

## Design and Construction Of Extension Box and Wiring Of Lighting Points: (Students' Work Experience Programme, Afe Babalola University, Ado Ekiti, Nigeria)

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### ABSTRACT

The students' Work Experience Programme (SWEP) is part of effort geared towards promoting practical application of acquired theoretical knowledge so as to develop students' innovative and creative abilities as well as skills relevant to their chosen career. During the 2012/2013 SWEP activities, students were given practical exposure in key aspects of engineering such as mechanical, civil and electrical. This report clearly describes the electrical activities carried out during the 2012/2013 Students' Work Experience Programme (SWEP) undertaken at Afe Babalola University, Ado Ekiti, Nigeria. Electrical activities undertaken include: construction of extension boxes and wiring of lighting points in series and parallel using 2.5 mm flexible wire, 2.5mm<sup>3</sup> core-cable, sockets, 3×6 mm pattress boxes, 13amps plug, 13 and 15 amp fuse, Junction boxes, etc. Performance evaluations of the developed materials were carried out with electric current flowing through the extension boxes when powered. Also, wires connected in parallel produces very bright illumination because the voltage is the same and not shared but the current varies hence, when one lamp goes off, others are not affected unlike series connection in which the same current flows and the voltage is divided between the lamps producing very dull illumination. Also, when one lamp goes off, all the lamps are put off as well because the current is broken.

**Keyword:** Cable, Current, Lighting Points, Pattress boxes, Voltage

### INTRODUCTION

The 2012/2013 students' Work Experience Programme (SWEP) lasted for six weeks during which students were resourcefully engaged in some engineering training so that they can become competent Engineers in future. It is a form of gradual introduction to industrial experiences so as to develop students' technical skills as well as occupational competencies in their chosen career. The Scheme was also designed to train students on how to acknowledge and appreciate the numerous professional challenges of their immediate environment and the society at large and offer solutions, which their knowledge empowerment avails them.

Electric wires are electrical conductors in form of a slender rod while electric cables are conductors which consist of two or more insulated wires grouped together in an overall covering [1]. Resistors can either be connected in series or parallel [2].

#### Parallel Wiring Connection

The parallel connection entails connecting components of a circuit in parallel so that when component is removed the others

continue to work. In other words, both ends of one element are connected directly [3]. This implies that when the bulbs are connected in parallel, when one goes off, the other continues to work. Also, same voltage passes through the parallel connection and the current flowing through circuit is the sum of all the current flowing through the components.

$$V = V_1 = V_2 = V_3 \dots V_n \quad (1)$$

The equivalent resistance of series connection is given as:

$$\frac{1}{R_{Total}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \dots + \frac{1}{R_n} \quad (2)$$

The total inductance of non-coupled inductors in parallel is equal to the reciprocal of the sum of the reciprocals of their individual inductances

$$\frac{1}{L_{Total}} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \dots + \frac{1}{L_n} \quad (3)$$

The total capacitance of capacitors in parallel is equal to the sum of their individual capacitances

$$C_{Total} = C_1 + C_2 + C_3 \dots + C_n \quad (4)$$

### Series Wiring Connection

Elements are connected in series when they are connected end to end [3]. The series connection involves connecting components of a circuit such that when a component is removed, others stop working. If bulbs are connected in series, when one goes off, the other goes off too. This is because same current flows through the series connection and the voltage is the sum of all the voltage drops across the components.

$$I = I_1 = I_2 = I_3 \dots = I_n \quad (5)$$

The equivalent resistance of series connection is given as:

$$R_T = R_1 + R_2 + R_3 \dots + R_n \quad (6)$$

Total conductance of series circuits of pure resistors is given as

$$\frac{1}{G_{Total}} = \frac{1}{G_1} + \frac{1}{G_2} + \frac{1}{G_3} \dots + \frac{1}{G_n} \quad (7)$$

Also, the total inductance of non-coupled inductors in series is equal to the sum of their individual inductances

$$L_{Total} = L_1 + L_2 + L_3 \dots + L_n \quad (8)$$

The total capacitance of capacitors in series is equal to the reciprocal of the sum of the reciprocals of their individual capacitances

$$\frac{1}{C_{Total}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} \dots + \frac{1}{C_n} \quad (9)$$

In order to distinguish wires from each other, the insulation is normally coloured. On a single phase system, the live phase is coloured red, the neutral black and the earth green and yellow [4]. Wires indicating neutral, earth, etc. are colour coded and installation must be done according to the colour codes to prevent electrical hazards [5] [6].

Polyvinyl chloride (PVC) also known as polyvinylchloroethane is often used as an insulating material in cable covering after being heat-treated and hardened to accommodate some degree of heat from cables and wires [7]. The insulation a non-current carrying material ensures current flow through the wire and prevents leakage of current in unwarranted directions thus, minimizing risk of fire or shock [8] [9].

### Resistivity

This is the resistance of a cable with unit length and unit cross sectional area [9] [10]. The resistance of a conductor depends on the nature of the material, temperature and size of the samples (length and cross-sectional area). [11]

Mathematically,

$$R \propto \frac{l}{A} \quad (10)$$

Where

$l$  = length

$A$  = cross sectional area

From equation 1

$$R = \rho \frac{l}{A} \quad (11)$$

$\rho$  = constant of proportionality also known as resistivity of the material measured in ohm meter ( $\Omega m$ ).

Electrical conductivity is a measure of the extent to which a material will allow current to flow easily through it when a potential difference is applied at a specific temperature [12]. It is the reciprocal of resistivity given as

$$\sigma = \frac{1}{\rho} \quad (12)$$

Where

$\sigma$  = electrical conductivity in  $(\Omega m)^{-1}$

The rate at which metals conduct electric current is a function of its resistance to current [12] [13].

The resistance of a resistor is said to be linear if the current through the resistor is proportional to the potential difference across its terminals [14]

From Ohm's law

$$I = \frac{V}{R} \quad (13)$$

Also,

$$I = \frac{E}{(R + r)} \quad (14)$$

Where

$I$  : main current in amperes,

$V$  : applied voltage in volt,

$r$  : internal resistance in ohm,

$R$  : combined resistance in ohm, and

$E$  : electromotive force in volt

The quantity  $Q$  of electric current  $I$  that passes through a metallic conductor for time  $t$  is given as

$$Q = It \quad (15)$$

While the electrical work done when electricity flows from one point to another is given as

$$W = IVt \quad (16)$$

The amount of electrical workdone also known as electrical power

$P$  is given by the relation

$$P = I^2 R \quad (17)$$

$$P = \frac{V^2}{R} \quad (18)$$

### Soldering and De-Soldering

Soldering is the process in which two or more metal items are joined together by melting and flowing a filler metal into the joint. Soldering is a method of joining two or more pieces of metal-sheets by means of fusible alloy or metal called solder, applied in the molten state [15].

On the other hand de-soldering involves the removal of soldered components.

## MATERIALS AND METHOD

Table 1: Materials and Tools used for Construction of Extension Box as well as Wiring of Lighting Points in Series and Parallel

S/N	Materials	S/N	Tools and Uses	
1	Pattress boxes	13	Hammer	Used for driving in nails
2	Screws	14	Board	Used as a plat form for working
3	2.5mm cable(flexible wire)	15	Screw driver	Used for driving in and tighten screws
4	2.5mm cable(double 3 core)	16	Tester	Used for checking if there is current in a wire
5	Single and double amp Sockets	17	Hack saw junior	Used for cutting plastics
6	13amps plug	18	Pliers	Used for cutting wires
7	13amps fuse	19	Soldering iron	Used for soldering or de-soldering
8	15amps fuse	20	Brush / sucker	Used for removing solder particles
9	Junction box	21	Plain board	
10	Lamp holders			
11	Clips and nails			
12	Bulbs			



Fig. 1: Hammer



Fig. 2: Hand Saw



Fig. 3: Pattress Box



Fig. 4: Switch



Fig. 5: Junction Box



Fig. 6: Lamp Holder



Fig. 7: Soldering Iron

### Construction of Extension Box

The first thing is to create holes on the pattress boxes to allow free passage of cables, connecting the three pattress boxes together. After this, temporarily set the pattress boxes with its sockets on the board, mapping out accurate and neat alignment which fits the setting of the extension box. Deriving these positions, students fixed the pattress box on the board using screw. This is followed by measurement and cutting of cable length to be used for the extension box construction (The cable with thickness of 3.5mm in diameter is pilled by the use of pliers so as to bring out the cores to connect to the socket, the cores are: the red wire (life) which is positive, the black wire (neutral), yellow wire (earth). The pattress boxes are labeled N which means neutral, L which means life and E which means earth, so therefore, the red wire is connected to L,

the black wire is connected to N and yellow is connected to earth then passed this cables through the pattress box and connect the cables neatly to the sockets. The 13amps and 15amps sockets are then fixed to the pattress boxes.

The 13amps plug is then connected to the power supply cable which is flexible and the extension box construction is completed.

### Wiring Lighting Point in Parallel Connection

To start the connection, holes were made on the junction box and lamp holders to allow the passage of wires from the junction box to the first lamp holder and then to the second lamp holder. Holes were also made on the pattress box, after which the students fixed the switch and junction box to the board using screw. Measuring the length of cables to be used and making use of color coding, two core cable was used to connect wires from the first lamp holder to the second lamp holder (red cable was connected to red cable and black cable connected to black cable respectively in each lamp holders). Two core wires was also drawn from the first lamp holder, each connected to different terminals in the junction box after which the two lamp holders were also fixed in neat alignment on the board. Still making use of color coding, two cable wire was also connected to the switch and drawn for the life wire (red wire) to be connected to a new terminal in the junction box and the neutral cable (black cable) connected to the junction box to join the life cable (red wire) that came from the first lamp holder. A new two core wire was selected, making use of one of its ends; its life cable (red wire) was drawn to the junction box joining the life cable that was drawn from the switch. Also, the neutral cable from the new wire was also drawn to the junction box joining the neutral wire that came from the first lamp holder. All the wires were then clipped to the board making use of clips. Bulbs were also connected to the lamp holders and the other end of the new two core wire connected to the source and powered from the switch.

The bulbs will come on and will produce a very bright illumination. This is because the bulbs do not share the same current.



8: Wiring of Lighting Points in Parallel

Fig.

### Wiring Lighting Point in Series Connection

To start the connection, holes were made on the junction box and lamp holders to allow the passage of wires from the junction box to the first lamp holder and then to the second lamp holder. Holes were also made on the pattress box, after which we fixed the switch and junction box to the board using screw. Two core wires were connected to the first lamp holder, connecting it to the second lamp holder. Then the first lamp holder is also connected to two straight terminals in the junction box serially, after which the lamp holders were also fixed to the junction box using screws. Two core wire coming from the switch was also connected to the junction box, with its neutral cable connected to the life cable that came from the first lamp holder and its life cable connected to the

life cable of a new 2 core wire that led out of the junction box. Also, the neutral cable of the new 2 core wire that led out of the junction box was joined to the terminal of the neutral cable that came from the first lamp holder in the junction box.

When this is done, all wires were tightly fixed to the board using clips and then the bulbs are inserted into the lamp holders. The two wires that were out of the junction box are then connected to the socket, then, the switch is put on. The bulb will come on but will produce a very low illumination. This is because both bulbs share the same current.



Fig. 9: Wiring of Lighting Points Serially

### EXPERIENCE GAINED

In the electrical aspect of SWEP, students learnt how to make extension box and also learnt how to make connection using the series and the parallel method of connection. How to solder and de-solder was also made known during this section of the exercise.

### RESULTS AND DISCUSSION

After the successful completion of the Electrical project, extension box was constructed as shown in fig. 11 also, light were wired through series and parallel connection and at the same time, components were successfully assembled and soldered shown in Fig. 10 11 and 12.



Fig. 10: Internal Structure of an Extension Box



Fig. 11: Constructed Extension box

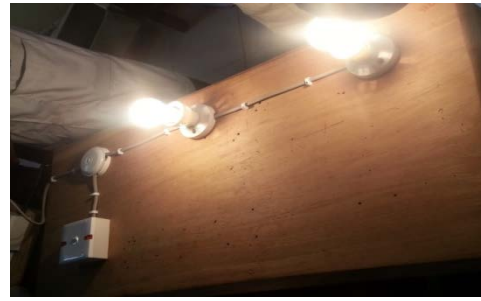


Fig. 12: Parallel Connection of Lighting Bulbs

### CONCLUSION AND RECOMMENDATIONS

After the successful completion of the SWEP, the following conclusions were drawn:

1. It enables students to obtain employment experience in preparation for longer period of industrial attachment as well as future entry into various organizations.
2. The SWEP helps student to be conversant with electrical laboratory tools and equipment so as to match theory with practice.
3. The feasibility of the programme helps to gather more knowledge and experience on workshop and industrial practices.
4. It also enables students to proficiently, resourcefully, creatively and proactively apply acquired skills to solve engineering challenges.

The following are hereby recommended:

- (1) It is recommended that the developed materials be subjected to test throughout the year for more performance evaluation.
- (2) Since the materials produced during this programme are standard products of high quality, they should be branded and sold to raise found for further research work (e.g ABUAD extension box)

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