GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

GSJ: Volume 10, Issue 12, December 2022, Online: ISSN 2320-9186
www.globalscientificjournal.com

MECHATRONICS SKILLS NEEDED BY MOTOR VEHICLE MECHANICS IN MINNA METROPOLIS OF NIGER STATE, NIGERIA

BY

MOHAMMED, EL- Mahmud[1] & MUSTAPHA, Mahmud Jebba[2]
[1&2]Department of Automobile Technology
School of Technical Education, Niger State College of Education, Minna
E-mail: elmahmudsp@gmail.com

ABSTRACT

This study was carried to determine the mechatronics skills needed by motor vehicle mechanics in Minna metropolis of Niger State, Nigeria. The study adopted a descriptive survey research design. The study was carried out in Minna metropolis of Niger State. The population for the study comprised 1,563 out of which 1540 are master Motor Vehicle Mechanics (MVM) and 23 are Institutional experts on mechatronics. Purposive sampling technique was used to select 310 master MVM using the Krecie and Morgan decision model table to choose them. All the 23 institutional experts on mechatronics were used because of their manageable number. All together a sample size of 333 respondents were used for the study The instrument used for the data collection was a structured questionnaire titled "Questionnaire for Assessing Mechatronics Skills of Motor Vehicle Mechanic (QAMSMVM). The instrument was subjected to face and content validation by three experts. Cronbach's Alpha was used to determine the internal consistency of the instrument and the reliability index was found to be 0.91. The data collected was analyzed using mean and standard deviation to answer the research questions while the null hypotheses were tested using z-test statistic at .05 significant level. The study found among others, that the MVM needed all the mechatronics skills in the maintenance of ignition system, and automatic transmission system which included ability to perform magnetic sensor testing, test running ignition system using multimeter, diagnosing defective reflector sensor, replacing leaking torque converter, among others. Based on the findings of the study, the following recommendations were made; MVM should be compelled to go through re-certification as a condition for renewing their registration

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

upon the completion of a training program in mechatronics. Automobile industries should be encouraged through legislation to established well equipped mechatronics laboratories for the use of MVM as part of their corporate social responsibility.

Keywords: Mechatronics, Skills, Motor Vehicle Mechanics, Institutional Experts

Introduction

Motor vehicle is an indispensable means of transportation of passengers, goods and services in modern societies. According to Omeji (2005), motor vehicle is a wheeled vehicle that carries its own motors and has seats for both the driver and passengers. Gscheidle (2006) defined motor vehicle as a complex technical system in which various subsystems operate in harmony to discharge a defined function. The vast majority of the motor vehicle work on the principle of internal combustion processes which is referred to as internal combustion engines. Motor vehicle systems are grouped based on means of operation as electrical, electronics, pneumatics and mechanical systems. The mechanical systems in a motor vehicle are largely replaced by electronic systems (Michael, 2014). According to Maitland (2013); and Aresa (2014), the motor vehicle that is built using electronics microcontrollers, digital signal processors using sensors and actuators are commonly described as modern motor vehicles.

Mechatronics system is composed of *mecha* from mechanical and *tronics* from electronics. According to Harshama *et al.* (2006), mechatronics is the synergetic integration of mechanical engineering with electronic and intelligent computer control in the design and manufacturing of industrial products such as a motor vehicle. Motor vehicle mechatronics can also be termed as replacement of mechanics with electronics or enhance mechanics with electronics. Motor vehicle mechatronics comprises of several systems which include electronic fuel injection, engine management, transmission control, Antilock Brake System (ABS), Traction Control System (TCS), Vehicle Dynamic Control System (VDCS), mechatronic suspension, power door locks, and airbags, air conditioning systems, seat, mirror control, and window lift systems, hydraulic assisted power steering among others (Tutunji, 2013). Each of these systems requires Electronic Control Unit (ECU) which reads sensor values from various parts of the engine and depending on these values it performs the appropriate actions. This allows the motor vehicle to adapt to environmental conditions such as air density to increase the combustion efficiency and subsequently improving fuel economy. According to Tutunji (2013), mechatronics systems are designed to offer motor

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

vehicle more efficient, comfort, safety enhancements, emission reduction and intelligent cruise control among others. William (2004) also confirmed that motor vehicle mechatronics systems offer increased safety, and comfort, driver assistance, reducing the emission of pollutants by the intelligent engine control and also increases the demands placed on diagnostics, maintenance and repair. Schweitzer (2006) revealed that the maintenance and repairs of these systems needed the services of motor vehicle mechanics.

The Master MVM is experienced person who specialized in motor vehicle maintenance, repairs and sometimes modification. Master MVM is a trained person with the knowledge or professional experience in the skills and techniques related to motor vehicle maintenance. According to Arase (2014), motor vehicle mechanic is skilled personnel, trained in any of the trades in auto mechanics, which include: auto body repair and spray painting, auto electrical work, auto-body mechanic work, auto-body building (panel beating) and auto parts merchandising. The Master MVM must possess an aptitude for electrical and electronics as well as mechanical systems, and provide routine maintenance to keep these systems operable and use troubleshooting skills when any of the automotive systems malfunction. According to Holderman *et al.* (2006) diagnostic procedures, skill development and performance are what MVM need most in the motor vehicle field today's Master MVM are equipped with the current skills and knowledge to be able to efficiently maintain and repair the modern highly automated and computerized electronics gadgets in modern motor vehicles. Obasa (2013) opined that, a successful MVM must be self-motivated individual, capable of working alone to solve complicated problems in consultation of an institutional expert on mechatronics.

Institutional Expert on Mechatronics in the context of this study, referred to those with the abilities, knowledge, and attitudes or competencies required for effective the maintenance in mechatronics field. Experts in mechatronics are set of academics that specialized in the Automotive and electronics content of the motor vehicle in the troubleshooting, finding fault, diagnosing and Turn-up of electronic faults (Kershaw et al, 2001). Experts on mechatronics are the technicians who holds the highest ethical standard in the mechatronics field. Institutional Experts on mechatronics are competent personnel with professional experiences in teaching and the used of more complex and highly technological specialty diagnostic equipment to analyze vehicle faults for repair and services. which include supervising mechatronics, approving repairs for successful maintenance

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

of the modern motor vehicle. Both master MVM and Experts on Mechatronics needed mechatronic skills.

Mechatronics skills could be defined as the level of efficiency attained by MVM through the repetitive performance of an operation in diagnosing, maintaining and repairing of mechatronics system in a motor vehicle. According to Bateson (2003), mechatronics skill is referred to as a well-established habit of diagnosing and fixing a fault in mechatronics systems' in the most economical way involving the display of capabilities and proficiency. ABS, electronic ignition, fuel injection and automatic transmission system required high level skills in their maintenance. It is, therefore, necessary for MVM to acquire mechatronics skills to carry out maintenance, repairs, services and sometimes modification on the modern motor vehicle.

Mechatronics skills needed by MVM, according to William (2004) include; diagnosing, ascertaining errors and malfunctions as well as their causes; maintaining, testing and adjusting motor vehicle and systems; disassembling, assembling and repairing motor vehicle systems, subsystems and components as well as equipping, adapting and retrofitting of motor vehicle systems. Tanuja *et al.* (2016) revealed that, mechatronics skills needed by MVM include: to identify the on-board diagnostic port in modern vehicles, connect the diagnostic device to the 16-pin on-board diagnostic connector, retrieve Diagnostic Trouble Codes (DTC's), record, print and interpret DTC's, check sensors and their wiring for damage conduct a careful visual inspection of the wiring and the mechanical components, inspect, repair and replace faulty electronic components and test run the mechatronics systems.

Lack of these mechatronics skills among MVM is identified as the cause of poor maintenance of the mechatronic system in a motor vehicle. Ariyo, et al (2021) and Jika (2010) confirmed that half-baked MVM in the society often cause more damage to motor vehicle when they are contracted to service them and as such, modern motor vehicle suffer disrepair. This is attributed to the mechanical skills acquired from training using obsolete technologies (tools/equipment) as against the mechatronics skills needed to repair modern motor vehicles (Godwin, 2012). MVM in Niger State is not exceptional, as they may have acquired little or no mechatronics skills for the maintenance of the modern motor vehicle. Against this background, there is a need to identify the

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

mechatronics skills needed by MVM. Hence, this study seeks to identify the mechatronics skills needed by MVM in Niger State, Nigeria.

Objectives of the Study

The objectives of the study are to identify:

1. Mechatronics skills needed by MVM in the maintenance of the ignition system
2. Mechatronics skills needed by MVM in the maintenance of the automatic transmission system

Research Questions

The following research questions guided the study:

1. What are the mechatronics skills needed by MVM in the maintenance of the ignition system?
2. What are the mechatronics skills needed by MVM in the maintenance of the automatic transmission system?

Hypotheses

The following null hypotheses were formulated to guide the study and were tested at 0.05 level of significance:

H_{O1}: There is no significant difference between the mean responses of Institutional Experts and Master MVM on the mechatronics skills needed by MVM in the maintenance of the ignition system.

H_{O2}: There is no significant difference between the mean responses of Institutional Experts and Master MVM on the mechatronics skills needed by MVM in the maintenance of the automatic transmission system.

Research Methodology

The study adopted a descriptive survey research design. The population of the study was 1563 which consisted of 1540 Master MVM from Minna metropolis and 23 Institutional Experts of Mechatronics from Federal University of Technology Minna in Niger State. Purposive random

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

sampling technique was used in the selection of 310 Master MVM from the population. The 310 MVM were sampled because they are considered suitable to represent the population of 1540 using Krecie and Morgan (1970) decision model table to determine the sample size. All the 23 institutional experts on mechatronics were used because of their manageable size. A sample size of 333 respondents were used for the study. The instrument used for data collection is a structured questionnaire titled: Questionnaire for Assessing Mechatronics Skills of Motor Vehicle Mechanics Questionnaire (QAMSMVM). The questionnaire is divided into two parts. Part I contained items designed to obtain personal information of the respondents. Part II is divided into two sections (A& B). Section A contained 18 skill items concerning mechatronics skills needed for the maintenance of ignition system while Section B was made up of 17 items designed to identify the mechatronics skills needed on the maintenance of automatic transmission system. The questionnaire items were assigned a five-point response scale option of Very Highly Needed (VHN), Highly Needed (HN), Needed (N), Needed (N) and Not Needed At all (NNA) with a corresponding value of 5, 4, 3, 2 and 1.

The instrument was subjected to face validation by three experts: two from the Department of Industrial and Technology Education and one from the Department of Mechatronics Engineering, all in Federal University of Technology, Minna. The reliability co-efficient of 0.91 was obtained through the use of Cronbach Alpha. The instrument was administered by the researchers with the aid of 4 research assistants. Data collected was analyzed using mean and standard deviation to answer research questions. The mean response of any item which falls between real limit of 0.50-1.49, 1.50-2.49, 2.50-3.49, 3.50-4.49 and 4.50- 5.0 were interpreted as Not Needed At all (NNA), Not Needed (NN), Needed (N), Highly Needed (HN) and Very Highly Needed (VHN) respectively. While hypotheses were tested using z-test statistics at 0.05 level of significance.

Results

Research Question One

What are the mechatronics skills needed by MVM in the maintenance of ignition system?

Table 1: **Mean response of Mechatronics skills needed by MVM in the maintenance of ignition system**

S/N	ITEMS	$\overline{X}_a$	SD_a	Decision

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

1	Identifying the on-board diagnostic port in modern vehicle	3.51	1.18	HN
2	Connecting the diagnostic device to the 16-pin on-board diagnostic connector	3.43	1.17	N
3	Retrieving ignition Diagnostic Trouble Codes (DTC's)	3.46	1.39	N
4	Recording and print ignition diagnostic trouble codes	3.23	1.24	N
5	Interpreting ignition Diagnostic Trouble Codes (DTC's)	3.28	1.19	N
6	Checking the crankshaft and camshaft sensors and their wiring for damages	3.28	0.99	N
7	Ability to Record ignition timing using digital multimeter	3.24	1.06	N
8	Identifying ignition system problem	3.86	0.96	HN
9	Performing magnetic sensor testing	3.37	1.02	N
10	Inspecting faulty crank position sensor	3.65	1.21	HN
11	Diagnosing defective reflector sensor	3.65	1.06	HN
12	Checking supply voltages and signals with multimeter and oscilloscope	3.22	1.11	N
13	Using plug wire or adapter to check for spark	3.35	1.09	N
14	Conducting a careful visual inspection of the wiring and the mechanical components	3.37	0.96	N
15	Checking the battery to be sure there is ample voltage to start the engine	3.31	0.94	N
16	Inspecting faulty electronic ignition components	3.05	0.82	N
17	Conducting engine performance test using engine analyser	3.54	0.99	H N
18	Testing run the ignition system using the multimeter	3.19	0.72	N
	$\overline{X}_g$	3.39		N
	SD_g		1.09	

Keys: $\overline{X}_a$= Average mean response of the respondents, SD_a= Average Standard Deviation of the respondents, $\overline{X}_g$= Grand Average Mean response of the respondents and SD_g = Grand Standard Deviation of the respondents.

Table 1 revealed that the MVM highly needed the mechatronics skills in the maintenance of ignition system on item number 1,8,10,11 and 17.The needed skills by MVM are skills on item number 2, 3, 4, 5, 6, 7, 9, 12, 13, 14, 15, 16 and 18. The result of $\overline{X}_g$ = 3.39 and the SD_g = 1.09 gives the impetus to conclude that the MVM needed all the mechatronics skills in the maintenances of ignition system, which provides answer to research question one.

Research Question Two

What are the mechatronics skills needed by MVM in the maintenance of automatic transmission system?

Table 2: Mechatronics skills needed by MVM in the maintenance of automatic transmission system.

S/N	ITEMS	$\overline{X}_a$	SD_a	Decision

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

1	Carrying out stall test to check the holding capacity of the converters stator overrunning clutch assembly	3.54	1.09	HN
2	Printing transmission diagnostic trouble codes	3.53	1.08	HN
3	Retrieving transmission Diagnostic Trouble Codes (DTC's)	3.43	1.25	N
4	Recording transmission diagnostic trouble codes	3.5	1.22	HN
5	Carefully inspect disassembled transmission to diagnose noise and vibration problems	3.43	1.05	N
6	Conducting thorough visual inspection on transmission linkage adjustments	3.23	1.16	N
7	Inspecting and adjust the shift cable	4.17	1.19	HN
8	Examining fluid level for leakage from the transmission vent	3.24	1.01	N
9	Checking transmission fluid and filters for oxidation or contamination	3.60	1.32	HN
10	Checking drive train for looseness or leaks	3.46	0.95	N
11	Removing or reinstall gasket to correct fluid leakage	3.92	1.07	HN
12	Checking torque converter for leaks	3.13	0.86	N
13	Replacing leaking or damaged torque converter	3.77	0.98	HN
14	Checking transmission vent for blockage	3.53	1.24	HN
15	Carrying out road test for proper gear engagement	3.23	1.01	N
16	Inspecting entire transmission wiring harness for tears	4.01	1.13	HN
17	Replacing damaged fluid lines and fittings	3.85	0.98	HN
	$\overline{X}_g$	3.97		HN
	SD_g		1.09	

Table 2 Keys: $\overline{X}_a$= Average mean response of the respondents, SD_a= Average Standard Deviation of the respondents, $\overline{X}_g$= Grand Average Mean response of the respondents and SD_g = Grand Standard Deviation of the respondents.

Table 2 revealed that the MVM highly needed the Mechatronics skills in the maintenance of automatic transmission system on item number 1, 2, 4, 7, 9, 11, 13, 14, 16 and 17. The needed skills are on item number 3, 5, 6, 8, 10, 12 and 15. The result of $\overline{X}_g$ = 3.97 and the SD_g = 1.09 gives the impetus to conclude that the MVM needed all the Mechatronics skills in the maintenances of automatic transmission system. This also provides answer to research question two.

Hypothesis One

Ho_1: There is no significant difference between the mean responses of Institutional Experts in Mechatronics and Master MVM on the mechatronics skills needed by MVM in the maintenance of ignition system.

Table 3: Z-test Analysis of the Respondents on the mechatronics skills needed by MVM in the maintenance of ignition system

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

Variable	N	Mean	SD	Z	p-value
Expert in Mechatronics	23	57.77	22.34	-3.004	0.003
Master MVM	310	66.52	11.12		

Table 3 indicates the z-test between Institutional Experts in Mechatronics and Master MVM for the maintenance of ignition system. The result revealed that the mean and standard deviation of Institutional Expert in Mechatronics are 57.77 and 22.34 while the mean and standard deviation of Master MVM for the maintenance of ignition system are 66.52 and 11.12 respectively. Since the P value (0.003) is less than α value (0.05), on this basis, it is concluded that there is no significant difference between the mean responses of Institutional Experts in Mechatronics and Master MVM on the mechatronics skills needed by MVM in the maintenance of ignition system. Therefore, the null hypothesis is accepted.

Hypothesis Two

HO_3: There is no significant difference between the mean responses of Institutional Experts in Mechatronics and Master MVM on the mechatronics skills needed by MVM in the maintenance of automatic transmission system.

Table 4: Z-test Analysis of the Respondents on the mechatronics skills needed by MVM in the maintenance of automatic transmission system

Variable	N	Mean	SD	Z	p-value
Expert in Mechatronics	23	54.59	20.98	-0.487	0.026
Master MVM	310	65.01	8.96		

Table 4 indicates the z-test between Institutional Experts in Mechatronics and Master MVM for the maintenance of ignition system. The result revealed that the mean and standard deviation of Institutional Experts in Mechatronics are 54.59 and 20.98 while the mean and standard deviation of Master MVM for the maintenance of ignition system are 65.01 and 8.96 respectively. Since the P value (0.026) is less than α value (0.05), on this basis, it is concluded that there is no significant difference between the mean responses of Institutional Experts in Mechatronics and Master MVM on the mechatronics skills needed by MVM in the maintenance of automatic transmission system. Therefore, the null hypothesis is accepted.

Discussion of Findings

The findings on the mechatronics skills needed by the MVM on the maintenance of ignition system revealed that the MVM needed the skills to perform magnetic sensor testing, test running ignition system, ability to diagnosing defective reflector sensor among others to function adequately. The findings are in line with Career Insight (2021) and Udogu (2015) who itemized the mechatronic skills needed to function well to include mechanical skills and analytical skills to perform magnetic sensor testing, use of plug wire or adapter to check for spark, test run the ignition system using the multimeter, check the crank sensor using diagnostic tool, check the battery to make sure there is ample voltage to start the engine, test and diagnose defective regulator sensor, among others.

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

The findings on the mechatronics skills needed by the MVM on the maintenance of automatic transmission system revealed that the MVM needed the skills to remove or reinstate gasket to correct fluid leakage, replacing leakage torque converter among others to function adequately. This finding concurs with Master Mechanic (2022) who stated that, regular check-up of seals and gaskets, keeping the oil at the normal level and ability to check the torque converter for leakage are among skills needed by MVM. Omkar (2011) also in agreement identified the mechatronics skills needed for the maintenance of automatic transmission system to include; conducting thorough visual inspection on transmission oil linkage and adjusting shift cable. Checking transmission fluid and filters for oxidation or contamination, checking drive train for looseness or leaks are mechatronics skills needed by MVM for the maintenance of automatic transmission system.

Conclusion

On the basis of the findings of this study, it is concluded that MVM needed all the mechatronic skills in both the maintenance of ignition and automatic transmission system. The highly needed skills in mechatronics in the maintenance of ignition system are ability to: identify on- board diagnostic port in modern vehicles, inspect faulty crank position sensor, diagnose defective reflector sensor, conduct engine performance test using engine analyzer among others. The highly needed skills in mechatronics to function well in the maintenance of automatic transmission system are: ability to carry out stall test to check the holding capacity of the stator over running clutch assembly, printing and interpreting transmission diagnostic trouble code, adjusting shift cable, reinstalling gasket to correct fluid leakage, replacing damaged torque converter, checking transmission vent for blockage, replace damaged fluid lines and fittings, among others.

Recommendations

Based on the findings of the study, the following recommendations are made:

1. MVM should be re-certified within a given period upon completion of a training program in mechatronics as a critical requirement for renewing their registration.
2. Automobile industries should be compelled through legislation to provide common mechatronics laboratories/workshops for the use of master MVM as part of their corporate social responsibility.

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

3. The Federal and State Ministries of Education in collaboration with other stakeholders should organize seminar and workshop for institutional experts of mechatronics.
4. Federal government should subsidize the importation of mechatronics working tools and equipment

References

Aresa, F. M. (2014). *Do not run our roadside mechanics out of business.* Retrieved from *http://www.nigeriavillagesquare.com/articles/do-not-run-our-roadside-mechanicsout-of-business.html*

Ariyo, S.; Udogu, K. & Danlandi, M. (2021). Integration of automobile mechatronics technology in to the curriculum of automobile trade programs at the technical colleges in Nigeria. *RIELS Journal 2(1), 20-28*

Bateson, R. N. (2003). *Introduction to control system technology,* 4th ed. Merrill, Columbus: Merrill

Career Insight, (2022). 16 Mechatronics engineering skills for your career and resume retrieved from *climbtheladder.com*

Godwin, A. (2012). *The dearth of skilled manpower in Nigeria*. Onitsha: Wisdom publisher

Gscheidle, R. (2006). *Modern automotive technology-fundamentals, service, diagnostics.* Verlag europa-lehrmittel

Harshama, F., Tomizuka, M., & Fukuda, T. (2006). Mechatronics-what is it, why, and how? *Institute of Electrical Electronic Engineers Trans. on Mechatronics*, 1(1), 1-4

Holderman, C., James, D., & Mittchell, D. (2006). *Diagnosis and troubleshooting of automotive electrical, electronic and computer Systems.* Carlisle publishers' services

Jika, O. F. (2010). Effect of guided discovery method of instruction on the students' performance in auto mechanics in technical colleges in Benue State. *Unpublished M. Ed Project, Department of Vocational Teacher Education, University of Nigeria, Nsukka*.

Kershaw, J. K., Bennett, S., & Erjavec. (2001). *Today`s mechanic.* Sage Publication

Krejcie, R. V. & Morgan, O. W. (1970). Determining sample size for research activities. Educational and Psychological measurement. Retrieved from *https//www.kenpro.org*

Maitland, R. (2013). *Auto mechanics need latest skills to succeed in industry - Houston Chronicle.* Retrieved from *http://m.chron.com/jobs/article/Auto-mechanics-need-latest-skills-to-succeed-in- 5062215.php*

GSJ: Volume 10, Issue 12, December 2022
ISSN 2320-9186

Master Mechanic, (2022). Gasket and sealing engine. Retrieved from *https//www.mastermechanic.ca>*

Michael, A. (2014). Modern motor vehicle repair practices in micro, small and medium scale garages in Ghana. *International Journal of Science, Technology and Society, 2*(6), 216-222

Obasa, B. O. (2013). *Nigeria's legion of illiterate' auto mechanics*. Retrieved from http://www.punchng.com/feature/super-saturday/nigerias-legion-of- illiterate-auto-mechanics

Omeji, O. (2005). Motor vehicle technology. Retrieved from*http://www.oemji.com/topics/auto/auto/motor vehicle? 4*

Omkar, P. (2011). *Troubleshooting car electrical problems.* Retrieved from *http://www.buzzle.com/articles/troubleshooting-car-electrical-problems.html*

Schweitzer, G. (2006). Mechatronics basics, objectives and examples. *Journal of Systems and Control Engineering, Proceedings 2*(10), 1-11.

Shafie, L. A. & Nayan, S. (2010). Employability awareness among Malaysian undergraduates. *International Journal of Business and Management, 5*(8), 45-49.

Tanuja, P. M., Meenal. R. M. & Gouri. P. B. (2016). Mechatronics in motor vehicle. *International Journal of Electrical and Electronics Engineering (IJEEE), 5*(5), 13-24

Tutunji, T. A. (2013). *Mechatronic Systems: Overview*. King University press.

Udogu, A. (2015). Emerging technology skills required by graduates of MVMW for Establishing MVMW enterprises in Anambra and Enugu States. *A M.Ed Dissertation, Department of Vocational Teacher Education, UNN, Nsukka Nigeria*

William, B. (2004). *Understanding automotive electronics*, 6-th Edit. An Imprint of Elsevier Science