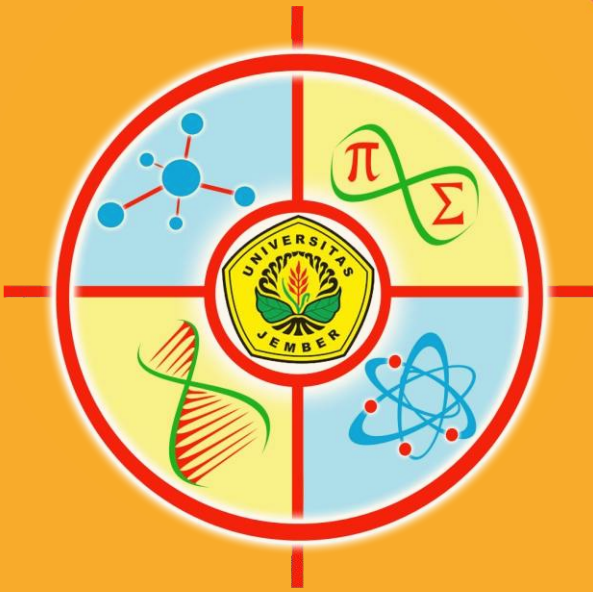


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PROCEEDINGS

The 1st International Basic Science Conference 2016
TOWARDS THE EXTENDED USE OF BASIC SCIENCE
FOR ENHANCING HEALTH, ENVIRONMENT,
ENERGY, AND BIOTECHNOLOGY

University of Jember, September 26 - 27, 2016



The 1st International Basic Science Conference 2016

(The 1st IBSC 2016)

“Towards the extended use of basic science for enhancing health, environment, energy and biotechnology”

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Preface

A Conference on the extended use of Basic Science was hosted by the Faculty of Mathematics and Natural Science (FMIPA), at CDAST building, Universitas Jember in 26-27th day of September 2016. This conference is intended to promote further developments of basic science for their tangible applications, especially health, environment, energy and biotechnology.

The conference posed the question “what biological, chemical, physical, geological, mathematical, statistical, medical, agricultural and other basic science field changes must be made in order to ensure better live quality in term of health, environment, energy and biotechnology. FMIPA was fortunate to welcome researchers, educators and engineers from various backgrounds representing a variety ways to extend the application of basic science in which safety, environmental friendly and energy efficiency were being pursued. More than two hundred contributors from fifty five different institutions presented the theory, methodology and application of the field and thus the 1st IBSC 2016 was very rich as the proceeding in this volume.

The major theme that emerged from the conference which was conducted by Faculty of Mathematics and Natural Science, Universitas Jember, and The Ministry of Technology and Higher Education (KEMENRISTEKDIKTI), Republic of Indonesia, was that basic science must extend in very fundamental way if high live quality is to become a stable standard of health, environment, energy and biotechnology. Ramkrishna Ramaswamy in his very inspiring talk, present the complexity and simplicity in biological systems; while Agus Salim discussed the big data of biostatistics with stressing on the quantity does not equal quality; Manabu Abe report the design and synthesis of a new Cromophore, and Bambang Sugiharto address the regularisation of sucrose-phosphate synthesis from sugarcane, and many more expert discuss the application of basic science for improving live quality.

Having introduced the 1st IBSC 2016, we will introduce the 2nd Conference of basic science (The 2nd IBSC) in near future. This collaboration and link will be maintain. Hand in hand researcher, expert, educator and other professional in basic science is needed to improve live quality.

Jember January 26, 2017

Agung Tjahjo Nugroho

The Chairman of The 1st IBSC

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Table of Contents

PREFACE	III
TABLE OF CONTENTS	IV
BIOLOGY	1
COMMUNITY STRATEGY FOR MANAGING TROPICAL FOREST RESOURCES IN THE AREA OF CAGAR ALAM PULAU SEMPU (NATURE RESERVE OF SEMPU ISLAND)	2
BIOREDUCTION ADSORBENT (BIOSORBENT): RECOVERY TECHNOLOGY OF HEAVY METAL POLLUTION (CADMIUM/ Cd) IN POLLUTED LAPINDO WATER SOURCES USING BACTERIA AND DURIAN LEATHER	7
COMPARATIVE STUDY OF THE MANAGEMENT OF VANAME SHRIMP (<i>LITOPENAEUS VANNAMEI</i>) BASED ON DEMOGRAPHIC FACTORS AT MOLANG BEACH TULUNGAGUNG	10
ANALYSIS OF THE INFLUENCE OF PUBLIC PARTICIPATION IN THE MANAGEMENT OF RESOURCES SUSTAINABLE WATER MALANG DISTRICT	13
CONSERVATION <i>COCCINELLA</i> SP. AS PREDATOR OF GREEN PEACH APHID <i>MYZUS PERSICAE</i> SULZER ON POTATO INTERCROPPING	16
THE EFFECT OF MYCORRHIZAL INOCULANT AND COMPOST OF VOLCANIC ASH ON GROWTH AND YIELD OF CHILLI (<i>CAPSICUM ANNUM</i> L.)	19
THE POTENTIAL OF ARTHROPODE DIVERSITY FOR ECOTOURISM DEVELOPMENT IN WONOREJO MANGROVE ECOSYSTEM, SURABAYA	23
THE EFFECTS OF WATER FRACTION OF BITTER MELON (<i>MOMORDICA CHARANTIA</i>) LEAF EXTRACT IN MAMMARY GLAND DEVELOPMENT OF BALB/C MICE (<i>MUS MUSCULUS</i>) WITH HISTOLOGICAL AND MOLECULAR BIOLOGICAL ANALYSIS OF PROTEIN APPROACHES	27
COMPETITIVENESS AND POTENTIAL OF SHEEP LIVESTOCK AS SOURCE INCREASING INCOME AND PROVIDER OF MEAT ANIMAL IN NORTH SUMATRA	30
MORPHOLOGICAL AND PHYSIOLOGICAL CHARACTERS OF CASSAVA (<i>MANIHOT ESCULENTA CRANTZ</i>) WHICH WET TOLERANT	32
THE EFFECT OF SOY TEMPEH FLOUR EXTRACT ON VAGINA HISTOLOGICAL STRUCTURE OF SWISS WEBSTER OVARIECTOMIZED MICE (<i>MUS MUSCULUS</i>)	36
THE TOXICITY OF SEEDS EXTRACT OF <i>ANNONA SQUAMOSA</i> L., LEAVES EXTRACT OF <i>TERMINALIA CATAPPA</i> L. AND LEAVES EXTRACT OF <i>ACACIA NILOTICA</i> L. ON THE MORTALITY OF <i>Aedes aegypti</i> L. LARVAE	39
ELEPHANTOPUS SCABER AND SAUROPUS ANDROGYNUS REGULATE MACROPHAGES AND B LYMPHOCYTE CELLS DURING SALMONELLA TYPHI INFECTION	42
THE EFFORT TO INCREASE PRODUCTION OF SUPER RED DRAGON FRUIT (<i>HYLOCEREUS COSTARICENSIS</i>) BY ARTIFICIAL POLLINATION	45
EVALUATION OF ZONATION OF THE MANGROVE CONSERVATION AREAS IN PAMURBAYA	47
INPUT OF NUTRIENT (NITROGEN AND PHOSPHORUS) FROM THE CATCHMENT AREA INTO RAWAPENING LAKE OF CENTRAL JAVA	50
RELATIONSHIP BETWEEN WATER QUALITY AND ABUNDANCE OF CYANOPHYTA IN PENJALIN RESERVOIR	52
HEMATOLOGICAL CHARACTERISTIC OF THE FEMALE ASIAN VINE SNAKE (<i>AHAETULLA PRASINA</i> BOIE, 1827)	57
HIGHLY SPESIFIC <i>BACILLUS CEREUS</i> -PHAGES ISOLATED FROM HOSPITAL WASTEWATER IN BANYUMAS REGENCY	60
BIOSYNTHESIS SILVER NANOPARTICLE USING FRESH WATER ALGAE	65
EFFECT OF SAPONIN-PODS EXTRACT <i>ACACIA (ACACIA MANGIUM)</i> TO HEMATOCRIT, HEMOGLOBIN AT TILAPIA (<i>OREOCHROMIS NILOTICUS</i>)	67
EFFECT OF DISSOLVED NUTRIENT CONCENTRATION (NITRATE AND ORTHOPHOSPHATE) ON ABUNDANCE OF CHLOROPHYTA IN PENJALIN RESERVOIR BREBES REGENCY	70
THE ANATOMY OF CAROTENE BIOSYNTHESIS IN <i>BETA VULGARIS</i> L., VAR. <i>RUBRA</i> USING SCAN ELECTRON MICROSCOPE	74
OPTIMIZATION OF YOGURT FERMENTED MILK PRODUCTS WITH THE ADDITION OF NATURAL STABILIZER BASED ON LOCAL POTENTIAL OF TARO STARCH (<i>COLOCASIA ESCULENTA</i>)	77
PTERIDOPHYTES OF ALAS PURWO NATIONAL PARK AND THEIR MEDICINAL POTENCY	80
GENETIC VARIATION OF <i>Aedes aegypti</i> (DIPTERA : CULICIDAE) BASED ON DNA POLYMORPHISM	83
THE EFFECT OF SOY TEMPEH FLOUR EXTRACT TO UTERINE HISTOLOGY OF OVARIECTOMIZED MICE	85
MATING BEHAVIOUR OF <i>CROCIDOLOMIA PAVONANA</i> F.	88
AGRICULTURE	91
THE DEVELOPMENT OF SUSTAINABLE RESERVE FOOD GARDEN PROGRAM'S VIDEO IN MALANG CITY	92
EFFECT OF MEDIUM COMPOSITIONS ON THE GROWTH OF RICE (<i>ORYZA SATIVA</i> L. CV. CIHERANG) CALLUS	97
BLOOD FIGURE OF RAMBON CATTLE FED FORMULATED CONCENTRATE CONTAINING SOYBEAN CAKE, POLLARD AND CORN OIL COMBINE WITH UREA XYLANASE MOLASSES CANDY	101
STRATEGIES FOR DEVELOPMENT OF BEEF CATTLE FARMING BASED ON INNOVATION TECHNOLOGY AND FEEDING PROGRAM TO MEET SELF SUFFICIENCY IN MEAT	103

FOOD TECHNOLOGY	106
MODIFICATION OF BEAN SPROUT AND UREA MEDIA TO SPIRULINA PLATENSIS CULTURE.....	107
COLLAGEN FROM SEA CUCUMBER (STICHOPUS VARIEGATUS) AS AN ALTERNATIVE SOURCE OF HALAL COLLAGEN.....	111
DEVELOPMENT OF NEW PRODUCT “COCOA SPIRULINA AS FUNCTIONAL FOOD”	114
THE PROTEIN AND WATER CONTENT OF TEN VARIATIONS OF THE FEED CASSAPRO OF YEAST TAPE.....	120
MEDICAL, DENDTISTRY, AND PUBLIC HEALTH	123
EFFECT OF POMELO (CITRUS GRANDIS) ETHANOLIC EXTRACT ON ATHEROSCLEROTIC PLAQUE FORMATION.....	124
CLINICAL MANIFESTATION OF ORAL TUBERCULOSIS.....	127
IDENTIFICATION OF DERMATOPHYTES BY MULTIPLEX-POLYMERASE CHAIN REACTION, POLYMERASE CHAIN REACTION- RESTRICTION FRAGMENT LENGTH POLYMORPHISM ITS1-ITS4 PRIMERS AND MVAI, AND POLYMERASE CHAIN REACTION (GACA) ₄ PRIMER.....	132
IMPACT PSYCHOLOGICAL AND PSYCHO-PHYSICAL WORK DISTRESS ON TOOTH MOBILITY IN RAT MODEL	136
ROLE OF REACTIVE OXYGEN SPECIES ON DEVELOPMENTS OF OSTEOCLASTOGENESIS IN AGING	140
DETERMINANT FACTOR THAT INFLUENCED ANXIETY LEVEL AND ENERGY INTAKE AMONG ELDERLY.....	144
P-CARE BPJS ACCEPTANCE MODEL IN PRIMARY HEALTH CENTERS	147
THE EFFORT OF TB CADRE IN THE IMPROVING OF THE SUCCESS OF TB THERAPY AND REDUCING SIDE EFFECTS OF ANTI TUBERCULOSIS DRUGS	151
RISK FACTOR OF GREEN TOBACCO SICKNESS (GTS) AT THE CHILDREN ON TOBACCO PLANTATION	153
PHYSICS	157
DIRECT SCATTERING PROBLEM FOR MICROWAVE TOMOGRAPHY	158
MICROSTRUCTURE AND MECHANICAL PROPERTIES OF DISSIMILAR JOINT OF COLD ROLLED STEEL SHEETS 1.8 SPCC-SD AND NUT WELD M6 BY SPOT WELDING.....	162
FEATURE EXTRACTION OF HEART SIGNALS USING FAST FOURIER TRANSFORM.....	165
ANALYSIS OF EL NIÑO EVENT IN 2015 AND THE IMPACT TO THE INCREASE OF HOTSPOTS IN SUMATERA AND KALIMANTAN REGION OF INDONESIA.....	168
(b) 170	
SYNTHESIS OF ZINC OXIDE (ZNO) NANOPARTICLE BY MECHANO-CHEMICAL METHOD	174
MODELLING DYNAMICS OF ZNO PARTICLES IN THE SPRAY PYROLYSIS REACTOR TUBE	177
THE INFLUENCE OF EXTREMELY LOW FREQUENCY (ELF) MAGNETIC FIELD EXPOSURE ON THE PROCESS OF MAKING CREAM CHEESE.....	181
AU GRADE OF EPITHERMAL GOLD ORE AT PANINGKABAN ASGM, BANYUMAS DISTRICT, CENTRAL JAVA PROVINCE, INDONESIA.....	184
RENEWABLE ENERGY CONVERSION WITH HYBRID SOLAR CELL AND FUEL CELL	188
RADAR ABSORBING MATERIALS DOUBLE LAYER FROM LATERITE IRON ROCKS AND ACTIVATED CARBON OF CASSAVA PEEL IN X-BAND FREQUENCY RANGE	192
INSTANTANEOUS ANALYSIS ATTRIBUTE FOR RESERVOIR CHARACTERIZATION AT BASIN NOVA-SCOTIA, CANADA	195
DEPLOYMENT POROSITY ESTIMATION OF SANDSTONE RESERVOIR IN THE FIELD OF HIDROCARBON EXPLORATION PENOBSCOT CANADA.....	197
SEISMIC RESOLUTION ENHACEMENT WITH SPECTRAL DECOMPOSITION ATTRIBUTE AT EXPLORATION FIELD IN CANADA ...	199
SIMULATION OF I-V CHARACTERISTICS OF SI DIODE AT DIFFERENCE OPERATING TEMPERATURE:EFFECT OF IONIZED IMPURITY SCATTERING.....	204
SIMULATION OF SELF DIFFUSION OF IRON (FE) AND CHROMIUM (CR) IN LIQUID LEAD BY MOLECULAR DYNAMIC	207
THE STUDY OF ELECTRICAL CONDUCTANCE SPECTROSCOPY OF THE INNER MEMBRANE OF SALAK.....	209
THE ACCURACY COMPARISON OF OSCILLOSCOPE AND VOLTMETER UTILIZATED IN GETTING DIELECTRIC CONSTANT VALUES.....	211
WINDOW FILTER (WINTER) TO CAPTURE POLLUTION OF LEAD (PB) FOR HOUSES NEAR THE HIGHWAY TO PREVENT HEALTH PROBLEMS	214
SIMULATION OF SOLAR CELL DIODE I-V CHARACTERISTICS USING FINITE ELEMENT METHODE: INFLUENCE OF P-LAYER THICKNESS.....	216
GEOLOGY	218
GIS-BASED OPTIMIZATION METHOD FOR UTILIZING COAL REMAINING RESOURCES AND POST-MINING LAND USE PLANNING: A CASE STUDY OF PT ADARO COAL MINE IN SOUTH KALIMANTAN	219
QUANTIFICATION MODEL OF QUALITATIVE GEOLOGICAL DATA VARIABLES FOR EXPLORATION RISK ASSESSMENT IN PROSPECT CU-AU PORPHYRY DEPOSIT RANDU KUNING, WONOGIRI, CENTRAL JAVA.....	226
A SENSOR-BASED OF DETECTION TOOLS TO MITIGATE PEOPLE LIVE IN AREAS PRONE TO LANDSLIDE	232
RELOCATION OF HYPOCENTER USING JACOBIAN’S MATRIX AND JEFFREYS-BULLEN’S VELOCITY MODEL	237
CHEMISTRY	239
SYNTHESIS AND CHARACTERIZATION MAGNETIC FE ₃ O ₄ NANOPARTICLE BY USING OLEIC ACID AS STABILIZING AGENT	240
SYNTHESIS OF ZEOLITES FROM LOMBOK PUMICE AS SILICA SOURCE FOR ION EXCHANGER.....	244

PREPARATION OF NANOBIOCATALYST MICROREACTOR USING IMMOBILIZED ENZYME ONTO NANOPOROUS MONOLITHIC POLYMER FOR HIGH SPEED PROTEIN DIGESTION	248
ANALYSIS OF PROTEIN PROFILE OF NEEM LEAVES JUICE (<i>AZADIRACHTA INDICA L. JUSS</i>).....	253
HYDROPHOBIC AEROGEL-BASED FILM COATING ON GLASS BY USING MICROWAVE	256
PREPARATION AND CHARACTERIZATION OF CACAO WASTE AS CACAO VINEGAR AND CHARCOAL	259
THE EFFECT OF PHYSICO-CHEMICAL PROPERTIES OF AQUATIC SEDIMENT TO THE DISTRIBUTION OF GEOCHEMICAL FRACTIONS OF HEAVY METALS IN THE SEDIMENT.....	262
INCREASED CONCENTRATION OF BIOETHANOL BY RECTIFICATION DISTILLATION SIEVE TRAY TYPE	266
DETERMINATION OF LEAD IN COSMETIC SAMPELS USING COATED WIRE LEAD (II) ION SELECTIVE ELECTRODE BASED ON PHYROPILLITE.....	270
PYROLYSIS TEMPERATURE EFFECT ON VOLUME AND CHEMICAL COMPOSITION OF LIQUID VOLATILE MATTER OF DURIAN SHELL	273
HIGH PERFORMANCE LIQUID CHROMATOGRAPHY OF AMINO ACIDS USING POTENTIOMETRIC DETECTOR WITH A TUNGSTEN OXIDE ELECTRODE	276
RAINWATER TREATMENT USING TREATED NATURAL ZEOLITE AND ACTIVATED CARBON FILTER.....	279
FILTRATION OF PROTEIN IN TEMPE WASTEWATER USING CELLULOSE ACETATE MEMBRANE.....	282
MATHEMATICS.....	285
IMAGE ENCRYPTION TECHNIQUE BASED ON PIXEL EXCHANGE AND XOR OPERATION.....	286
FUZZY ANP METHOD AND INTERNAL BUSINESS PERSPECTIVE FOR PERFORMANCE MEASUREMENT IN DETERMINING STRATEGY SMES.....	289
APPLICATION OF FUZZY TOPSIS METHOD IN SCHOLARSHIP INTERVIEW	295
THE EFFECT OF INFLATION, INTEREST RATE, AND INDONESIA COMPOSITE INDEX (ICI) TO THE PERFORMANCES OF MUTUAL FUND RETURN AND UNIT LINK WITH PANEL DATA REGRESSION MODELLING	299
USING LOGISTIC REGRESSION TO ESTIMATE THE INFLUENCE OF ADOLESCENT SEXUAL BEHAVIOR FACTORS ON STUDENTS OF SENIOR HIGH SCHOOL 1 SANGATTA, EAST KUTAI-EAST KALIMANTAN	303
APPLICATION CLUSTER ANALYSIS ON TIME SERIES MODELLING WITH SPATIAL CORRELATIONS FOR RAINFALL DATA IN JEMBER REGENCY	307
A ZERO CROSSING-VIRUS EVOLUTIONARY GENETIC ALGORITHM (VEGA) TO SOLVE NONLINEAR EQUATIONS.....	311
ANALYSIS OF SIMULTANEOUS EQUATION MODEL (SEM) ON NON NORMALLY RESPONSE USED THE METHOD OF REDUCE RANK VECTOR GENERALIZED LINEAR MODELS (RR-VGLM).....	316
THE RAINBOW (1,2)-CONNECTION NUMBER OF EXPONENTIAL GRAPH AND IT'S LOWER BOUND	319
CONSTRUCTION OF SUPER H-ANTIMAGICNESS OF GRAPH BY USES A PARTITION TECHNIQUE WITH CANCELATION NUMBER ON THE TOTAL R-DYNAMIC COLORING OF EDGE COMB PRODUCT GRAPH G D H.....	325
ON THE METRIC DIMENSION WITH NON-ISOLATED RESOLVING NUMBER OF SOME EXPONENTIAL GRAPH.....	328
ON TOTAL R-DYNAMIC COLORING OF SEVERAL CLASSES OF GRAPHS AND THEIR RELATED OPERATIONS	331
ON THE RAINBOW VERTEX CONNECTION NUMBER OF EDGE COMB OF SOME GRAPH.....	340
HANDLING OUTLIER IN THE TWO WAYS TABLE BY USING ROBUST AMMI AND ROBUST FACTOR.....	347
AN EPIDEMIC MODEL OF <i>VARICELLA</i> WITH VACCINATION	351
BASIC SCIENCE.....	356
THE CORRELATION BETWEEN PERCEPTION AND BEHAVIOR OF RIVER POLLUTION BY COMMUNITIES AROUND BRANTAS RIVERBANK IN MALANG.....	357
ISOLATION AND SCREENING OF SPECIFIC METHICILLIN RESISTANT- <i>STAPHYLOCOCCUS AUREUS</i> BACTERIOPHAGE FROM HOSIPTAL WASTE AT BANYUMAS.....	360
CO (III) AS MEDIATOR IN PHENOL DESTRUCTION USING ELECTROCHEMICAL OXIDATION	365
DESIGN OF SYSTEM BATCH INJECTION ANALYSIS (BIA) FOR MONITORING THE PRODUCTION OF ALCOHOL (II)	370
PRELIMINARY STUDY GOLD MINERALIZATION HOSTED BY METAMORPHIC ROCKS IN THE SOUTHEASTERN ARM OF SULAWESI, INDONESIA.....	375
EFFECTS OF PACKAGING TYPES ON MOISTURE CONTENT, MICROBE TOTAL AND PEROXIDE VALUE OF INSTANT GANYONG (<i>CANNA EDULIS</i> KERR) YELLOW RICE	379
AUTHOR INDEX.....	384

The Accuracy Comparison of Oscilloscope and Voltmeter Utilized in Getting Dielectric Constant Values

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Abstract— Parallel plate capacitor is widely used as a sensor for many purposes. Researches which have used parallel plate capacitor were investigation of dielectric properties of soil in various temperature [1], characterization of cement's dielectric [2], and measuring the dielectric constant of material in various thickness [3]. In the investigation the changing of dielectric constant, indirect method can be applied to get the dielectric constant number by measuring the voltage of input and output of the utilized circuit [4]. Oscilloscope is able to measure the voltage value although the common tool for that measurement is voltmeter. This research aims to investigate the accuracy of voltage measurement by using oscilloscope and voltmeter which leads to the accuracy of values of dielectric constant. The experiment is carried out by an electric circuit consisting of ceramic capacitor and sensor of parallel plate capacitor, function generator as a current source, oscilloscope, and voltmeters. Sensor of parallel plate capacitor is filled up with cooking oil in various concentrations, and the output voltage of the circuit is measured by using oscilloscope and also voltmeter as well. The resulted voltage values are then applied to the equation to get dielectric constant values. Finally the plot is made for dielectric constant values along the changing of cooking oil concentration. The results show that the plot of dielectric constant values which are gained from the voltage measurement using voltmeter have better linearity compare to the other plot in which the voltage measurement utilize the oscilloscope. In conclusion, voltmeter is considered better equipment to measure a voltage compare to the oscilloscope in term of getting dielectric constant values of parallel plate capacitance sensor.

Keywords— Oscilloscope, voltmeter, accuracy, dielectric constant

INTRODUCTION

Parallel plate capacitor is one of capacitors which compose of two conductor plates separated in d and normally, in the space is put an isolator medium called dielectric. The common dielectric materials used in the capacitor are air, paper, ceramic, or electrolyte liquid [1, 5]. In the alternating current (AC) circuits, the parallel plate capacitor which act as capacitive sensor is put in series with the fix capacitor [6]. The capacitance value of capacitive sensor is affected not only by the dimensions of the sensor (plate distance, area of plate) but also by dielectric material in between those two plates [5].

Capacitance of capacitor represents the ability to save the electric charge. The kind of dielectric materials affects significantly to the capacitance values. Every material has own electric characteristics and the magnitude depend on the internal condition of the material such as moment dipole and its compositions. Compositions and volumes of the dielectric are also have impact to the capacitance values.

Measuring capacitance value can be performed directly by using capacitance meter or indirectly by measuring the output voltage of the capacitance. This indirect method has been done by [6] and the relationship between output voltage and the capacitance value has also been published by [4].

The usual equipment which is used to measure voltage is voltmeter. However, the oscilloscope is also has ability to do that task. The voltage values can be read on the oscilloscope's screen by counting the signal amplitudes and then multiply by volt per div which is show in the oscilloscope channel.

The accuracy of voltage measurement is important in getting the capacitance values gained by indirect measurement. The inaccurate results lead to the error values of capacitance. Further, the dielectric constant values will follow the error and give incorrect information.

Based on the descriptions above, we interest to investigate the difference of dielectric constant values that are got by measuring the voltage using voltmeter and oscilloscope. This research will recommend the better meter of voltage measurement to get the dielectric constant values. In this case we compare the oscilloscope and voltmeter. From this research, it can later be used as a reference to recommend a better measuring tool in the measurement of dielectric materials.

REVIEW OF LITERATURE

Dielectric is an isolator material which cannot transfer electric charges or electrons cannot flow through the material. The examples of dielectric materials are mica, papers, water, oil, air, etc. Dielectric materials are commonly used in between two conductor plate in capacitor [7].

Construction of parallel plate capacitor is very simple. It constructs of two conductor plates which place parallel with dielectric material in between. Figure 1 show the diagram of that parallel plate capacitor.

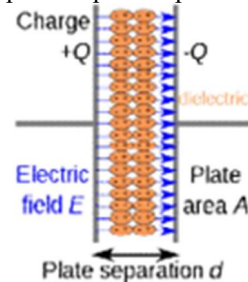


Figure 1. Parallel Plate Capacitor

If a parallel-plate capacitor with a cross-sectional area (A) separated by a dielectric at a distance (d), and the plate rated voltage (V), then there will be an electric field (E) working in the dielectric. Due to the electric field, the charge contained in the dielectric will be polarized [8].

Capacitance sensor circuit consisting of parallel capacitor plates are arranged in series with the capacitor components as shown in the Figure 2 below.

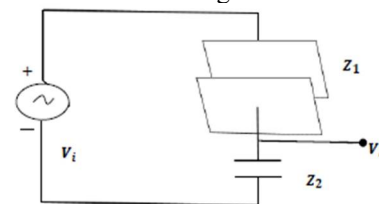


Figure 2. The circuit of capacitance sensor

Figure 2 shows the trajectory of a voltage divider with V_i is the input voltage and V_o is a voltage signal sensor, Z_1 and Z_2 are the impedances of dielectric materials. So we get the equation for the circuit above, namely:

$$\frac{V_o}{V_i} = \frac{Z_2}{Z_1 + Z_2} \quad (1)$$

If a capacitor is connected to an oscilloscope and voltmeter as a voltage meter, it will produce a voltage output signal form, so that the capacitance-voltage is calculated following the equation (2) below.

$$C_1 = \frac{C_2}{\left(\frac{V_i}{V_0} - 1\right)} \quad (2)$$

Capacitors are initially has a capacitance of C_0 (before given dielectric material), then after being added the dielectric material the value of capacitance becomes:

$$\kappa = \frac{C}{C_0} \quad (3)$$

or,

$$C = \kappa \frac{\epsilon_0 A}{d} \quad (4)$$

METHODS

a. Equipments and Materials

The equipment used in this study are oscilloscope and voltmeter as a voltage meter, capacitance meter, capacitors, project board, function generator, digital scales, measuring cups and connecting cables. Materials used in this research are bulk cooking oil, refined (bottled) cooking oil and margarine.

b. Collecting Data

Data collection was done with filled containers with samples (bulk cooking oil, refined cooking oil, margarine and oil mixture to the margarine. Mixing is done with the volume of oil remains (50ml) by adding margarine as much as 1g - 15g with intervals of addition 1g each. Data is collected in three repetitions at room temperature (29°C). All data collection was done in the same way, using a frequency of 200 kHz. So we get the value of the input voltage and output voltage values.

c. Preparation of Assessment Tools

Preparation of research equipments arrange to get the best possible results, in which two conductive plates placed side by side but not touching each other, and among them there are measuring samples as dielectrics. Each plate is connected to the output and input of voltage meter (voltmeter and oscilloscope) and also connected to the function generator. Further the read voltage values were applied to the equation to get the capacitance value of a material that can later be used to determine the value of the dielectric constant of each tested sample.

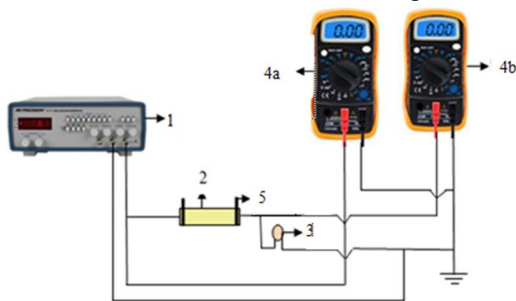


Figure 3. Measurement circuit using a voltmeter

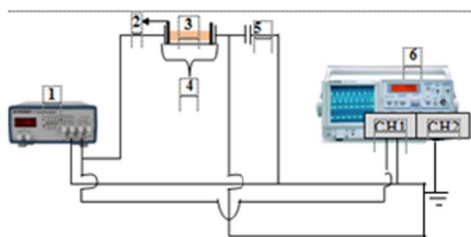


Figure 4. Measurement circuit using an oscilloscope

d. Data Analysis

Measurement data in the form of input voltage value and output voltage value are inputted to the equation (2) to gain the capacitance value of a material. By inserting a fix capacitance value in equation (3) it is known the value of the dielectric constant of the material. Data retrieval is

performed three times, so do the average value of the dielectric constant. So we get the value of the dielectric constant with the accuracy of the tool using the equation:

$$\kappa = (\bar{\kappa} \pm \Delta\kappa) \quad (5)$$

Furthermore, the addition of margarine mass is plotted as the x-axis and the value of the dielectric constant is plotted as the y-axis. So it can be seen the graph of the relationship between the two variables. To determine whether there is a relationship between the mass of margarine addition to the value of the dielectric constant, then the linearity is tested by using SPSS. Furthermore, the measured results obtained from the oscilloscope are compared to the results measured by a voltmeter.

RESULTS AND DISCUSSION

Measurements were conducted by the full filling containers sized of 10cm x 3cm x 2,3cm. The frequency used is 2200 kHz, either when using a measuring instrument voltmeter or oscilloscope.

The first measurement was done on bottled palm cooking oil. With the same treatment, the dielectric value obtained by oscilloscope is 3.409, while the dielectric value gotten by using voltmeter is 3.113. Furthermore, the value of the dielectric constant of packaging cooking oil generated by using an oscilloscope is 7.066, but the one by using a voltmeter is 10.370. In addition, the dielectric value of margarine is 14.466 and 15.184 which are obtained by oscilloscope and voltmeter respectively.

Measurement is then performed on each additional mass of margarine for every resulted data. The results of each measurement instruments are shown in the graph of Figure 5 and Figure 6 below:

Dielectric constant value of any additions to the mass of margarine by using a voltmeter

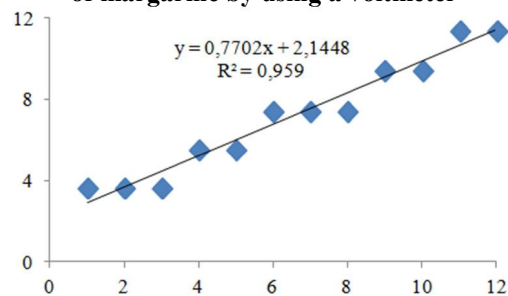


Figure 5. Graph of the relationship between the addition of margarine masses against the value of the dielectric constant of palm cooking oil packaging

Dielectric constant value of any additions to the mass of margarine by using an oscilloscope

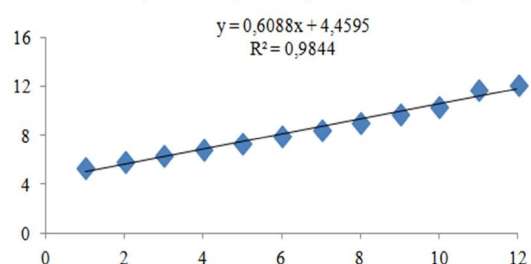


Figure 6. Graph the relationship between the addition of margarine masses against the value of the dielectric constant of palm cooking oil packaging

Figure 5 shows the relationship of dielectric constant value with the addition of masses of margarine. The data on the graph shows the addition of 1g - 12g to 1g every span the addition, the resulting value of the dielectric constant increase. Also there is a very strong correlation between increased in mass margarin the dielectric constant value, the linearity resulting equation is equal to 0.991 or 99.1% value of the dielectric constant of palm cooking oil packing masses influenced by the addition of margarine.

The image above shows the relationship between the value of the constant dielectric against margarine increased in mass by using an oscilloscope. From the data obtained, the resulting changes in the dielectric constant increase in value at the time of the mass penambahan margarine. However, these changes did not occur on any additions, changes in the value of the dielectric konstanta each additional 2g - 3g. In contrast with the results obtained in measurements using a voltmeter, linearity obtained from the graph by using an oscilloscope is 0,959, it does show that linearity relationship between the independent variable on the dependent variable is 9.959% of the equation linear line as shown in Figure 4. From these data, the correlation value of the oscilloscope is smaller than the voltmeter. The correlation of the independent variables on the dependent variable is declared strong when getting close to 1 [9].

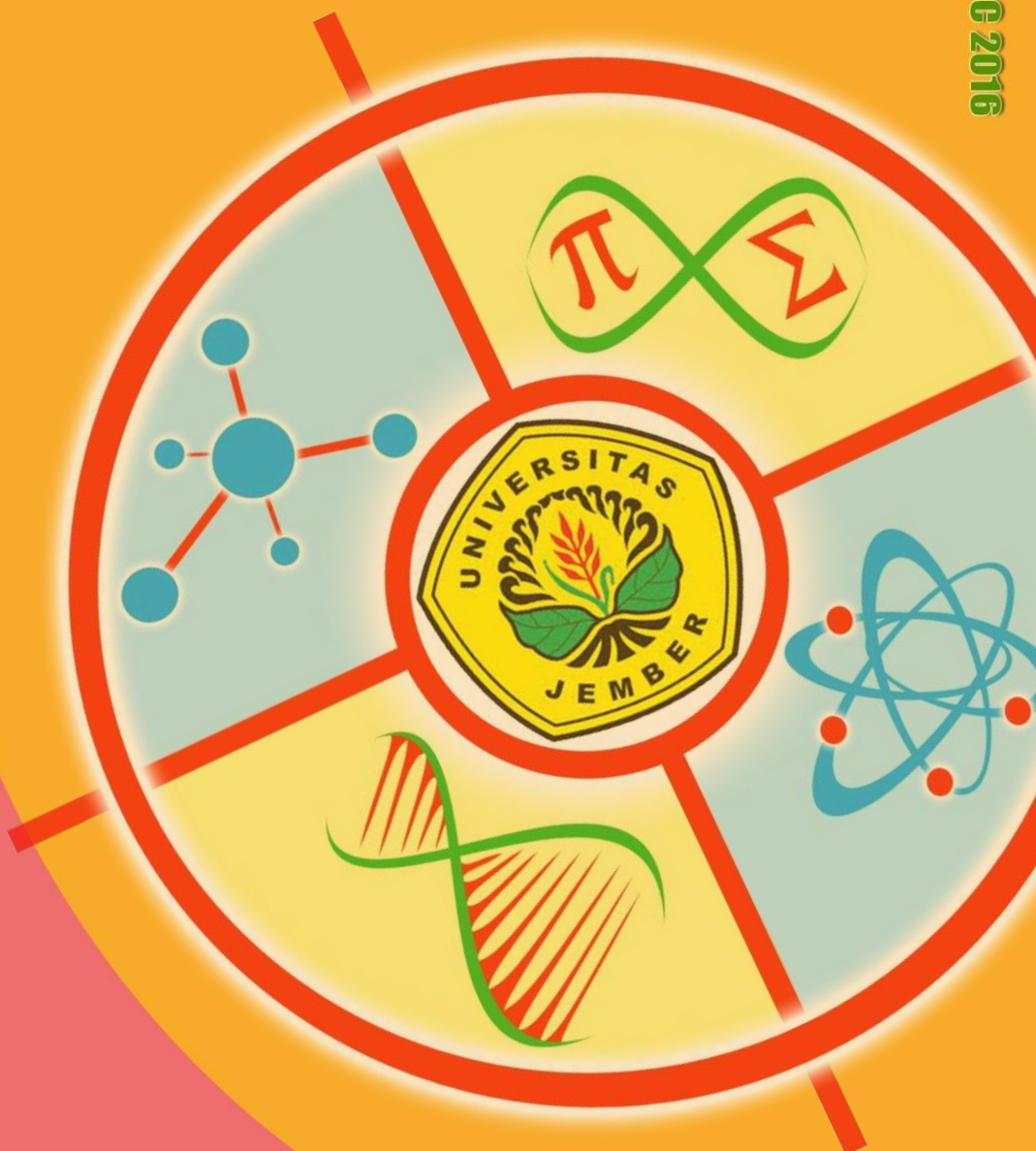
CONCLUSION

Oscilloscope and voltmeter measuring devices can be used to determine the characteristics of a material by using a capacitive method. The greater the correlation value is obtained, the stronger the influence of independent variables on the dependent variable, and the greater the linearity of the resulting graphs. Then it shows the accuracy of the used tool and we can see which one is better. In this study, we can state that the measuring instrument voltmeter has a higher accuracy compared to oscilloscope. So it is advisable for readers and future research to use voltmeter as a gauge in measuring electrical properties of a material using a capacitive method.

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