathematics, Statistics, and Modeling, Instrumentation and Measurement, as well as Energy. The proceeding is aimed at collecting and sharing any useful information that had been gathered during the BaSIC conference.

The editorial team has made some editing and correction needed in some cases. Most of the editing correction are conducted and concentrated in the organization of the paper based on the guideline and the language. Some figures and tables were corrected, and placed accordingly. In addition, the language is the most time-consuming work; hence on behalf of the committee we apologize for the late publishing of this book and for any inconvenience as a result of the delay.

We give our gratitude to the reviewing and editing team for their hard work and for making the publication of this proceeding happen. We again thank all participants and presenters for the kindness to be part of the BaSIC conference. We hope the readers of this book could gain new knowledge, information, and idea for a research and further research collaboration, particularly in the topics or subjects related to basic sciences.

Best regards,

Achmad Efendi, PhD
Chairman of BaSIC 2016

WELCOME MESSAGE

On behalf of the Dean of Faculty of Mathematics and Natural Sciences, we are very pleased to welcome you in the proceeding of the Sixth Annual Basic Sciences International Conference 2016. This proceeding is one of the continuation for the conference. Based on these papers, hopefully more collaboration can be initiated or should be followed up.

I would like to express my gratitude to all of the contributed papers, also keynote and invited speakers. Many thanks also goes to the reviewers and the editorial team for the big effort in supporting this proceeding.

Last but not least my big appreciation to the steering and organizing committees, in realizing this proceeding.

Faculty of Mathematics and Natural Sciences,

Dean,



Prof. Dr. Marjono, M.Phil.

TABLE OF CONTENTS

A. Abstract of Keynote Speaker and Invited Speaker		1
1	The Environmental Importance of Shade Grown Coffee	1
	Derek Thomas	
2	Role Of Allee Effect And Functional Response In A Leslie-Gower Predator-Prey Model	2
	Agus Suryanto, Danang Indrajaya and Abdul Rouf Alghofari	
3	Analysis of bioaerosol emissions by MALDI-TOF mass spectrometry and NIR spectroscopy	3
	Katharina Druckenmüller, Andrea Gärtner, Udo Jäckel, Gereon Elbers	
4	On a Hierarchical Mixture Model	4
	Nur Iriawan	
5	Formation of Low Refractive Index glass layer for solar cells	6
	Shuichi Nonomura and Hiroyuki Miwa	
6	Tailored Synthesis of Magnetic Nanostructures	7
	Mutsuhiro Shima	
7	Development Study of Spatio Temporal Modeling based on Real Phenomena	8
	Budi Nurani Ruchjana	
B. Material Science and Technology		10
8	Alfatih Algorithm	10
	Mohamad Ali Sadikin, Bella Intan Aulia	
9	Potential Study Of Ethanol Extract Of Karamunting (<i>Melastoma Malabhatricum</i>) As Growth Precursor For Larvae Of Giant Tiger Prawn (<i>Penaeus Monodon</i>) By Dipping Method	14
	Ridwan A, Awaludin, Wibowo I, Nurasmi	
10	Immobilization of Crude Lipase from <i>Mucor miehei</i> in Polyurethane Foam for Hydrolysis of Coconut Oil	18
	Maria Angelina Suku, Dwina Moentamaria, Arief Widjaja	
11	The Growth of AlN Nanomaterial via Vapor-Liquid-Solid (VLS) Method with Various Growth Temperature and Holding Time	22
	Diah Susanti, Mavindra Ramadhani, Haniffudin Nurdiansah, Hariyati Purwaningsih	
12	Precipitation of Alkaline Protease from <i>Bacillus sp</i>	26
	Suharti, Apriani Wike Nur M, Wahidatul Ainia Rosyai, and Surjani Wonorahardjo	
13	Effect of Post-Annealing on Structure, Hardness, and Fracture Toughness of Twin Wire Arc-Sprayed FeCrBMnSi Coatings	30
	Agung Purniawan, Sigit Tri Wicaksono, Hengki Irawan,	
14	Statistical Parameter Of The Sediment: A Case Study in Wonorejo Indonesia	34
	Zhelvyanie, Suntoyo, Wahyudi	
15	Bioassay MOSNON™ as Biolarvacide Towards <i>Aedes aegypti</i> Larvae	38
	Priska Ristianadewi, A. Hasan Huda, Minoru Maeda, Zulfaidah Penata Gama	
16	P53 and Small molecule inhibitor changed Formation and stabilized structure of MDM2 Protein	42
	Widodo	

17	Morphological Analysis Of Manganese (Mn) Concentration Doped Zn_{0.85}Mn_{0.15}O Nanoparticles. Heru Harsono, ING.Wardana, A.A.Sonief, Darminto	46
18	Rock Magnetism And Paleomagnetism From Una Una Island And Its Implication For Tectonic Of Sulawesi..... Muhammad Rusli M, Subagyo Pramumijoyo, I Wayan Warmada, Wiwit Suryanto	50
19	Phycobiliprotein And Lipid Content Of <i>Chroococcus Turgidus</i> Cultivated at Various of Concentration of Liquid Waste Tofu..... Ni Wayan Sri Agustini and Maria Ulfa	54
20	Microscopic Observation of Endophytic Fungi in Afo Clove From Ternate Island Arini Zahrotun Nasichah, Utami Sri Hastuti, Endang Suarsini, Fatchur Rohman	59
21	Aphrodisiac Activity of <i>Areca Catechu</i> L.Root Infuse In Normal DDY Strain Male Mice..... Nur Laili Dwi Hidayati , Ilham Alifiar , Hilman Taufiq Nurdin	62
C. Science and Technology Education		66
22	Biological Control of <i>Crociodolomia Binotali</i>, Zeller by Using <i>Bacillus Thuringiensis</i> Fusants Strain Culturing in the Coconut Water Containing Fish Powder..... Siti Sumarmi, Retno Peni Sancayaningsih, Sebastian Margino , RC. Hidayat Soesilohadi	66
23	Implementing Haversine Formula on Google Map to Find Nearest Student Position M Zainal Arifin	69
24	e-Evaluation Measurement for Javanese Script Handwriting Studies Priandani, Nurizal D., and Utamingrum, F.	73
25	Mobile Game Android for Education Method Using MCRN-Generator Basid, Puspa Miladin Nuraida Safitri A., and Utamingrum, F.	77
26	Gifu University Students of the Department of Civil Engineering at Asia Bridge Competition 2015 Shogo Yamamoto, Rina Hasuike, Koji Kinoshita, Yuichi Uchida	82
27	Students' Representation on Allele Gene Kristianti T.,Widodo A., Suhandono S., & Waldrip B	87
28	MLC Positioning Error Detection using Water Planar Dose Maps S Herwiningsih, A Fielding	90
29	Evaluating and Monitoring Student's Satisfaction Based on Student Sentiement in Social Media Fahmi Candra Permana, Yusep Rosmansyah	94
30	Screening of Probiotic Candidates from Rumen Bacteria Isolates for Improving Rumen Fermentation and Feed Digestibility A.A. Win Ariga Bungsu, Anuraga Jayanegara, Indah Wijayanti, Roni Ridwan, and Yantyati Widyastuti	99
31	Impact of Scientific Inquiry-Based Reflective Learner as Teacher Lecturing Strategy on Students' Conceptual and Scientific Inquiry Understanding in Learning School Chemistry Muntholib and Munzil	102
32	Improving Students' Mathematical Problem Solving Skillsthrough Cooperative Learning of The Group Investigation Type Ahmad Dzulfikar, Dadan Dasari, Stanley Dewanto	108

33	Immune protein of the insect pest <i>Crocidolomia pavonana</i>, previously treated with <i>Mirabilis jalapa</i> extract, after infection with <i>Beauveria bassiana</i> fungi	112
	Tjandra Anggraeni	
34	Optimization of Trastuzumab Digestion by Pepsin Enzyme for Preparation of Radioimmunotherapy Agent	116
	R.D. Haryuni, Triningsih, Sutari and S. Hermanto	
35	Synthesis and Characterization of Coordination Compounds of Silver(I) Nitrite with Ligands Ethylenethiourea and <i>N,N'</i>-diethylthiourea	120
	Fariati, Effendy, Nurul Istikfaroh, Lutfia Ayu Darojah	
D. Environmental Science and Technology.....		124
36	The Fluctuation of Adult Filial Number and Eclosion Time of <i>Drosophila melanogaster</i> that Exposed by Mobile Phone in Multiple Generations.....	124
	Ahmad Fauzi, Aloysius Duran Corebima, Siti Zubaidah	
37	Accurate Hypocenter Location and 1-D P Wave Velocity Structure in the Subduction Zone between the Eurasian Plate and the Philippine Plate, In Taiwan Based on Shallow Earthquake Data	129
	Uswatun Chasanah, Bagus Jaya Santosa	
38	Measurement of Methane (CH₄) Emission from Spontaneous-Combustion Coal at an Open Pit Coal Mining Activity	135
	Maulana Yusuf, Eddy Ibrahim, Edward Saleh, Rasyid Ridho dan Iskhaq Iskandar	
39	Effect of <i>Pseudomonas aeruginosa</i> Addition on DDT Biodegradation by <i>Daedalea dickinsii</i>	139
	Hamdan Dwi Rizqi, Adi Setyo Purnomo	
40	Determination Subsurface Structure of Geothermal Area in Mount Arjuno Using Electrical Resistivity Schlumberger Array	144
	F. K. Ayu Anggraeni, Eko Minarto	
41	Investigation Archaeological Objects with Electrical Resistivity Tomography Method (ERT) 2D in Mount Kelud, East Java	148
	Arie Realita, Eko Minarto	
42	Biological Control And Managemen Of Insect Pest On Strawberry Community: 2. Screening Of Pathogenic <i>Bacilus Thuringiensis</i> (Bt) Isolated From The Soil In Strawberry Community Against <i>Spodoptera</i> Larvae.....	152
	RCH. Soesilohadi, S. Sumarmi, S. Margino dan R. Susandarini	
43	Remote sensing application for initial geothermal survey in East Java, Indonesia (case study Blawan and Iyang-Argopuro geothermal prospecting areas)	155
	Sukir Maryanto, Yoel Marthen, Anjar P. Azhari, James Foster, Cinantya N. Dewi	
44	Application of 3D Resistivity Method for Distribution of Seawater Intrusion in the Tanah Mas Residential North Semarang	160
	Andya Satya Purnomo Putro, Supriyadi, Khumaedi	
45	Coral Disease on Scleractinian Coral at South Java Sea, Indonesia.....	164
	Oktiyas Muzaky Luthfi	
46	Fishery Management Unit Assessment Of Big Eye Tuna (<i>Thunnus Obesus</i>) in South Java Sea	170
	Feni Iranawati, Luh Nyoman Didik Tri Utami, Diana Arfiati, Syarifah Hikmah, Ledhyane Ika Harlyan	
47	Dominance of Acroporids Coral in Coral of Bali Strait, Indonesia.....	173
	Oktiyas Muzaky Luthfi, Andik Isdianto, Erma Juwita Sari	

48	Effects of 1-Methylcyclopropene, Plastic Wrapping, and Storage Temperature on Fruit Shelf-life and Qualities of ‘Crystal’ Guava.....	179
	Zulferiyenni, S. E. Widodo, M. Rahmawati	
49	Effects of Chitosan and Plastic Wrapping on Fruit Shelf-life and Qualities of ‘California’ Papaya.....	183
	Soesiladi E. Widodo, Zulferiyenni, Suskandini R. Dirmawati, Rachmansyah A. Wardhana, Sunarti, Maret L. Wahyuni	
50	The Influence of Motorcycles Smokes to Mice Organs.....	187
	A. Y. P. Wardoyo, U. P. Juswono, J. A. E. Noor	
51	Atmospheric Boundary Layer Model on the Indonesian Low Speed Wind Tunnel	193
	Matza Gusto Andika, Subagyo, R. Wibawa Purabaya	
52	Bioconversion of Vegetables Waste by Black Soldier Fly Larvae : Optimum rate for waste reduction and efficiency of conversion	197
	Ramadhani Eka Putra, Agus Dana Permana, Ida Kinasih, Finsa Firlana Gusmara, Raeka Okata Soerbakti	
53	Electrical Conductivity of Ions Major and Heavy Metal Contribution for Electrolyte Electrical Conductivity of Leachate and Groundwater in Piyungan Landfill, Bantul Yogyakarta	201
	Jaingot A. Parhusip, Agung Harijoko, Doni Prakasa Eka Putra, Wiwit Suryanto	
54	Anisotropy of Magnetic Susceptibility (Ams) Studies of Granitic Rocks in Sulawesi, Indonesia .	206
	Muhammad Rusli M, Subagyo Pramumijoyo, I Wayan Warmada, Wiwit Suryanto	
55	Effect of Vinasse from Juice of Sorghum Var. Samurai 1 on the Methane Production by Buffalo Rumen Microbial	210
	Irawan Sugoro, Teguh Wahyono, Sihono, Wiwi Sevtiyani, D. Tetrana, Megga Ratnasari Pikoli	
56	Mineralogical Characteristics of Landslide-Induced Hydrothermal Altered Rocks at Southern Mountain Slope of Lombok Island, Indonesia	214
	Dwi Winarti, Sriyono, Hary Christady Hardiyatmo, Dwikorita Karnawati	
57	Test Larvacides of Morizena Bioinsecticides on Aedes aegypti	219
	Rina Priastini Susilowati	
E. Molecular and Health Science.....		222
58	Risk Factors Related to Dermal Exposure on Herbicide Applicators (Case Study in Palm Oil Plantations Banyuasin District, South Sumatera).....	222
	Maksuk, Tan Malaka, Suheryanto, Abu Umayah	
59	Evaluation of Crude Glycerin in High Roughage Dairy Heifer Diet on <i>In Vitro</i> Gas Production	228
	A.M. Abdurrahman, S. Buaphan, L. Boonek, S. Sindhuvanich	
60	Isolation and Characterization of Nematocysts’ Venom Proteins of the Jellyfish <i>Mastigiaspauain</i> Kakaban Lake and Sea.....	233
	Nurasmi Ridwan A, Awaludin	
61	The β Fibrinogen Gene G-455A Polymorphism in Asian Subjects with Coronary Heart Disease: A Meta Analysis	236
	Jonny Karunia Fajar	
62	Polysaccharide Krestin Activity from <i>Coriolus versicolor</i> on Antibody Titer of Mice Exposed <i>Staphylococcus aureus</i>	241
	Sri Puji Astuti Wahyuningsih	

63	Hip Geometry to Predict Collum Femur Fracture: Only Neck Width Had Significant Association	245
	Jonny Karunia Fajar, Rusydi, Safrizal Rahman, Armia Nur Alam, Azharudin Azharudin	
64	Cell wall nitrogen content, degradability and gas production kinetics of Calliandra and Leucaena leaves as influenced by different drying temperatures	250
	Servis Simanjuntak, Anuraga Jayanegara, Suryahadi, Roni Ridwan, Yantyati Widyastuti	
65	The Effect of Rambutan Peel Extract on Leptin Efficiency and Lipid Peroxidation in Obesity Rat Model	254
	Sri Rahayu Lestari, Umie Lestari, Abdul Gofur, M. Fitri Atho'illa, A. Setyawati I A. Kusuma Dewi	
66	Biodistribution and Clearance of ¹⁹⁸AuNP-PAMAM G4-Nimotuzumab for Theranostic Agent .	258
	Adang H.G., Abdul Mutalib, Rista D.S., Anung Pujiyanto, Indrarini L., Iyus M.Y., Rien R., Herlan S., Sutriyo C.	
67	Prediction Model of Depression Incidence Among Elderly in Nursing Home	263
	Faiza Yuniati, Indra Febriani	
68	Fiber Content of bmr Sorghum as Promising Future Forage	268
	Widhi Kurniawan, Luki Abdullah, Supriyanto	
69	Increase of Insoluble Nitrogen Fractions in Soybean (<i>Glycine max (L.) Merrill</i>) and Redbean (<i>Phaseolus vulgaris L.</i>) due to Higher Drying Temperatures	272
	Yesi Chwenta Sari, Erika B. Laconi, Didid Diapari, Anuraga Jayanegara, Roni Ridwan, and Yantyati Widyastuti	
70	Sustainable Health Development and Availability of Healthcare Insurance Covered for the Prevention of Hepatitis A in Malang	275
	Prayudi Lestantyo, Rizki Mustika Riswari, Dafid Bayu Firmansya	
71	Genetic Diversity Of Local Durian (<i>Durio Zibethinus Murr.</i>) From Tidore Island Province North Maluku Based On Rapd Analisis	280
	Sundari, Estri Laras Arumingtyas, Luchman Hakim, Rodiyati Azrianingsih	
72	Basic Nutrient Content Characterization of Uwi Banggai (<i>Dioscoreaalata</i>)	285
	Ayu Puspitasari, Wisnu Istanto, Nurcholis	
73	Association Between Estrogen Receptor α Gene Polymorphisms PvuII And Occurance Of Ephetelial Ovarian Carcinoma In Malays Population	288
	Ocktariyana, Irsan Saleh, Triwani, Theodorus	
74	Ethyl Acetate Extract of Microalgae <i>Porphyridium cruentum</i> Potentially as Antioxidant and Toxicity	292
	Ni Wayan Sri Agustini and Kusmiati	
75	Identification of Target Receptor for <i>N'</i>-benzoylisonicotinohydrazide: a Pharmacophore Approach	296
	Ruswanto, Siswandono, Tresna Lestari, Tita Nofianti	
F. Mathematics, Statistics, and Modeling		300
76	Total Cost of Distribution on 4-Echelon System, Consider the Selection of Transportation Modes and Defective Product	300
	Timotius Febry, Cynthia Priscillia	
77	A Cryptographic Algorithm based on Max plus Wavelet Transform	304
	Joko Cahyono, Subiono	

78	Application Of Model Predictive Control (Mpc) For Flow Line Production System Using Max-Plus Algebra.....	309
	Imam Fauzi, Dieky Adzkiya	
79	Energy Consumption and GDP in ASEAN Countries: a Multivariate Cointegration Analysis....	313
	Fitri Kartiasih	
80	A New Condition of p-Supremum Bounded Variation Double Sequences	317
	Moch. Aruman Imron	
81	Characterization of The Solution of Non Homogeneous System of Linear Equations Over Supertropical Algebra	321
	Dian Yuliati, Subiono	
82	Comparison Parametric and Non-Parametric Classification Methods on Medical Data	326
	Noviyanti Santoso and Santi Wulan Purnami	
83	NUMERICAL BOUNDARY-VALUE PROBLEM SOLVING FOR CREDIBILITY.....	331
	Windiani Erliana, Agah D. Garnadi, Sri Nurdiati, I Gusti Putu Purnaba	
84	The Basic Reproduction Number of the Recombination Mathematical Model between HIV and Virus Hepatitis B	335
	Aminatu Zuhriah, Hariyanto, Chairul Imron	
85	The Behavior of Eigenvalues and Eigenvectors of Square Matrices over Supertropical Algebra.	340
	Aprilia Divi Yustita, Subiono	
86	Viscous Fluid Flow With Presence of Magnetic Field Past An Elliptical Cylinder	345
	Dwi Ariyani Khalimah, Basuki Widodo, Chairul Imron	
87	Robust Geographically Weighted Regression.....	350
	Nadya Rizki Mulyani, Vita Ratnasari, Purbadi	
88	Prediction of Money Inflow and Outflow Bank Indonesia in Sulawesi Using ARIMA and ARIMAX	354
	Haeriah, Irhamah, Suhartono	
89	Persistence Analyze of the Spreading Ebola Virus Between Two Countries	359
	Awawin Mustana Rohmah, Hariyanto, Chairul Imron	
90	The Unsteady Flow Magnetohydrodynamic in Micropolar Fluid through Porous Sphere	363
	Indira Anggriani, Basuki Widodo, Chairul Imron	
91	Modelling of Queue in a Bank using Coloured Petri Nets.....	369
	Suci Rahmawati, Dieky Adzkiya, Endah Rokhmati	
92	Unsteady Mixed Convection Flow Past a Vertical Plate with The Effect of Magnetohydrodynamics	373
	Firdha Dwishafarina Zainal, Basuki Widodo, Chairul Imron	
93	Bayesian Estimation of Linear Mixed Response Models of Skew-Normally Distributed Stimuli: Evidence from Monte Carlo Simulation	377
	Mohammad Masjkur, Henk Folmer	
94	The Position Estimation of AUV Based on Non-Linear Ensemble Kalman Filter Method.....	382
	Ngatini, Erna Apriliani, Hendro Nurhadi	
95	Construction of Lyapunov Function for SIRS Models.....	387
	Bulqis Nebulla Syechah, Erna Apriliani	

96	Unsteady Mixed Convection Flow Past a Vertical Plate with The Effect of..... Magnetohydrodynamics Firdha Dwishafarina Zainal, Basuki Widodo, Chairul Imron	392
97	Prediction of Currency Outflow Inflow in Bank Indonesia Papua Province Using Hybrid ARIMAX-ANFIS Bobi Frans Kuddi, Suhartono, Santi Puteri Rahayu	396
98	Classification of Aofb Enzyme using Hybrid Binary Logistic Regression and Genetic Algorithm Muhammad Rizki Hidayat, Irhamah	401
99	Forest Type Classification Based Spectral Characteristics using Hybrid Discriminant Analysis and Genetic Algorithm Irwan Permadi Kurnianto, Irhamah	406
100	Glass Type Classification using Hybrid Multinomial Logistic Regression and Genetic Algorithm for Crime Investigation..... G K Risma Saputra, Irhamah	411
101	Manova Statistical Analysis of Chemical Groundwater from Landfill Bantar Gebang and Galuga in Indonesia Heruna Tanty, Rokhana Dwi Becti, Taty Herlina, Solihudin	416
102	Analysis Some Properties from Construction of Finite Projective Plane of Order 3 Vira Hari Krisnawati	421
103	Copula Regression to Modeling The Rice Harvest in Jember Regency..... Iis Dewi Ratih, Sutikno, Puhadi	426
104	Seasonal GSTAR-SUR Model Used Spatial Weight Normalization Statistical Inference of Partial Cross-Correlation..... Mike Prastuti ¹ , Erma Oktania Permatasari	431
105	Modeling Number Cases of Dengue Hemorrhagic Fever (DHF) in East Java by using Geographically Weighted Negative Binomial Regression..... Fefy Dita Sari, Puhadi, Santi wulan Purnami, I Nyoman Latra	435
106	A Modified Model Averaging for High Dimensional Data Deiby Tineke S, Anang Kurnia, Arief Gusnanto, I Wayan Mangku, Bagus Sartono	439
107	Empirical Study on Randomized Model Averaging Approach for High Dimensional Regression..... Septian Rahardiantoro, Anang Kurnia, Bagus Sartono	443
108	Computation of Shortest Path on the Distribution Route by Using Min-Plus Algebra Radhiyatil Khaira, Subiono, Dieky Adzkiya	446
109	BYM Model Application to Estimate the Relative Risks of Dengue Disease Considering the Level of the Severity: Bandung, Indonesia Case of Study Farah Kristiani, Benny Yong, Robyn Irawan	450
109	Modelling of Inventory Systems Using Petri Nets with Counters Ruvitalffahtur Pertiwi, Dieky Adzkiya, Subiono	454
110	Numerical Solution of Incompressible Navier-Stokes Equation in Interface-Fluid Coupled Model..... Nur Shofianah	457
111	Estimating Matrix Travel Light Vehicle Observations by Volume Sleeve Approach Inference Bayes..... Sobri Abusini	461

The Unsteady Flow Magnetohydrodynamic in Micropolar Fluid through Porous Sphere

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Abstract – Micropolar fluid is non-Newtonian fluid type with microstructure. Micropolar fluid support body couples and exhibit microrotational effects. The MHD is study about the motion of electrically conducting fluids under magnetic fields. This research is about unsteady MHD problem in micropolar fluid through porous sphere at stagnation point. The MHD effect in micropolar fluid is influence of magnetic field on the microrotation that also affect the motion of the fluid. The microrotation characteristic that has been taken into account is the attribute that distinguish micropolar fluid model from others. This research was developed from a mathematical model of MHD boundary layer flow in micropolar fluid. Micropolar fluid flow that influenced magnetic field evokes boundary layer. From the boundary layer formed a dimensional governing equation, it was continuity equation, momentum equation and angular of momentum equation. Then the equation is transformed into non-dimensional form and similiarity equation. The similiarity equations are solved numerically solution by Keller-Box method. Numerical results obtained, used to observe the influence of some parameters: magnetic parameter, micropolar parameter, and porous parameter of the velocity profile and the profile of the microrotation. The result of numerical solution that the velocity profile be increased along with magnetic parameter increased. Moreover the velocity decreased when micropolar parameter increased. When porous parameter increased, the velocity profile decreased but the difference not significant. Profile microrotation increased and changed with increased micropolar parameters.

1. INTRODUCTION

Fluid is a substance that has the ability to change shape when exposed to a continuously shear stress [1,2]. Two types of fluids are Newtonian fluid and Non Newtonian fluid. In most real cases, fluids cannot be easily modeled as viscous fluid under the Newton's law of motion or by the Navier-Stokes equations. Generally, any fluids that do not obey the Newton's law of motion are classed as non-Newtonian fluids and micropolar fluid is one of them (Hayat et al., 2009). Example of non-Newtonian fluids is micropolar fluids. The theory of micropolar fluids developed by Eringen [4,5] has been of much interest because it can be used to explain the characteristics in certain fluids. Micropolar fluids is fluids with microstructure. The micropolar fluids are theoretically represent fluids that contain rigid randomly oriented particles with their own and microrotations, suspended in a viscous medium. In the micropolar fluid, rigid particles contained in a small volume element can rotate about the center of the volume element described by the microrotation vector [6].

Due to its importance, we conduct a research about micropolar fluid. In this paper will be discussed about the unsteady magnetohydrodynamics boundary layer flow in micropolar fluid past a porous sphere. Boundary layer is a thin layer which is near the solid surface caused by the viscosity of fluid flow on the porous medium. The equation is built by boundary layer theory which can be called boundary layer equation. By considering the MHD effect on micropolar fluid, this paper also discuss the influence of magnetic field on the microrotation and magnetohydrodynamics effect on velocity profiles.

2. METHODS

2.1 Procedures

The governing equations are developed by continuity, conservation equations of linier momentum and angular momentum based from physical model of porous sphere. The boundary layer governing equations get under the Boussinesq approximation. Furthermore, we reduce the boundary layer equations to a dimensionless form by

applying several dimensionless variable and using boundary layer approximation. Then the equation is transformed into dimensionless form and similarity equation. The similarity equations are solved numerically solution by using Keller-Box method.

2.2 Problem Formulation

We consider the unsteady state two-dimensional near a porous sphere in micropolar fluid, as shown in Fig. 1, where a is the radius of the sphere. In this figure, the coordinate x and y are chosen such that x measures the distance along the surface of the sphere from the lower stagnation point and y measures the distance normal to the surface of the sphere, respectively[7]. For an incompressible micropolar fluid, in the presence of MHD, by neglecting the body force and body couple, the equation of continuity, the conservation equations of linear momentum and angular momentum are as follow.

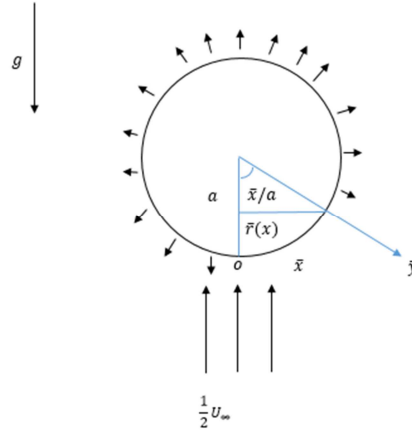


Figure 1. Physical model and coordinates for a porous sphere

Continuity Equation :

$$\frac{\partial(\bar{r} \bar{u})}{\partial \bar{x}} + \frac{\partial(\bar{r} \bar{v})}{\partial \bar{y}} = 0 \quad (1)$$

Momentum Equation :

$$\rho \left(\frac{\partial \bar{u}}{\partial \bar{t}} + \bar{u} \frac{\partial \bar{u}}{\partial \bar{x}} + \bar{v} \frac{\partial \bar{u}}{\partial \bar{y}} \right) = -\frac{\partial \bar{p}}{\partial \bar{x}} + (\mu + k) \left(\frac{\partial^2 \bar{u}}{\partial \bar{x}^2} + \frac{\partial^2 \bar{u}}{\partial \bar{y}^2} \right) + k \frac{\partial \bar{N}}{\partial \bar{y}} - \sigma B_0^2 \bar{u} - \frac{\mu_0}{K^*} \bar{u} \quad (2)$$

$$\rho \left(\frac{\partial \bar{v}}{\partial \bar{t}} + \bar{u} \frac{\partial \bar{v}}{\partial \bar{x}} + \bar{v} \frac{\partial \bar{v}}{\partial \bar{y}} \right) = -\frac{\partial \bar{p}}{\partial \bar{y}} + (\mu + k) \left(\frac{\partial^2 \bar{v}}{\partial \bar{x}^2} + \frac{\partial^2 \bar{v}}{\partial \bar{y}^2} \right) + k \frac{\partial \bar{N}}{\partial \bar{x}} - \sigma B_0^2 \bar{v} - \frac{\mu_0}{K^*} \bar{v}$$

Momentum Angular Equation

$$\rho j \left(\frac{\partial \bar{N}}{\partial \bar{t}} + \bar{u} \frac{\partial \bar{N}}{\partial \bar{x}} + \bar{v} \frac{\partial \bar{N}}{\partial \bar{y}} \right) = \gamma \left(\frac{\partial^2 \bar{N}}{\partial \bar{x}^2} + \frac{\partial^2 \bar{N}}{\partial \bar{y}^2} \right) - k(2\bar{N} + \frac{\partial \bar{u}}{\partial \bar{y}} - \frac{\partial \bar{v}}{\partial \bar{x}}) \quad (3)$$

In this problem the dimensionless variables are given as

$$x = \frac{\bar{x}}{a}, y = Re^{1/2} \frac{\bar{y}}{a}, u = \frac{\bar{u}}{U_\infty}, t = \frac{U_\infty \bar{t}}{a}, r(x) = \frac{\bar{r}(\bar{x})}{a}, v = Re^{1/2} \frac{\bar{v}}{U_\infty}, p = \frac{\bar{p}}{\rho U_\infty^2} \quad (4)$$

where Reynold Number $Re = \frac{U_\infty a}{\nu}$. Substitution (4) into (1-3) leads to the following non-dimensional equations

$$\frac{\partial(ru)}{\partial x} + \frac{\partial(rv)}{\partial y} = 0 \quad (5)$$

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} = -\frac{\partial p}{\partial x} + \frac{(1+K)}{Re} \frac{\partial^2 u}{\partial x^2} + (1+K) \frac{\partial^2 u}{\partial y^2} + K \frac{\partial N}{\partial y} - (M + \phi)u \quad (6)$$

$$\frac{1}{Re} \left(\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} \right) = -\frac{\partial p}{\partial y} + \frac{(1+K)}{Re^2} \frac{\partial^2 v}{\partial x^2} + \frac{(1+K)}{Re} \frac{\partial^2 v}{\partial y^2} - \frac{K}{Re} \frac{\partial N}{\partial x} - \frac{(M + \phi)}{Re} v$$

$$\frac{\partial N}{\partial t} + u \frac{\partial N}{\partial x} + v \frac{\partial N}{\partial y} = \left(1 + \frac{K}{2} \right) \left(\frac{1}{Re} \frac{\partial^2 N}{\partial x^2} + \frac{\partial^2 N}{\partial y^2} \right) - K \left(2N + \frac{\partial u}{\partial y} - \frac{1}{Re} \frac{\partial v}{\partial x} \right) \quad (7)$$

where micropolar K , magnetic M and microrotation field N are dimensionless parameter.

In order to solve (5-7) using the same procedure of boundary layer approximation and the stream function, the following variables are assumed

$$\psi = xf(x, y), \quad \theta = \theta(x, y) \quad (8)$$

where stream function ψ defined as

$$u = \frac{\partial \psi}{\partial y}, \quad v = -\frac{\partial \psi}{\partial x}. \quad (9)$$

By substituting (8-9) into (5-7), we obtain :

$$(1 + K) \frac{\partial^3 f}{\partial \eta^3} + \frac{\eta}{2} \frac{\partial^2 f}{\partial \eta^2} + \frac{3}{2} \lambda t \left[1 - \left(\frac{\partial f}{\partial \eta} \right)^2 + f \frac{\partial^2 f}{\partial \eta^2} \right] + K \frac{\partial h}{\partial \eta} + (M + \phi) t \left(1 - \frac{\partial f}{\partial \eta} \right) = t \frac{\partial^2 f}{\partial \lambda \partial t} \quad (10)$$

$$\left(1 + \frac{K}{2} \right) \frac{\partial^2 h}{\partial \eta^2} + \frac{\eta}{2} \frac{\partial h}{\partial \eta} + \frac{1}{2} h + \frac{3}{2} \lambda t \left(f \frac{\partial h}{\partial \eta} - h \frac{\partial f}{\partial \eta} \right) = t \frac{\partial h}{\partial t} + tK \left(2h + \frac{\partial^2 h}{\partial \eta^2} \right) \quad (11)$$

with respect to the following Boundary Conditions

$$\begin{aligned} t < 0 : f = \frac{\partial f}{\partial \eta} = h = 0 \text{ at } x, \eta \\ t \geq 0 : f = \frac{\partial f}{\partial \eta} = 0, \quad h = -n \frac{\partial^2 f}{\partial \eta^2} \text{ at } \eta = 0 \\ \frac{\partial f}{\partial \eta} = 1, \quad h = 0 \text{ at } \eta \rightarrow \infty \end{aligned} \quad (12)$$

At the lower stagnation point of the solid sphere, $x \approx 0$, Equation (12-14) are reduced to the following ordinary differential equation :

$$(1 + K) f''' + \frac{\eta}{2} f'' + \frac{3}{2} \lambda t [1 - (f')^2 + f f''] + K h' + (M + \phi) t (1 - f') = t \frac{\partial f'}{\partial t} \quad (13)$$

and,

$$\left(1 + \frac{K}{2} \right) h'' + \frac{\eta}{2} h' + \frac{h}{2} + \frac{3}{2} \lambda t [f h' - h f'] = t \frac{\partial h}{\partial t} + tK (2h + f'') \quad (14)$$

3. RESULTS AND DISCUSSION

The system of equation (13) and (14) are solved numerically for some values of the micropolar parameter (K) and magnetic parameter (M) using Keller-box method [8,9]. The variation on velocity and microrotation profile at front stagnation point ($x = 0^0$) with various value of magnetic parameter are illustrated in Fig. 2(a) and Fig. 2(b) respectively. These numerical results have been made at fixed values of micropolar $K = 1$. The results show that velocity profiles in Fig. 2(a) increase when the magnetic parameters increase, there is no values of velocity in negative. The microrotation profile of boundary layer flow in the MHD micropolar fluid of $n = 0$ at $x = 0^0$ and when $K = 1$. Increasing M leads to higher microrotation $-h$ under the influence of MHD at the region near the surface of a porous sphere but as $\eta > 0.5$, $-h$ is decreased under the effect of MHD.

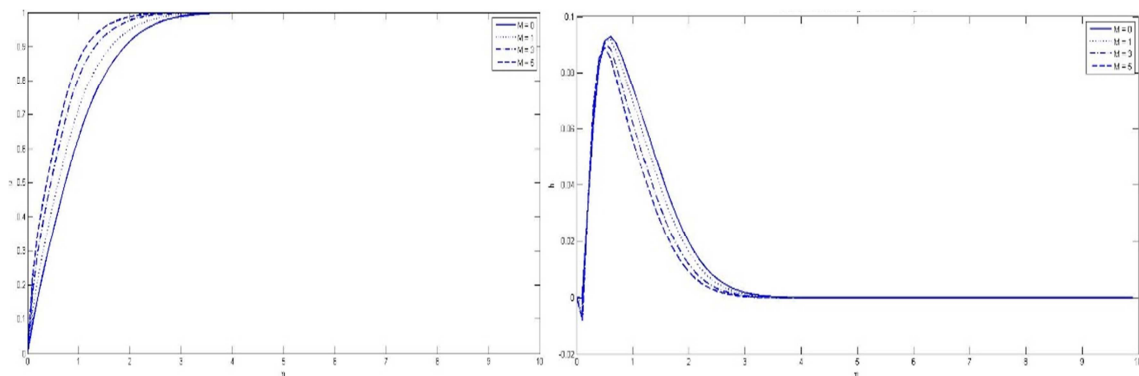


Figure 2.(a) Velocity profile for various M at lower stagnation point ($x = 0^0$), $K = 1$, $\phi = 1$, and $n = 0$
(b) Microrotation profile for various M at lower stagnation point ($x = 0^0$), $K = 1$, $\phi = 1$, and $n = 0$

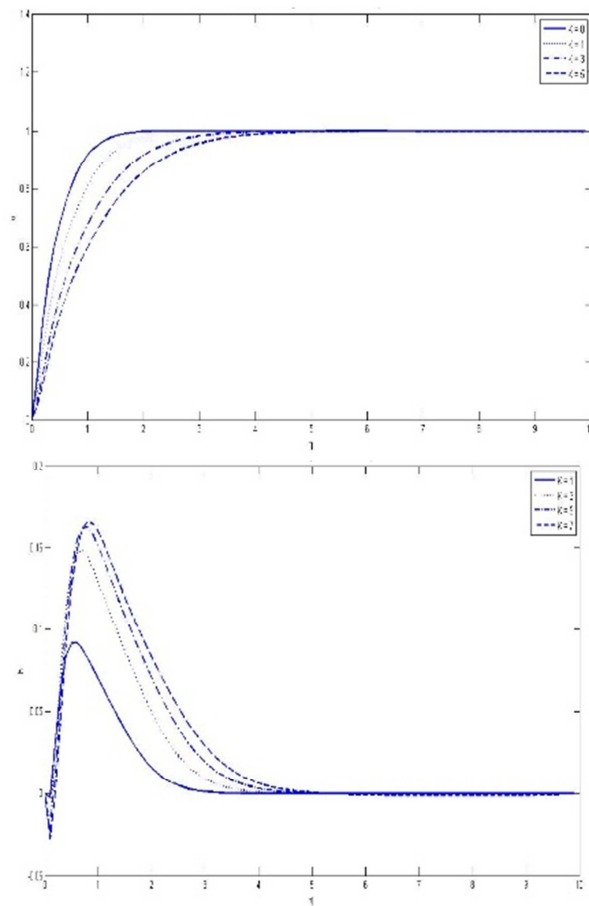


Figure 3(a) Velocity profile for various K at lower stagnation point ($x = 0^0$), $M = 1$, $\phi = 1$, and $n = 0$
(b) Microrotation profile for various K at lower stagnation point ($x = 0^0$), $M = 1$, $\phi = 1$, and $n = 0$

Figure 3(a) shows the velocity profile of the boundary layer flow in the magnetohydrodynamic micropolar fluid at various K when $n = 0$ and $M = 1$. It is noticed that u a micropolar fluid is decreasing with increasing K . The microrotation profile of boundary layer flow in the magnetohydrodynamic micropolar fluid of $n = 0$ at $x = 0^0$ and when $M = 1$. Increasing K leads to higher microrotation $-\omega$ under the influence of micropolar parameter at the region near the surface of a porous sphere but as $\eta > 0.5$, $-\omega$ is increased under the effect of micropolar parameter.

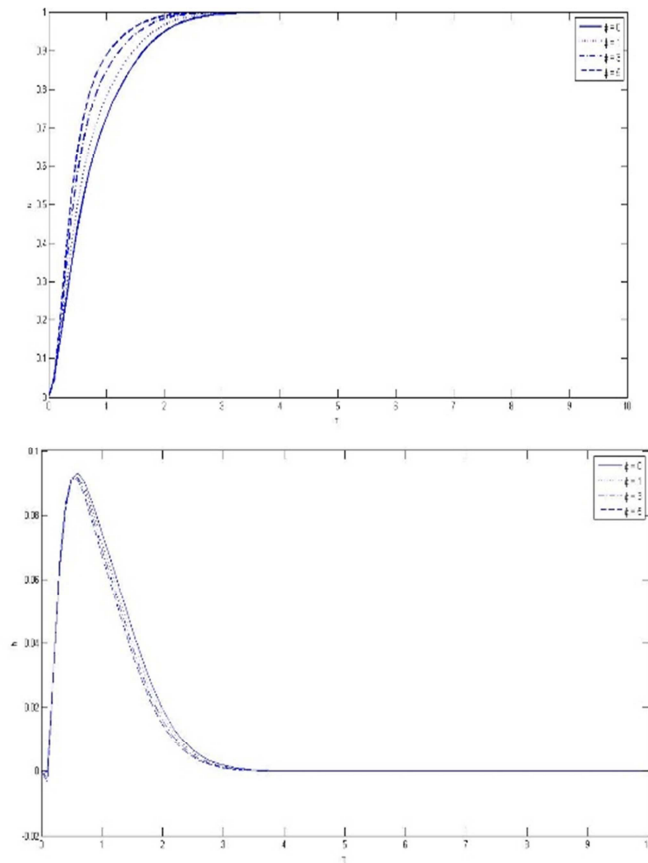


Figure 4(a) Velocity profile for various ϕ at lower stagnation point ($x = 0^0$), $M = 1$, $K = 1$, and $n = 0$
(b) Microrotation profile for various ϕ at lower stagnation point ($x = 0^0$), $M = 1$, $K = 1$, and $n = 0$

The variation on velocity and microrotation profile at front stagnation point ($x = 0^0$) with various value of porosity parameter are illustrated in Fig. 4(a) and Fig. 4(b) respectively. These numerical result have been made at fixed values of micropolar $K = 1$. The results show that velocity profiles in Fig. 4(a) increase when the porosity parameters increase, there is no values of velocity in negative. The microrotation profile of boundary layer flow in the MHD micropolar fluid of $n = 0$ at $x = 0^0$ and when $K = 1$. Increasing ϕ leads to higher microrotation $-h$ under the influence of porous at the region near the surface of a porous sphere but as $\eta > 0.5$, $-h$ is decreased under the effect of porous.

4. CONCLUSION

This paper considers the boundary layer flow in the MHD microfluid past a solid sphere. From the analysis and discussion of the result, the following conclusions are:

1. The governing equations are developed from continuity, momentum, and momentum angular. Furthermore, those equations are transformed into boundary layer equations and transformed into a non-dimensional form. The resulting nonlinear system of partial differential equations are solved numerically using the Keller-Box method.
2. This research has revealed how the microrotation, magnetic and porosity parameter affect the velocity flow and microrotation characteristics. The velocity distributions increase and the microrotation decreases when the value of magnetic parameter and porous parameter increase. The velocity decreases and the microrotation increase when micropolar parameter increase.

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