Lamp control using the principles of mathematical logic

E Yudianto¹,*, F F Firmansyah¹, P S B S Akbar², R Nisyak¹, F A Maudi¹ and A N Saputri¹

¹ Department of Mathematics Education, University of Jember, Indonesia
² Department Electrical Engineering, University of Jember, Indonesia

*Corresponding author: erfanyudi@unej.ac.id

Abstract Along with the rapid development of technology, there are so many innovations on tools that can facilitate human’s work, one of which is a remote lamp controller. This light controller can provide convenience and comfort for people in turning on or off lights, especially they are traveling. The way remote light controller is used applies the principle of mathematical logic, particularly biimplication. The principle of mathematical logic (biimplication) on this light controller is applied to GSM module (gprs) and SMS.

1. Introduction
In daily life we are often unaware that Mathematics are not only applied at schools. Almost all societies apply Mathematics, such as the application of the mathematical logic used in controlling electrical appliances. The process of controlling information, information systems, information storage, and austerity operates in the symbolic language of mathematical logic [1]. Mathematical logic makes its contributions from other fields such as the introduction of new logic [2–4].

The principle of mathematical logic on the control of electrical appliances (lamps) is an important thing at home. This is because the current human life cannot be separated from a variety of electrical equipments is increasingly sophisticated and automated. Various tools used by human in daily life serve various purposes, such as lighting, kitchen utensils, and the security system automated.

However, there are some problems arising from the use of electrical equipment commonly encountered, one of which is the wastage of electricity when one forgets to turn off electrical equipment at home, leading to the wastage of energy and costs to be incurred [5].

Understanding energy savings as a practical measure is not developed yet in community and is still scarcely disseminating information on energy-saving techniques. The control of an electronic or electrical component (lamp) becomes very important. This requires the awareness of the community to save energy [6].

In addition to the right way to save energy, we make an electrical controller (lamp) using the principle of mathematical logic, which can facilitate the community in use. The problem of logic in electrical control (lamp) is applied in the circuit, which is in Global System for Mobile Communication (GSM) and HP (mobile phone) using SMS facility, also on motion sensor (PIR), camera and alarm, using AC voltage facility.

2. Methods
SMS (Short Message Service) is a facility owned by GSM network that allows subscribers to send and receive short messages of 160 characters. SMS is handled by the network through a service center that serves to store and forward messages from the sender to the recipient. The SMS format used by the MS (mobile station) manufacturer is the Protocol Description Unit (PDU). The PDU format changes the
septet of ASCII code (7 bits) into a PDU byte (8 bits) byte when transmitted, and it will be converted back into ASCII code upon received SMS [5,7].

Lamp is a tool that provides lighting, both inside the house and outside [8,9]. Lights have different shapes and functions, by type and place. Especially for home lighting, lamps are needed and adapted to the layout.

Logic comes from the Greek word "logos" which means word, speech, or reason. Logic is a method or technique created to examine the accuracy of reasoning and examine the principles of logical reasoning and reasoning valid conclusions. Mathematical logic is a branch of Mathematics that is a combination of the science of logic and the science of Mathematics.

3. Result and Discussion
Mathematical logic is a translation of symbolic logic on what can be interpreted as a way of thinking or mathematical thinking. Mathematical logic provides a foundation on how to draw conclusions. The thing gained by studying mathematical logic is the ability to take and determined which conclusions are right or wrong. The science of mathematical logic includes statements, negations, disjunctions, conjunctions, implications, biographies, tautologies, contradictions, two equivalent statements, office sentences, and conclusions [4,10].

The statement in mathematical logic is a sentence in which there are values that can be declared 'true' or 'false'. The conclusion of a mathematical logic sentence cannot have both (false and true). A sentence can’t be declared as a statement if we can’t determine whether the sentence is true or false and relative. In Mathematical logic, there are several statements, one of which is biimplication. In biimplication, the statement will be considered true when both of them have equally true or false values. Addition statement will be considered wrong. The biography is indicated by the meaning "p \iff q" or can be written with "p \iff q" [9].

Mathematical logic can be applied in the science of programming. Logic is the mathematical foundation of a software, which is used to formalize the semantics of programming languages and program specifications, and to test the accuracy of a program [11,12]. This shows how important mathematical logic is in the field of computer science [2,6,13,14]. Logic used as a basis in learning programming languages, data structures, artificial intelligence, database, computational theory, software engineering, expert systems, neural networks, techniques / digital systems, and others that use logic intensively.

A digital system can be modeled into a logical sequence. This logic circuit has one or more input and output. The logic sequence represents the logic function of the system. The function of logic can be expressed mathematically in the form of logic equations, concerned with what shows the input-external relationship of the system. The logic sequence is composed of logical statements that are interconnected. Each logic circuit is represented by a symbol that represents the output function of the input of a system. In application of the distance lamp controller, the principle of mathematical logic biimplication is operative [15,16].

The biimplication is a combination of two statements with the conditional form (cause-effect) [17]. The cause and effect are interchangeable, which we call biimplication. The statements of cause result in a statement of effect and vice versa, denoted by \( \Leftrightarrow \). The bias of the statement and written \( p \iff q \) is read "if and only if" and is often also read "equivalent" where it is necessary and sufficient (Table 1).

| \( p \) | \( q \) | \( p \iff q \) |
|-------|-------|-------|
| B     | B     | B     |
| B     | S     | S     |
| S     | B     | S     |
| S     | S     | B     |

Table 1. Value of Biimplication Truth
The application of mathematical logic (biimplication) on light controller applies to camera with alarm and handphone with GSM module [18,19] (Table 2). When we send SMS "lamp on", then the light is on. When we send SMS "lamp off", then the light is off. So we do not need to control the light switches manually, but we can control the switch from a distance (Figure 1).

![Figure. 1 Work system biimplication model](image)

**Table 2.** The value of truth biimplication SMS with GSM module

| SMS  | System | Conclusion |
|------|--------|------------|
| on   | on     | B          |
| off  | on     | S          |
| on   | off    | S          |
| off  | off    | B          |

4. Conclusion
The principle of mathematical logic (biimplication) is modified in the control of electrical appliances (lamps). The principle of mathematical logic (biimplication) on light controller on GSM module (gprs) with SMS. This is important for energy management in a place, for example at home. The control of these lights is important in the present, where society needs high efficiency.

The controller of this lamp when look at from the table value of abduction SMS with GSM module (needs revising), get a conclusion "B-S-S-B" in accordance with the conclusion in the biimplication table. This has concluded this light controller applies the principle of mathematical logic (biimplication).

References
[1] Pryadko I and Ishkov A 2016 The problem of using logic in structural mechanics and electrical engineering as viewed by the Russian researcher boris biryukov *Procedia Eng.* **165** 1162
[2] Blass A 2016 Symbioses between mathematical logic and computer science *Ann. Pure Appl. Log.* **167** 868
[3] Kovalev A A, Dumer I and Pryadko L P 2011 Design of additive quantum codes via the code-word-stabilized framework *Phys. Rev. A - At. Mol. Opt. Phys.* **84**
[4] Chu-Carroll M C 2013 *Good Math*
[5] Sharma H K, Tomar R and Patni J C 2015 HRJ-encryption: An ASCII code based encryption algorithm and its implementation *2015 International Conference on Computing for Sustainable Global Development, INDIACom 2015*
[6] Baez J and Stay M 2011 Physics, topology, logic and computation: A Rosetta Stone *Lect. Notes Phys.* **813** 95
[7] O’Neill B 2013 Mirror, Mirror on the Screen, What Does All this ASCII Mean?: A Pilot Study of Spontaneous Facial Mirroring of Emotions *Arbutus Rev.* **4** 19
van Casteren D H J, Hendrix M A M and Duarte J L 2007 Controlled HID lamp-ballast interaction for low-frequency square-wave drivers IEEE Trans. Power Electron. 22 780

Laksono P W, Jauhari W A, Iftadi I, Christina Ayu K, Ibnu Pandu B P, Jamaluddin A, Saputro D E and Haijunowibowo D 2016 A system based on fuzzy logic approach to control humidity and temperature in fungus cultivation Proc. - Jt. Int. Conf. Electr. Veh. Technol. Ind. Mech. Electr. Chem. Eng. ICEVT 2015 IMECE 2015 344

Gabbay D M and Guenthner F 2014 Handbook of philosophical logic vol 17

Connectives L and Constraints I P 2009 Logic and Integer Programming vol 130

Lindström S and Segerberg K 2007 Handbook of Modal Logic vol 3

Williams H P 2013 Model building in mathematical programming

Harper R 2010 Practical foundations for programming languages vol 9781107029

Berry D M 2013 The essential similarity and differences between mathematical modeling and programming Sci. Comput. Program. 78 1208

Chhun L, Maussion P and Zissis G 2010 HPS lamp control with adjacent frequency signal injection for acoustic resonance avoidance IECON Proceedings (Industrial Electronics Conference) p 2571

Harel D, Marron A and Weiss G 2012 Behavioral programming Commun. ACM 55 90

Hassan A M A 2015 Enhancement of a GSM based control system Int. J. Appl. Eng. Res. 10 21991

Zhang Q, Wang B and Yin A 2010 Design and Implementation of Temperature Monitoring System Based on GSM Short Message Service ASIA-PACIFIC YOUTH CONFERENCE ON COMMUNICATION TECHNOLOGY 2010 (APYCCCT 2010) p 625