KERSL's COMPETENCY BASED DIPLOMA PROGRAMME

IN

INDUSTRIAL SKILLS, AUTOMATION AND MECHATRONICS

A PROFESSIONAL TRAINING PROGRAMME BASED ON INDUSTRY NEEDS

APPLICATION FOR ACCREDITATION
Presented to NABPTEXT

February 2018

Our training programmes are 100% industry-driven and ensure a competent workforce and "industry-ready" graduates

We believe that a well-trained technical workforce is one of the significant paths to Ghana's industrialization.

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ABOUT KERSL'S DIPLOMA PROGRAMME

This document describes KERSL's 3-semester diploma programme. A student who successfully graduates from the programme will obtain a diploma in ***"Industrial Skills, Automation and Mechatronics."***

A unique aspect of KERSL's diploma programme is that it is designed to meet the needs of industry. That is, the programme is 100% demand-driven. KERSL's focus on providing a demand-driven programme ensures that the courses offered provide the skills industry needs to increase productivity and be globally competitive. The 3-semester intensive programme provides an alternative, industry-driven training opportunity for high school graduates.

The diploma programme includes basic mechatronics courses from the vocational level through the technician/technologist level. The term *mechatronics* encompasses a broad range of technical disciplines including mechanics, electronics, control systems, and computer systems. It is defined as the "multidisciplinary application of mechanics, electronics, control systems and computer systems to optimize the performance of products or processes." Many industrial and/or manufacturing processes today involve a combination of these disciplines. Technicians that have a strong practical background in the requisite components of these disciplines have the best chance of functioning optimally and increasing productivity in industry.

The diploma programme provides learners with the versatile background and practical skills required in today's industrial or manufacturing environment. Participants will be equipped with the critical skills required to operate, maintain, and troubleshoot an industrial facility. In particular, participants will be equipped not only with the necessary basic mechanical skills, but also with the basic electrical and computer skills necessary to troubleshoot today's sophisticated machines in manufacturing plants as well as programme and troubleshoot programmable logic controllers (PLC), the workhorse of any modern-day industrial facility. In short, the programme will equip a person to function in all of the following traditional roles at the entry level in industry:

A. Machine operator
B. Industrial maintenance mechanic
C. industrial electrician, or
D. PLC maintenance technician.

Other components of the diploma programme include workplace safety, health, and supervisory skills, data acquisition and LabVIEW programming and renewable (solar) energy systems design and applications. Another demonstration of the excellence of KERSL's multi-faceted diploma programme is that a graduate will be able to successfully sit for the Energy Commission's diploma course in electrical wiring practice in **domestic electrical wiring** if he or she so chooses.

Taken together, these courses are all designed to produce competent technicians that are able to even start their own businesses in the areas outlined above, including solar power installations. Therefore, in further pursuit of this goal, the students will undertake a **practical project** during the third semester of the programme. **This project will be industry-driven**. That is, KERSL will work with industry to develop projects desired by the industry itself. This

collaboration with industry will result in a win-win situation for both industry and the students. On the one hand, industry will get the (newly designed or repaired) equipment it needs at a very low cost, while the student will acquire the much-needed experience.

The following chapters explain KERSL's diploma programme in detail. Chapter 1 provides a profile of the company and its focus areas of operation and also describes its training facilities. Chapter 2 provides detailed course-contents for all the courses that make up the diploma programme. Table 1 (page 27) lists the complete set of courses for the diploma programme.

1. COMPANY PROFILE

1.1 Background of the TVET Provider

Korsika Energy Research and Services Ltd (KERSL, www.kersl.com) is an industrial-skills continuing education provider based in Tema (Community 7). The company is wholly Ghanaian owned and has excellent training facilities at the Ghana Industrial Skills Development Center (GISDC, located within the premises of Tema Technical Institute). KERSL offers technical training (and also provides design solutions) in industrial automation, mechatronics, computer engineering and solar power systems design and installation for the up-skilling of engineers, programmers and technicians employed in Ghana's industrial sector.

KERSL has a pipeline of clients and partners that drive success in executing its core objectives and maintaining market leadership. The institution has trained engineers, programmers and technicians in the manufacturing industry and academic professionals on a "train-the-trainer" basis. Our client base includes Ghana Manganese Limited, Crown Cans, Limited, Promasidor, Anglogold Ashanti Ltd and Caltech Ventures, All Nations University (Koforidua), Ghana Water Company, Accra Polytechnic, Sunyani Polytechnic, Cape Coast Polytechnic, Ghana Telecoms University and University of Mines and Technology. Our strategic partners for an effective and robust training program include both local as well as international partners. They include the Association of Ghana Industries (AGI), Ghana Regional Appropriate Technology Industrial Service (GRATIS), Scientific Management Techniques [(SMT) – based in USA] and National Instruments [(NI) – based in USA].

KERSL leverages 5 years of experience in industrial, mechanical, electrical, and computer engineering to provide world-class instruction to professionals from industry and academia. The expertise that is leveraged drives change, innovation, quality, discipline, and demand driven training service in Ghana's industries. Most importantly, it ensures Ghana's workforce participation in industries is secure to drive sustained and gainful employment for economic benefit. KERSL is a state-of-the-art training facility whose core objective is to provide effective training programmes for the players in the manufacturing sector.

1.2 Organizational Structure

KERSL is run by the President, who is assisted by the Vice President, Human Resources Coordinator and the Chief Financial Officer. All decisions are taken by them. However, the day-to-day running of the organization is delegated to department heads and team leads. For example, the technical operations manager overseas the day-to-day technical activities, while the National Instruments Technical Support Team Lead is responsible for overseeing sales and technical support of National Instruments hardware and software products. Non-teaching staff report to the Human Resource manager. The organogram is shown in Figure 1.

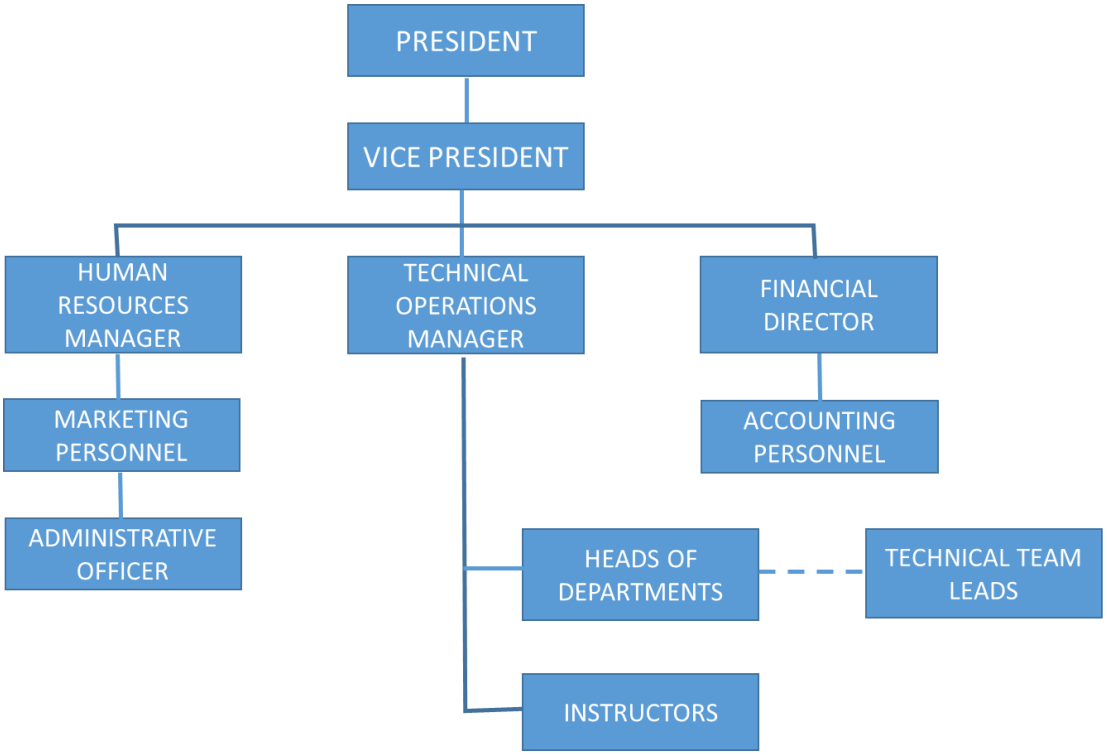

Figure 1 KERSL organizational structure

1.3 KERS's Vision

KERSL's vision is to be the leading catalyst in moving Ghana into a globally recognized industrialized country.

1.4 KERSL's Mission

To achieve its vision, KERSL will be the enabling interface between industry and academia. Therefore, KERSL is committed to the following specific services and objectives:

1. Be the lead provider of continuing education and professional development training in industrial automation to the different segments of the workforce in the industrial sector including engineers and technicians in Ghana. The offering of short courses to employees already in the work force is extremely convenient to the industries who cannot afford to release their technical workforce for a relatively long time, and yet would like them to upgrade their skills for greater benefit to the company.

2. Be a "trainer of trainers," providing up to date skills to instructors to facilitate effective knowledge and skills transfer to both currently employed technical workers as well as trainees who opt for the technical disciplines.

3. In addition to its continuing education programmes for working professionals and technicians, KERSL is implementing an innovative, hands-on training programme leading to a diploma in "Industrial Skills, Automation and Mechatronics" designed to address the technical skills shortage in industry.

4. Spearhead the formation of a consortium among KERSL, the GRATIS Foundation, Food Science and Agricultural departments at the University of Ghana to develop home-grown cottage factories for rural communities to bring added value to raw materials, thereby improving the standard of living of rural communities.

5. Contribute to the creation of jobs and improvement of livelihoods of unskilled workers through the provision of customized informal training programs to make them more productive and profitable.

6. Collaborate with industry and trade organizations to study and forecast manpower requirements at the skilled worker level.

1.5 Linkages, Affiliations and Recognitions

KERSL has signed a memorandum of understanding (MOU) with Scientific Management Techniques, Inc., (SMT, www.scientific-management.com), a U.S.-based company, to market KERSL's manufacturing skills training equipment in Ghana. SMT's business focus is the design, marketing, and sale of industrial and manufacturing skills training programmes on a global basis. SMT is a forty-year old, US-based company and its unique assessment machines and training equipment have broad applicability in several areas—manufacturing, mining, construction, and education.

KERSL also is a local distributor of National Instruments' (NI, www.ni.com) hardware and software products. With headquarters in the United States, NI is a globally recognized manufacturer of controls, testing, and measurement hardware and software products for education, manufacturing, and research. KERSL currently works closely with NI-Armenia, serves as the local sales agent for NI in Ghana, and offers technical support for these products.

KERSL is a COTVET[a]-registered work-place training provider (Reference Number REG13/10/07). KERSL also is a member of the Association of Ghana Industries (AGI).

[a] COTVET (Council for Technical and Vocational Education and Training). COTVET was set up by an act of Parliament (ACT 718) to formulate national policies on skills development across pre-tertiary and tertiary education in both formal and non-formal sectors of the economy.

1.6 Profile of Senior Management and Facilitating Staff

KERSL management has over ninety man years of industrial, research and teaching experience. KERSL management consists of the President, Vice President and Director of Finance. The following are brief profiles of members of the management team:

Dr. Kofi Korsah is the President of KERSL. He holds a B.Sc. in Electrical Engineering, MSc. in Nuclear Engineering and PhD in Nuclear Engineering. He has over 35 years' experience in instrumentation and control, data acquisition systems, systems integration, sensor research, and development of hardware/software systems for both nuclear and electrical applications. His work experience also includes several years in U.S. government research laboratories and teaching positions at universities in the United States, Ghana, and Liberia.

Dr. John H. Amuasi is the Vice President of KERSL He has a B.Sc. in physics, M.Sc. in Radiation Physics, and PhD in Medical Physics. He has over thirty 35 years' experience in nuclear medical physics, quality control of nuclear medicine equipment and radioimmunoassay. Dr. Amuasi has worked with the Ghana Atomic Energy Commission (GAEC) since 1974 rising through the ranks to become the Director General of the GAEC and retiring on the position of Chief Research Scientist in January 2006.

Mr. Joe Biney Arthur is the Director of Finance. He has over 24 years' experience in Accountancy & Administration. His experience includes work at Regimanuel-Gray Limited as Cost Accountant, The Canadian High Commission as Accountant, Maritime Trading (Shipping) Ghana Ltd as Finance & Admin Manager, and the Australian High Commission as Accountant and Office Manager.

KERSL also has 4 instructors as well as several part time instructors with expertise in industrial automation, instrumentation, industrial electricity, solar energy technology and mechatronics. This "instructor force" is more than adequate because of the narrow focus of training (i.e. unlike a typical polytechnic or university, KERSL does not have to have instructors in several different and disparate disciplines such as engineering, food science, agriculture, etc.).

1.7 Access to Learning Facilities

KERSL has more than adequate resources in terms of classrooms, lecture rooms, workshops, etc., to facilitate learning and meeting requirements of stakeholders. This infrastructure (laboratories, workshops, etc.) is described in more detail in chapter 2. This section is devoted to the technical focus areas of KERSL that enable the company to provide the necessary skills to meet stakeholder requirements:

1.7.1 Operational Focus Areas that Facilitate Offering the Diploma Programme

KERSL's current operational focus areas that contribute to the successful implementation of the diploma programme discussed in ths application are the following:

- ***Focus Area #1: Technical Skills and Continuing Education Provider***

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KERSL specializes in industrial automation and manufacturing skills training for technical professionals, engineers and technicians for Ghana's growing industrial environment. KERSL has training equipment such as industrial control panels, instrumentation equipment, full complement of solar power equipment, LabVIEW software and hardware for engineering education, etc., to facilitate instruction in the following areas:

- **Basic, intermediate, and advanced levels of training on programmable logic controllers (PLCs),** the workhorse of industrial and process controls, and how to use them to develop practical industrial applications and automate a company's operations.

- **Process instrumentation** training that enables students to learn about process sensors and their applications in industry. The manufacturing industries rely heavily on accurate monitoring, control, analyses, and interpretation of several variables such as temperature, pressure, flow, and level for productive and reliable operations. KERSL's training program in process instrumentation provides both classroom instruction as well as hands-on experience in construction, measurement techniques, calibration, and maintenance of typical instruments used in the process industries.

- **Industrial skills training** that provides learners with the versatile background and practical skills required in today's industrial or manufacturing environment. The training modules provide basic mechatronics skills required to operate, maintain, and troubleshoot an industrial facility. Unique assessment machines are used to teach troubleshooting skills and assess the mechanical and electrical aptitudes of each student so that the instructor will know which materials to emphasize to maximize assimilation of the subject matter by all. Companies can also use these Industrial Skills Assessment Machines to assess the level of competence of a technician being hired for a certain position (maintenance mechanic, machine operator, industrial electrician, or PLC (Automation) technician). Companies can buy the assessment machines themselves and use them to screen technicians being hired, or KERSL can screen/test the potential hires for the company for a fee.

- **Solar power construction and maintenance training on** how to design, install, and maintain a solar power system either as backup power for a home or for small commercial applications. In line with the word "energy" in the company's name, KERSL offers a practical course that includes, but is not limited to ways to assess the power needs for a home or small commercial enterprise; to design a residential stand-alone system, including the array, inverter, batteries, and overcurrent protection; and to maintain a photovoltaic (PV) solar power system.

- **Courses in LabVIEW programming** use LabVIEW, a graphical programming environment that provides an integrated software and hardware platform, simplifying development of any system that needs measurement and control. Engineers and scientists use this platform from design to production in multiple industries, research facilities, and educational institutions.

Maintenance Mechanics Skills

Industrial Electrician Skills

PLC Technician skills

Figure 1 Industrial Skills, Automation and Mechatronics training offered by KERSL

- ***Focus Area #2: Industrial Automation Solutions Provider***.

KERSL has expertize in **designing**, **installing**, and **maintaining** industrial automation systems for industries. This in-house practical expertize enables the company to impart practical hands-on experience diirectly to students. Services in this focus area include the following:

- **Turnkey automation design and installation contract:** If your industrial facility has outdated or no industrial automation systems and if you want to upgrade to more modern automation systems, KERSL can plan and install a complete automation system for you. Our expertize covers Siemens, Allen-Bradley(Rockwell Automation), and National Instruments automation products.

- **Maintenance contract:** KERSL can provide repair services on major automation brands such as Siemens and Allen-Bradley products. With KERSL, you have a single-source solution for all of your electrical, electronic, mechanical, and servo product repairs. The automation brands and products KERSL provides maintenance for include:

  - AC drives
  - DC drives
  - Programmable logic controllers
  - Servo motors and drives
  - Distributed control systems

KERSL engineers troubleshooting an automation system at one of the factories at the heavy industrial area in Accra.

Equipment at one of the factories that KERSL services.

Figure 2 Examples of maintenance services offered by KERSL

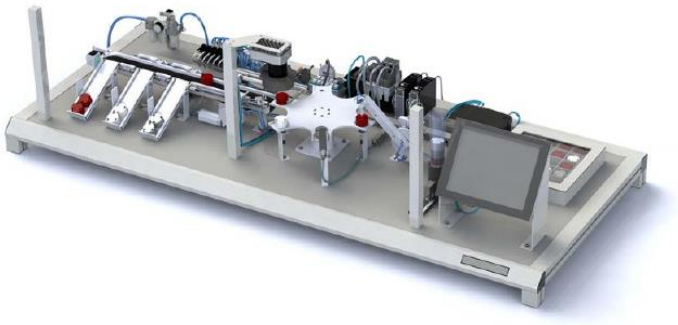
- ***Focus Area #3: Sales and Technical Support of National Instruments Products***

KERSL works in partnership with National Instruments of Armenia and sells NI's measurement and automation products as well as provides technical support for such. Again, this in-house expertize in the LabVIEW hardware and software platforms and the partnership with NI-Armenia enables the company to provide technical resources to students in a way not commonly found in typical Ghanaian engineering schools. NI is a recognized leader in hardware and software products for data acquisition and monitoring, control, machine vision, and engineering education. The software platform for all these applications is LabVIEW, an easy-to-use graphical programming language that enables applications to be developed in a much shorter time compared with the use of a conventional procedural language such as C.

Through NI-Armenia, KERSL offers a range of products for an electronics laboratory and engineering education in general. For an electronics laboratory, for example, KERSL offers NI's Educational Laboratory Virtual Instrumentation Suite (NI ELVIS II). This hands-on design and prototyping platform integrates 12 of the most commonly used instruments—including the oscilloscope, digital multimeter (DMM), function generator, and Bode analyzer—into a compact form factor ideal for the hardware laboratory, training room, or classroom. The ELVIS II is designed to facilitate the performance of laboratory experiments for entry-level electrical and electronic experiments with the flexibility to adapt to more specialized modules such as telecommunication, controls, and embedded application-based experiments

NI Lab equipment based on the ELVIS (Educational Laboratory Virtual Instrumentation System)

NI equipment for mechanical transmisions laboratory



NI Lab equipent to teach production line automation

Figure 3 Some of the various Laboratory products from National Instruments. KERSL is the local distributor of National Instruments products in Ghana.

- ***Focus Area #4: Hardware and Software Design Solutions Using NI Products***

KERSL has expertize in designing, installing, and maintaining measurements and control systems using NI's LabVIEW platform. In particular, if a company or institution needs technical support in designing a LabVIEW-based system to meet a particular application, KERSL can provide such services.

Engineers engaged in LabVIEW-based systems design for a client at KERSL's National Instruments Lab.

Instructors teaching basic hardware design solutions to students.

Figure 4 KERSL can design hardware and software products based on the LabVIEW platform for industry and academia.

- ***Focus Area #5: Mobile Laboratory Concept for Polytechnics and Universities***

It is well-recognized that a significant shortcoming in technical education is the lack of practical hands-on training. To help address this gap, KERSL has developed a unique mobile laboratory concept, in which a mobile laboratory, along with an instructor or instructors, are made available to a school for a laboratory class. KERSL provides the necessary hardware and/or software and develops the laboratory courses in close collaboration with the course instructor(s) from the institution that needs the mobile lab facility.

The programme has been started with the Biomedical Engineering Department of the University of Ghana. Specifically, KERSL provides biomedical sensors and instrumentation equipment for use by the students during each instrumentation laboratory session for a fee. The programme has been well-received and will be extended to other departments when appropriate equipment suitable for a particular class becomes available.

Where applicable, the KERSL mobile laboratory concept will be leveraged to enhance practical training to the students taking the diploma course by guiding the students to design and construct appropriate mobile equipment for training at other industries and institutions.

KERSL engineer explaining a point at one of the laboratory sessions at university of Ghana Biomedical Sciences department.

Figure 5 KERSL has developed a mobile laboratory concept for use at the instrumentation laboratory at the University of Ghana Biomedical Sciences department.

1.8 Scope of Facilitating Services – Internal Evaluation and Placement Services

KERSL has state-of-art facilities for training in manufacturing skills, automation, and solar power technology. The following photographs show some of the facilities and training sessions.

Mechatronics and automation training room

Mechatronics and automation training room

Practical training in industrial electricity

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Training in solar power installatiom

KERSL engineers troubleshooting an automation system at one of the factories at the heavy industrial area in Accra

KERSL instructor explaining how some of the training equipment works during KERSL Open Day (9, July, 2015)

KERSL engineer installing a solar panel

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KERSL instructors building a circuit with the ELVIS II for a training class

Several of the training stations are equipped with Siemens PLC and HMI equipment

The Standard Timing Model (STM) is a mechanical skills assessment tool used to identify mechanical aptitude, skills, and instincts.

The Electrical Skills Test Device (ESTD) is designed to screen and train industrial electricians and electro-mechanic production positions.

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Sample training session

Sample training session

Sample practical training session

Sample practical training session

Some of the training equipment

Training with KERSL-designed automation panels.

2. DETAILS OF KERSL's DIPLOMA PROGRAMME

This chapter describes KERSL's diploma programme in ***Industrial Skills, Automation and Mechatronics***. The format of the following sections follow COTVET's competency-based curriculum development procedure.

2.1 Needs Assessment

The need for a well-trained technical workforce has long been recognized by the government, industry, as well as the general public. The following excerpts from speeches by recognized leaders and educators in the country echoes the need to revolutionize the skill gap hampering the manufacturing sector:

> *"...due to the challenges of the global world, it is imperative for polytechnics to offer programmes that would give trainees the required skills and training to enable them to meet the demands of the job market..." Professor Jane Naana Opoku Agyemang, Minister of Education (**Ghana News Agency Publication on 24 Feb. 2013,** www.ghananewsagency.org/print/56770).*

> *"The development of curriculum for all the HND programmes appears to be lagging behind and requires immediate attention to make them relevant and industry-friendly. Moreover, Polytechnic education is not career-oriented with less emphasis on the practical content of the various courses. There is limited collaboration between Polytechnics and industry in Ghana. The programmes run by the institutions are less relevant to the needs of industry (**Address by Rev. Prof. Daniel A. Nyarko, Rector, Takoradi Polytechnic on 23rd March 2011**).*

> *"... There still exists a big gap between competence and theory in polytechnic education..." Mrs. Emelia Anang, Chairman of the Cape Coast Polytechnic Council (www.ghananewsagency.org/print/56770). There is also a disconnect between theory and practical learning. As indicated by Mrs. Emelia Anang, there exists a gap between competence and theory. The disconnect leads to low performance on the job, with the consequential impact being low productivity.*

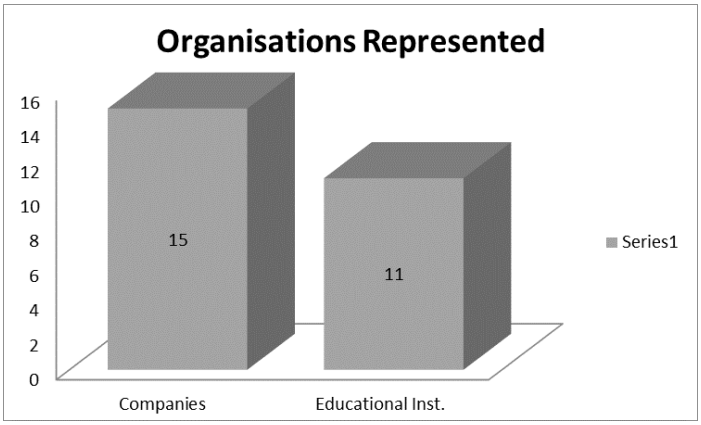
Lack of technical skills of personnel among manufacturing firms prompted AGI to write to KERSL in September 2013 to demand establishment of training modules to address skill gaps. Several companies have also contacted KERSL to train their workers in production and automation techniques. In order to further ascertain the automation training needs of industry, KERSL organized a free one day workshop on November of 2015, for executives of AGI, GRATIS, company managers, engineering training supervisors, and leaders of technical training institutions. The purpose of the one-day "Manufacturing Skills Awareness" workshop was to provide stakeholders with a first-hand understanding of how KERSL's training provides the core skills needed to troubleshoot an industrial facility.

Participants at the workshop completed a questionnaire that was later analysed to assess industry leaders' opinion on the effectiveness of KERSL's raining programme and how KERSL can improve its training and other operations to industry and institutions.

Below are the results of the questionnaires illustrated with tables and charts.

1. *Number of companies and institutions that were represented at the one-day workshop*

Fifteen companies from the Accra and Tema industrial areas were represented. Examples of the companies include Flour Mill Ghana Ltd, Reroy Cables Ltd, Duraplast Ghana Ltd, Fan Milk Ghana Ltd etc. Eleven government and technical institutions were also represented. These include GRATIS Foundation, Accra, Cape Coast, Takoradi, Koforidua, and Kumasi Polytechnics, and St. Pauls Technical Institute.



2. *Assessment of interest in KERSL programmes.*

KERSL wanted to know how much interest participants had in all the programmes offered by KERSL. To assess this, participants in both workshops were asked which of the six programmes offered by KERSL they are likely to recommend to people for training. The six programmes offered by KERSL are as follows:

a. Manufacturing skills Programme
b. Industrial Automation Programme
c. Factory Floor Supervisory skills Programme
d. Statistical Process Control
e. Measurement, Control and LabVIEW Certification
f. Renewable Energy Systems Design and Applications Programme.

The results are shown in the table and graph below and are also summarized as follows:

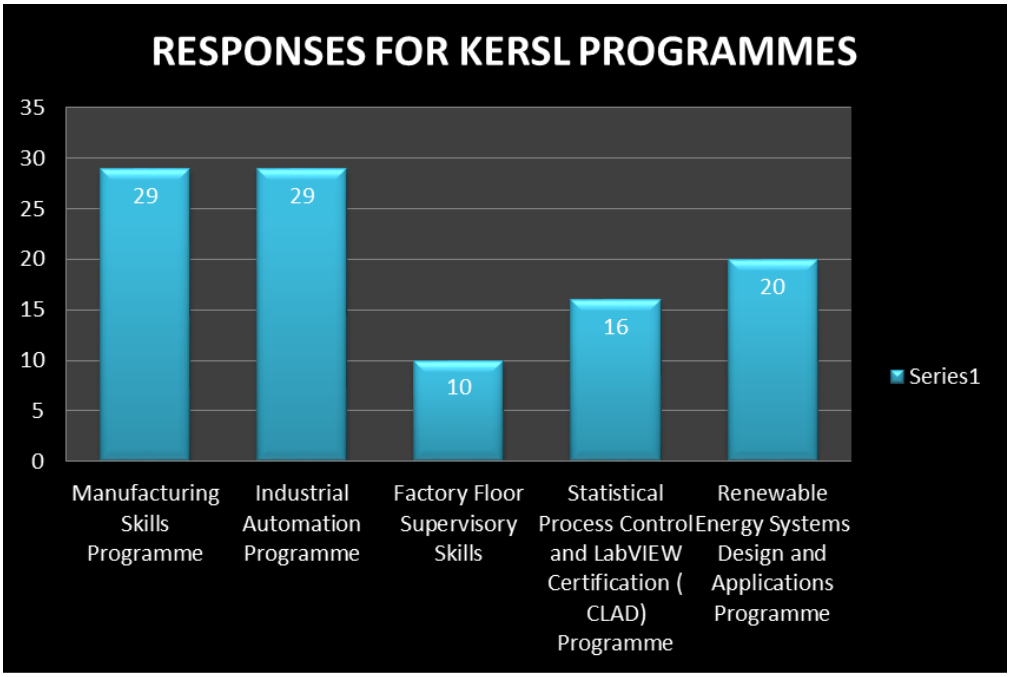
i. The KERSL programmes that are clearly of most interest to companies and institutions are the Manufacturing Skills programme and the Industrial Automation programme. This is a strong validation of the manufacturing skills (i.e., industrial skills) programme and forms the basis for KERSL's application for accreditation to offer these two programmes under one diploma programme for high school graduates. The 3-semester programme provides an alternative and industry-driven training opportunity for high school graduates.

According to the results of the survey, 29% of respondents said they will either bring or recommend people for training in the Manufacturing Skills programme. A similar percentage said they will also recommend the industrial automation programme. Thus, 58% of respondents were in favour of the two programmes.

ii. KERSL programmes that were of least interest to respondents were the Factory Floor Supervisory Skills programme (about 10%) and the Statistical Process Control and LabVIEW Programming (about 15%).

iii. While interest in the renewable energy systems programme was relatively low (about 19% of all respondents), the programme is clearly of interest since it came third in the ranking (see table and graph below).

KERSL Programme	Programmes Description	Number of Responses
A	Manufacturing Skills Programme	29
B	Industrial Automation Programme	29
C	Factory Floor Supervisory Skills	10
D	Statistical Process Control and LabVIEW Programming	16
E	Renewable Energy Systems Design and Applications Programme	20
	Total	**104**



3. *Perspectives of respondents on the need for KERSL's training programmes for industry*

Participants were asked how this training workshop had affected their perspective on the need for KERSL's training. There were three options to answer this question:

i. It has made a positive impact
ii. It has made a negative impact
iii. It has not made any impact

Analysis of the results revealed that all respondents had chosen option (I). That is, 100% of the participants viewed the workshops as having made a positive impact on them regarding the need for KERSL's training programmes. This is a significant validation of KERSL's programmes.

4. Respondents that would recommend KERSL's training programmes to their companies/Institutions as well as other companies/institutions

Participants were asked if they would recommend KERSL's training programmes either to their own companies or institutions or to other companies and/or institutions. All respondents said they would recommend KERSL training programmes to either their own companies or institutions, or companies and institutions outside their own.

2.2 Occupational Standards Generation

This section discusses the competences required of learners to reflect appropriate knowledge, values, and practical skills required of students who complete the diploma programme.

2.2.1 Required Knowledge

A student who completes the diploma programme will be equipped with the **critical skills required to operate, maintain, and troubleshoot an industrial facility**. The training provides the student with the background and practical skills required in today's industrial or manufacturing environment. Part of the program involves basic mechatronics courses from the vocational level through the technologist level. The term *mechatronics* encompasses a broad range of technical disciplines including mechanics, mechanical engineering, electronics, control systems, and computer systems. It is defined as the "multidisciplinary application of mechanics, electronics, control systems and computer systems to optimize the performance of products or processes." Many industrial and/or manufacturing processes today involve a combination of these disciplines. Technicians that have a strong practical background in the requisite components of these disciplines have the best chance of functioning optimally and increasing productivity in industry.

As products, systems, and manufacturing facilities have become increasingly mechatronic in nature, it has become necessary that the people who design, install, maintain, repair, and calibrate products and systems in such facilities have the skills to integrate mechanical, electronic, and computer software systems.

Participants in the diploma programme will be equipped not only with the necessary basic mechanical skills, but also with the basic electrical skills necessary to read and troubleshoot using electrical schematics as well as programme and troubleshoot programmable logic controllers (PLC), the workhorse of any modern-day industrial facility. In short, the programme will equip a person to function in all of the following traditional roles at the entry level in industry:

A. Machine operator
B. Industrial maintenance mechanic
C. Industrial electrician, or
D. PLC maintenance technician.

The student will also learn the following:

E. Workplace ethics, health and safety procedures through KERSL's health, safety and supervisory skills courses.
F. Use of the LabVIEW platform to design hardware and software solutions for some applications likely to be encountered in process industries.
G. Design, installation, and maintenance of a solar power system either as backup power for homes or for small commercial applications.

Maintenance mechanic skills

Industrial electrician skills

PLC technician skills

The Industrial Skills and Mechatronics programme equips the student with the skills illustrated here.

Overall the programme delivers three significant impacts:

1. It provides students with a sufficiently versatile background and enough hands-on experience to be able to start their own businesses if they so choose;
2. It guarantees that trainees graduating from the programme will be "employment-ready" at the entry level in a manufacturing or industrial facility;
3. The training guarantees that employee students sponsored by their employers will provide their companies with improved industrial performance, productivity, and profitability.

The following briefly describes each of the areas A through E above.

A. Machine Operator Component

Machine operators operate equipment and tools in manufacturing plants. Their job involves adjusting machine settings, lifting material onto machines, and testing finished products. The basic machine operator typically has a high school diploma and receives on-the-job training. This module in the KERSL diploma programme provides the student with the basic skills needed to work in this capacity almost immediately he/she is hired, without a steep learning curve. The course content includes theory and hands-on experience with machining equipment, machine tools, machinist application math, blueprint reading and precision measurement.

B. Industrial Maintenance Mechanics Component

Maintenance mechanics are needed in every industry that uses machinery, from assembly plants to power equipment manufacturers. Mechanics typically repair and maintain equipment but may also install and dismantle it. The courses are designed to prepare students for positions as maintenance mechanics, maintenance technicians, and operations technicians in mining, refinery, power generation, natural gas, pharmaceutical companies, and other industries.

C. Industrial Electrician Component

Industrial electricians install, maintain, test, troubleshoot, and repair electrical equipment, including electrical and electronic controls on various types of equipment found in an industrial plant. They often work in maintenance or construction in various industries, and their specific duties may depend on the employer. Other responsibilities may include running electronic tests and inspections, cleaning contacts or circuit boards, ensuring that systems are grounded, and installing outlets, lighting fixtures, and switches. Preventive measures such as oiling motors, bending conduit, and replacing old wiring are also among their duties. When electrical systems break down, industrial electricians are responsible for troubleshooting and solving the problem.

D. PLC Maintenance Technician (or Automation Technician) Component

Programmable logic controllers are the workhorse of today's industries. KERSL's PLC training courses prepares the PLC maintenance technician (automation technician) to troubleshoot PLCs and programme in ladder logic. At a higher level, automation technicians monitor, troubleshoot, and service the computerized systems and robotic devices that are designed to reduce human participation and interaction in industries such as food and beverage processing, pharmaceutical manufacturing, and mining. Automated devices include assembly-line machines and computer-controlled, air-conditioning systems for buildings.

An automation technician should have a good background in mechatronics (combination of electronics, mechanical engineering, and computer science). This is why the diploma programme begins with the basic mechatronics component as described above. The automation component of the diploma programme focuses on advanced concepts in PLC applications (hardware and software design, human-machine interfaces (HMI)) in industry:

E. Workplace Safety, Health and Supervisory Skills Component

The Workplace Safety, Health and Supervisory Skills component of the diploma programme primarily provides basic training in occupational safety and health, but also includes a component that highlights work ethics and supervisory skills. Factory managers and supervisors are often in charge, so they must have good work ethics and the ability to take the lead and encourage their factory floor teams to enhance productivity.

In a factory environment, getting items produced, sorted, assembled, tweaked, packed, and ready for distribution requires teamwork and communication, which a factory floor supervisor should know how to develop in the workers. Often the factory floor supervisor may be selected from the factory floor staff because of his or her seniority, skills, work experience, etc. The supervisor is the one person who can take immediate, direct action to make sure that his or her work area is safe and healthy for all employees. Also, the supervisor bears the greatest responsibility and accountability for implementing the safety and health programme because it is he or she who works most directly with the employee. The course discusses the need for the supervisor to understand and apply management and leadership principles to safety and health issues in the workplace to ensure that employees enjoy an injury- and illness-free work environment.

F. Data Acquisition and LabVIEW Programming Component

Instrumentation, control and data acquisition is at the heart of several industrial processes. An understanding of the hardware and software used in data acquisition systems for measuring process variables such as temperature, flow, conductivity, etc., and the ability to program such systems for analysis in industry (manufacturing, food processing, pharmaceutical, etc.), research or academic environment, increases the marketability of a technician. In this module, students acquire practical hands-on experience in data acquisition using the LabVIEW software platform.

LabVIEW is an easy-to-use graphical programming language that enables applications to be developed in a much shorter time compared with the use of a conventional procedural language such as C. With LabVIEW, you can write sophisticated programs and applications in a shorter amount of time without the need for a computer science degree. It is also an industry-standard software for data acquisition and instrument control. More than 24,000 companies around the world use National.

G. Renewable Energy Systems Design and Applications Component

One of the objectives of the diploma course is to produce competent technicians that are able to even start their own businesses in the areas outlined above, including energy. The use of solar energy in the country is beginning to grow, albeit slowly. It is the perfect time to develop technical competency in solar power systems. This component of the diploma programme offers a practical course on how to design, install, and maintain a solar power system either as backup power for homes or for small commercial applications. Students will learn several practical skills including, but not limited to, the following:

- How to assess the power needs for your home or small commercial enterprise;
- How to design a residential stand-alone system, including the array, inverter, batteries, and overcurrent protection;
- How to maintain a photovoltaic (PV) solar power system.

Table 1 lists the complete set of courses for the diploma programme.

2.3 Duration of the Diploma Programme and Method of Administration

Table 1 lists the courses, contact hours and credit hours for the diploma programme. The credit hours for each course was calculated based on COTVET's criterion that 15 contact hours is equivalent to 1 credit hour. The total number of contact hours for the duration of the diploma program is 795, which is equivalent to 53 credit hours. Instruction will be structured such that each student will carry 22 credit hours per semester. This means that the programme will take ((53 credit hours) / (22credit hours per semester)), or 2.4 semesters to complete. In addition, each student will also be required to complete a project that is industry-driven. Thus, the total duration for the diploma course will be 3 semesters. The requirement for an industry-driven project means that KERSL will work with industry to develop projects desired by the industry itself. This collaboration with industry will result in a win-win situation for both industry and the students. On the one hand, industry will get the (newly designed, fabricated, or repaired) equipment it needs, while the student will acquire the much-needed experience.

Table 1 Complete list of courses for the *Industrial Skills, Automation and Mechatronics* programme

COURSE NAME	COURSE CODE	CONTACT HOURS	CREDIT HOURS*
Shop Mathematics and Blueprint Reading	KCSMBP-02	30	2.0
Basic Mechanical Components and Measurement Tools	KCBMCM-02	30	2.0
Machine Operator Essentials and Shop Practices	KCMSPR-02	30	2.0
Fundamentals of Industrial Pneumatics	KCFIPN-02	30	2.0
Fundamentals of Industrial Hydraulics	KCFIHY-02	30	2.0
Electrical Wiring Practice I	KCEWP1-02	30	2.0
Industrial Electricity I	KCIEL1-02	30	2.0
Industrial Electricity II	KCIEL2-02	30	2.0
Industrial Electricity III	KCIEL3-02	30	2.0
Practical Electronics	KCPREL-02	30	2.0
Fundamentals of Digital Electronics	KCFDEL-03	45	3.0
Introduction to Process Instrumentation and Measurement Techniques	KCIPRI-04	60	4.0
Basic PLC Programming	KCBPLC-02	30	2.0
Intermediate PLC	KCIPLC-02	30	2.0
Introduction to Process Control	KCIPRC-02	30	2.0
Industrial Power Electronics	KCIPEL-02	30	2.0

COURSE NAME	COURSE CODE	CONTACT HOURS	CREDIT HOURS*
Variable Speed Drives	KCVSDR-02	30	2.0
Advanced PLC with Electro-pneumatics	KCAPLE-02	30	2.0
Advanced PLC with HMI	KCAPLH-02	30	2.0
Advanced PLC with PROFIBUS Communication and Networking	KCAPCN-02	30	2.0
Workplace Safety, Health and Supervisory Skills	KCOSHS-02	30	2.0
Introduction to LabVIEW Programming	KCLVP1-02	30	2.0
Intermediate LabVIEW Programming	KCLVP2-02	30	2.0
Introduction to Data Acquisition and Measurements with LabVIEW	KCDAQM-02	30	2.0
Solar Power Design, Installation, and Maintenance	KCSPDI-02	30	2.0
TOTALS		795	53

*Calculation of credit hours is based on the COTVET criterion that 1 credit hour is equivalent to 15 hours of instruction.

2.4 Statement of Standards: Unit Specifications

This section defines the learning outcomes for all the courses. The statement of standards defines the learning outcomes and aspects of achievement, which ensure that a student has demonstrated the necessary skills and knowledge. A student following this prescribed course of study (standards) demonstrates that the necessary skills and knowledge has been acquired by the student and that the latter is worthy of being awarded a diploma in Industrial Skills, Automation and Mechatronics. Table 1 lists all the courses whose unit specifications are provided in this section.

2.4.1 Shop Mathematics and Blueprint Reading

COURSE CODE: KCSMBP-02

Course Title: Shop Mathematics and Blueprint Reading
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:
On completion of this course the student will be able to

1. Demonstrate ability to perform basic mathematical functions used on the shop floor and various industrial processes.
2. Demonstrate ability to read and interpret blueprints.

Performance Criteria:

Learning Outcome 1: Demonstrate ability to perform basic mathematical operations used on the shop floor and in various industrial processes.

Objectives:
Demonstrate understanding of shop mathematics:

Base 10, decimals, decimal equivalents, percentages, fractions, algebraic expressions, simple equations, ratio, proportion, graphs, charts, data handling, weights, measures, metric conversion, exponents, square roots, right triangles, angles, plane figures, area, measurement of solid figures, volume, introduction to trigonometric tables.

Learning Outcome 2: Demonstrate ability to read and interpret blueprints.

Objectives:

a. Demonstrate understanding of the use orthographic projection techniques to describe three dimensional objects.
b. Demonstrate understanding of the use auxiliary views in conjunction with orthographic projections to describe three dimensional objects.
c. Demonstrate the use of sectioning to describe internal features of three dimensional objects.
d. Demonstrate understanding of how to interpret features of engineering drawing (linework and dimensioning).
e. Demonstrate understanding of how to iinterpret title blocks of engineering drawings.
f. Demonstrate understanding of how to interpret complete engineering drawings.
g. Demonstrate understanding of how to iinterpret assembly drawings.

2.4.2 Basic Mechanical Components and Measurement Tools

COURSE CODE: KCBMCM-02

Course Title: Basic Measurement Tools and Mechanical Components
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:
On completion of this course the student will be able to:

1. Demonstrate an understanding of linear measurements on the shop floor
2. Demonstrate an understanding of hand tools used on the shop floor
3. Demonstrate an understanding of the mechanical components that form the fundamental building blocks of mechanical machines.
4. Demonstrate an understanding of the principles of bearing operation and lubrication.

Performance Criteria

Learning Outcome 1: Demonstrate an understanding of linear measurements on the shop floor

Objectives:

a. Understand linear measurement fundamentals and common errors made in making linear measurements.
b. Understand the fundamental applications of a combination square in English and Metric units.
c. Understand the fundamental applications of a combination square with center head in English and Metric units.
d. Understand the Vernier Scale as a measurement scale or system.
e. Understand the applications of the vernier caliper in English and Metric units.
f. Understand the application of dial caliper in English and Metric units.
g. Understand the application of the digital caliper in English and Metric units.
h. Understand the application of the vernier micrometer in English and Metric units.
i. Understand the applications of the digital micrometer in English and Metric units.
j. Understand the care and maintenance of measuring devices.

Learning Outcome 2: Demonstrate an understanding of hand tools used on the shop floor

Objectives:

a. Understand the major types of hammers, chisels, pliers, wrenches, screwdrivers and punches and be familiar with their functions.
b. Understand how to use hacksaws.
c. Be familiar with twist drills and demonstrate their use

Learning Outcome 3: Demonstrate an understanding of the mechanical components that form the fundamental building blocks of mechanical machines.

Objectives:

a. Understand the definition of Mechanical Advantage for the following components and demonstrate familiarity with their common applications: (a) pulley; (b) wheel; (c) lever; (d) inclined plane; (e) screw.
b. Be familiar with the common applications of a wedge.
c. Be familiar with levers as machine elements and be able to calculate force and distance adjustments in simple lever applications.
d. Be familiar with the cranks as machine elements.
e. Be familiar with linkages and how they function.
f. Be familiar with the four bar linkage and its variations.
g. Be familiar with springs as machine elements.
h. Identify simple machine elements in compound machinery
i. Be able to recognize the major types of cams.
j. Be familiar with the components of cam applications.

k. Be able to measure the relationship between cam shape and stroke length in a given application.
l. Be able to measure the relationship between cam shape and stroke timing in a given application.
m. Be familiar with cam maintenance techniques.
n. Be able to identify machine elements in cam applications.
o. Be familiar with the elements of machine timing.
p. Be familiar with the interaction of timing elements.
q. Be familiar with the installation and use of timing wheels.
r. Be able to cconstruct standard and bar timing charts.
s. Be familiar with basic timing adjustments.
t. Be able to make basic timing adjustments using the Elementary Timing Model.
u. Be able to chart basic timing adjustments for the Elementary Timing Model.

Learning Outcome 4: Demonstrate an understanding of the principles of bearing operation and lubrication.

Objectives:

a. The student will understand the following:
   i. bearing technology.
   ii. the characteristics and functions of plain bearings.
   iii. the characteristics and functions of ball bearings.
   iv. the characteristics and functions of roller bearings.
   v. rotational forces on shafts and bearings.
   vi. the characteristics and functions of thrust bearings.
   vii. standard mounts and mounting techniques.
   viii. bearing lubrication.
   ix. bearing maintenance technique.

b. The student will understand the following:
   i. characteristics of friction.
   ii. differences between static and kinetic friction of lubricated and un-lubricated sliding elements.
   iii. the functions of lubricants.
   iv. the major types of lubricants.
   v. the lubrication of gear mechanisms.
   vi. the lubrication of plain and anti-friction bearings.
   vii. the major methods of lubrication.
   viii. The techniques for storing and handling lubricants.

2.4.3 Machine Operator Essentials and Shop Practices

COURSE CODE: KCMSPR-02

Course Title: Machine Operator Essentials and Shop Practices
Commencement Date: August 2018

Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:
On completion of this course the student will be able to:

1. Identify and operate various hand tools (saw, file, drill)
2. Plan and produce work pieces on a manual drill press to required blueprint specifications using common industry methods
3. Plan and produce work pieces on a manual engine lathe to required blueprint specifications using common industry methods
4. Plan and produce work pieces on a manual milling machine to required blueprint specifications using common industry methods

Performance Criteria:

Learning Outcome 1: Identify and operate various hand tools (saw, file, drill).

Objectives:
The student will understand the following:

a. Machine shop safety
b. Use of various hand tools such as saw, file and drill; basic bench work
c. Metal cutting

Learning Outcome 2: Plan and produce work pieces on a manual drill press to required blueprint specifications using common industry methods

Objectives:
The student will be able to use the knowledge gained in the "Shop Mathematics and **blueprint Reading**" course to plan and produce work pieces on a manual drill press to required blueprint specifications using common industry methods.

Learning Outcome 3: Plan and produce work pieces on a manual engine lathe to required blueprint specifications using common industry methods

Objectives:
The student will be able to use the knowledge gained in the "Shop Mathematics and **blueprint Reading**" course to plan and produce work pieces on a manual engine lathe to required blueprint specifications using common industry methods

Learning Outcome 4: Plan and produce work pieces on a manual milling machine to required blueprint specifications using common industry methods

Objectives:
The student will be able to use the knowledge gained in the "Shop Mathematics and **blueprint Reading**" course to plan and produce work pieces on a manual milling machine to required blueprint specifications using common industry methods

2.4.4 Fundamentals of Industrial Pneumatics

COURSE CODE: KCFIPN-02

Course Title: Fundamentals of Industrial Pneumatics
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:
On completion of this course the student will be able to:

1. Demonstrate an understanding of the units and measurement scales associated with compressed air systems and the fundamentals of compressed air generation and distribution.
2. Demonstrate the ability to identify and describe the design, features and operation of pneumatic components.
3. Demonstrate the ability to build basic pneumatic circuits and solve pneumatic problems.
4. Demonstrate an understanding of troubleshooting and maintenance practices for pneumatic systems.

Performance Criteria:

Learning Outcome 1: Demonstrate an understanding of the units and measurement scales associated with compressed air systems and the fundamentals of compressed air generation.

Objectives:

a. Understand the advantages and disadvantages of air.
b. Understand the theory of air and gas laws.
c. Understand SI units and conversions related to gas pressures, temperatures and volumes.
d. Understand the fundamentals of compressors dryers and distribution systems for compressed air.

Learning Outcome 2: Demonstrate the ability to identify and describe the design, features and operation of pneumatic components.

Objectives:

a. Understand Single acting cylinders
b. Understand pressure switches, regulators and relief valves
c. Understand directional and solenoid operated valves
d. Understand Double acting cylinders
e. Understand quick exhaust valves
f. Understand Logic valves including shuttle valves and two pressure valves

g. Understand speed control including flow control valves
h. Understand timing valves

Learning Outcome 3: Demonstrate the ability to build basic pneumatic circuits and solve pneumatic problems.

Objectives:
a. Understand valve port labelling
b. Understand schematic symbols for directional valves
c. Understand symbols for valve actuators
d. Understand circuit diagram layout
e. Understand direct and indirect control
f. Understand how to solve pneumatic problems

Learning Outcome 4: Demonstrate an understanding of troubleshooting and maintenance practices for pneumatic systems.

Objectives:
a. Understand the functions of filters and lubricators.
b. Understand maintenance of compressed air systems (the effects of water vapor and moisture in an air system and how to control it; how temperature affects pressure and air volume).
c. Understand how to troubleshoot and test compressors, receivers, relief valves, dryers, valves and cylinders.
d. Understand how to adjust system control devices such as pressure switches, regulators, lubricators and dew points for dryers.
e. Understand how to read the pneumatic symbols for troubleshooting from the schematic.

2.4.5 Fundamentals of Industrial Hydraulics

COURSE CODE: KCFIHY-02

Course Title: Fundamentals of Industrial Hydraulics
Commencement Date: August 2018
Post-Secondary Diploma Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:
On completion of this course the student will be able to:
1. Demonstrate an understanding of the units and basic concepts of hydraulics such as pressure, Pascal's Law, hydraulic leverage versus mechanical leverage, simple hydraulic press
2. Demonstrate an understanding of how hydraulic components and actuators work
3. Demonstrate an understanding of troubleshooting and maintenance practices for hydraulic systems.

Performance Criteria:

Learning Outcome 1: Demonstrate an understanding of the units and basic concepts of hydraulics such as pressure, Pascal's Law, hydraulic leverage versus mechanical leverage, simple hydraulic press

Objectives:

a. Understand the units of measure for pressure (Pascal, bar, lb per square inch
b. Understand the basic laws governing fluid power: Pascal's law, Boyle's law, Charles' law, static head pressure.
c. Understand work and power, compressibility of fluids.
d. Understand hydraulic versus mechanical leverage
e. Understand the workings of a simple hydraulic press

Learning Outcome 2: Demonstrate an understanding of how hydraulic components and actuators work

Objectives:

a. Understand various types of hydraulic pumps
b. Understand various types of valves, cylinders and motors
c. Understand uses of hydraulic hoses and fittings
d. Understand hydraulic circuits and schematics

Learning Outcome 3: Demonstrate understanding of troubleshooting and maintenance practices for hydraulic systems.

Objectives:

a. Understand uses of hydraulic oil, oil and viscosity recommendations; maintenance of hydraulic fluids in the system
b. Understand causes of component failure; effect of incorrect flow, excessive temperature, etc.
c. Safety procedures and practices related to hydraulic equipment

2.4.6 Electrical Wiring Practice I

COURSE CODE: KCEWP1-02
Course Title: Electrical Wiring Practice 1
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

This course is especially designed to enable a student who graduates with the KERSL diploma in Industrial Skills, Automation and Mechatronics, to be able to sit for the Ghana Energy Commission's Electrical Wiring Practice Certification in Domestic Wiring. Additional course content will be picked up by the student during the Industrial Electricity courses.

Learning Outcomes:
On completion of the course, the student will be able to:

1. Demonstrate an understanding of electrical safety practice.
2. Demonstrate an understanding of electric current, electric potential and simple DC battery circuits.
3. Demonstrate an understanding of how to use tools used in the electrical wiring trade.
4. Demonstrate an understanding of electrical and electronic symbols.
5. Demonstrate and understanding of wiring diagrams and residential wiring installations.
6. Demonstrate an understanding of how to prepare bill of quantities.
7. Demonstrate an understanding of energy efficiency and alternate sources of supply.
8. Demonstrate an understanding of customer relations and regulations.

Performance Criteria:

Learning Outcome 1: Demonstrate an understanding of electrical safety practice.

Objectives:

a. Identify dangerous situations and behaviours likely to cause accidents
   i. Some dangerous situations are ladders, hand tools, scaffolds and contact with electricity.
   ii. Dangerous behaviours include lack of concentration, disregard for safety practices, laziness, impatience, indecision and complacency.
b. Select suitable protective clothing for specific jobs.
   i. Goggles, hand gloves, helmet, safety boots, safety belt, overall/overcoat
c. Understand practical application of health and safety at work.
   i. Employer's obligation: ensuring health and safety of employees, providing and maintaining equipment, provision of protective equipment clothing for employees, enforcement of safety rules.
   ii. Employee's obligation: (corporation with employer and colleagues to ensure safe work practices.
d. Understand what to do in case of an accident
   i. Wash wound with clean water, cover with sterilized dressing, seek medical attention.
   ii. Understand the use of first aid and use of fire extinguisher.

Learning Outcome 2: Demonstrate an understanding of electric current, electric potential and simple DC battery circuits.

Objectives:

a. Demonstrate an understanding that all matter consists of a nucleus of proton and neutrons, and outer shells of electrons.
b. Demonstrate an understanding of the nature of electricity:
   i. The electron as a charge-carrying entity and the coulomb as a unit of charge.

ii. Static electricity as charges separated by some distance.
iii. Electric current as a flow charge (electrons), with “amp” as the unit.
iv. Electric potential as the amount of work needed to move a unit positive charge from a reference point to a specific point, with “volt” as the unit.
v. Simple DC battery circuits (e.g., components of a flash light). Introduction of the “resistor” as a component that impedes the flow of current.

Learning Outcome 3: Demonstrate an understanding of how to use tools used in the electrical wiring trade

Objectives:

a. Understand the selection and use of hand / power tools to perform a specific task on a given job.
   i. Voltmeters, multimeters, insulation resistance testers, earth resistance testers, drills, cutters, etc.

b. Identify tools and materials used for cable joining and termination
   i. Blow lamp/heat gun
   ii. Crimping tool
   iii. Hacksaw
   iv. Side cutters
   v. Combination pliers
   vi. Knife
   vii. Soldering iron
   viii. Set of screw drivers

Learning Outcome 4: Demonstrate an understanding of electrical and electronic symbols.

Objectives:

a. Understand symbols for home appliances and electrical symbols
   i. Air conditioner, Refrigerator, Freezer, Fan, Electric oven, Microwave oven, Washer, Dishwasher, Dryer, Cooker, Electric heater, Water heater, Television, Electric pump, Thermostat, Electric bell.

   ii. Switches, sockets, home system detectors (gas detectors, motion detectors, infrared detectors, fire detectors, etc.).

Learning Outcome 5: Demonstrate an understanding of wiring diagrams and residential wiring installations.

Objectives:

a. Identify types of wiring and schematic diagrams
   i. Block diagrams, single line diagrams
   ii. As-fitted / As-built / As-installed drawings

b. Distinguish between schematic and wiring diagrams
    i. Design, draw and interpret types of schematic and wiring diagrams
        - Identify components in a wiring diagram
        - Identify terminal conventions in a wiring diagram
        - Identify wiring conventions in a wiring diagram
        - Identify and interpret bundles in a wiring diagram
        - Relate the wiring diagram to actual hardware
        - Relate the wiring diagram to actual wires
        - Troubleshoot a circuit using wiring diagram

c. Identify types of cables
    i. Single core PVC insulated and sheathed cable
    ii. Single core PVC insulated only cable
    iii. Multicore core PVC insulated and sheathed cable
    iv. Vulcanized rubber insulated cable
    v. Tough rubber insulated cable
    vi. Mineral insulated cable

d. Understand sizes, current-carrying capacity, and how to select cables for a particular task.
    i. 1.5mm^2 for lighting
    ii. 2.5mm^2 for socket outlets
    iii. 4.0mm^2 for water heaters and air conditioning
    iv. 6.0mm^2 for cooker
    v. 16mm^2 for earthing unit and service mains

e. Identify types of cable joints and understand how to make cable joints and terminate cables.

f. Explain space factor for conduits
    i. Trunking – 45% or 0.45 pu
    ii. Conduit – 40% or 0.4 pu
    iii. Duct – 35% or 0.35 pu

g. Perform surface and conduit wiring systems

h. Identify types of distribution systems

i. State functions of the distribution units (for protection, distribution and controlling)

j. Determine final circuits and number of points per circuit

k. Apply diversity factor to determine maximum current per circuit.

Learning Outcome 6: Demonstrate an understanding of how to prepare bill of quantities.

Objectives:

a. Explain bill of quantities.
b. Explain types of estimates.
c. Understand how to prepare estimates for a given job.

Learning Outcome 7: Demonstrate an understanding of energy efficiency and alternate sources of supply.

Objectives:

a. Identify types of energy efficient lighting technologies
    i. Compact fluorescent lamps (CFLs)
    ii. Fluorescent lamps (T5, T8, T9)
    iii. Light Emitting Diodes

b. Define power factor and recommend energy efficient measures
    i. Define power factor using the following considerations: phase angle, (lagging or leading), active power (kW), reactive power (kVAr), apparent power (kVA)

    ii. Recommend energy efficiency measures: occupancy sensors, using energy efficient appliance, use of photocells, etc.

c. Apply energy efficiency regulations of Ghana
    i. L.I. 1815- Energy Efficiency Standards and Labelling (Non-Conducted Air Conditioners and Self-Ballasted Fluorescent Lamps) Regulations 2005.

    ii. L.I. 1932- Energy Efficiency (Prohibition of Manufacture, Sale or Importation of Incandescent Filament Lamp, Used Refrigerator, Used Refrigerator Freezer, Used Freezer and Used Air Conditioner) Regulation 2008.

    iii. L.I. 1558- Energy Efficiency Standards and Labelling (Household Refrigerating Appliances) Regulations, 2009.

d. Identify alternative sources of electricity
    i. Solar systems, wind turbine, biomass, mini hydro, micro hydro.

e. Describe how electricity is generated from each alternative source of supply.

Learning Outcome 8: Demonstrate an understanding of customer relations and regulations.

Objectives:

a. Demonstrate interpersonal and communication skills.
    i. Explain interpersonal skills (skills used by a person to properly interact with others, practical language skills)

ii. Apply types of communication and interpersonal skills

b. Understand and apply electrical wiring regulations.
   i. Interpret the guidelines for domestic wiring (2011, LI. 2008)
   ii. Apply rules and regulations governing domestic wiring
   iii. Comply with regulations and guidelines as specified in the electrical wiring regulation, 2011, L.I. 2008.

2.4.7 **Industrial Electricity I** (Applied Electricity and Magnetism)

COURSE CODE: KCIEL1-02
Course Title: Industrial Electricity I
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:

On completion of this course the student will be able to:

1. Demonstrate an understanding of electric current, electric potential and simple DC battery circuits.
2. Demonstrate an understanding of the principles of magnetism, electromagnetic induction, and application of these principles to the design of basic DC motors.
3. Demonstrate an understanding of basic DC networks and components (resistors, switches, relays, generators, motors) and how they operate in electrical circuits.
4. Demonstrate an understanding of basic single phase AC networks and components (resistors, inductors, capacitors, transformers) and how they operate in electrical circuits.

Performance Criteria:

Learning Outcome 1: Demonstrate an understanding of electric current, electric potential and simple DC battery circuits.

Objectives:

b) Demonstrate an understanding that all matter consists of a nucleus of proton and neutrons, and outer shells of electrons.
c) Demonstrate an understanding of the nature of electricity:
   i. The electron as a charge-carrying entity and the coulomb as a unit of charge.
   ii. Static electricity as charges separated by some distance.
   iii. Electric current as a flow charge (electrons), with “amp” as the unit.
   iv. Electric potential as the amount of work needed to move a unit positive charge from a reference point to a specific point, with “volt” as the unit.
   v. Simple DC battery circuits (e.g., components of a flash light). Introduction of the “resistor” as a component that impedes the flow of current.

Learning Outcome 2: Demonstrate an understanding of the principles of magnetism, electromagnetic induction, and application of these principles to the design of basic DC motors.

Objectives:

a) Demonstrate an understanding of magnetism and magnetic poles:
   i. An understanding that the spinning of the electrons around the nucleus of an atom creates a tiny magnetic field.
   ii. An understanding that most objects are not magnetic because their electrons spin in different, random directions, and cancel out each other.
   iii. An understanding that magnets are different; the molecules in magnets are arranged so that their electrons spin in the same direction. This arrangement of atoms creates two poles in a magnet, a North-seeking pole and a South-seeking pole.
   iv. Understand magnetic lines of force and magnetic field around a bar magnet (experiments with iron filings)
   v. Understand electromagnetic induction and the fact that a magnet can be produced with an electromagnet (a current-carrying wire wound around an iron core). Experiments with a bar magnet and an electromagnet. Experiments with an electric bell.

b) Demonstrate an understanding of electric motor basics:
   i. Understand torque (Force x Distance) and power (voltage x current)
   ii. Understand the law of electromagnetic induction; explain the fact that a current through a magnetic field experiences a force at right angles to both the field and the current.
   iii. Understand magnetic circuit principles (magnetic flux, magnetic flux density, magnetic flux intensity)
   iv. Understand how the DC motor works; understand commutation
   v. Understand and compare the two large classes od DC motors: (1) integral horsepower types having power ratings of 1 horsepower or more, and (2) fractional horsepower types, with horsepower ratings of less than 1 horsepower.

Learning Outcome 3: Demonstrate an understanding of basic DC networks and components (resistors, switches, relays, generators, motors) and how they operate in electrical circuits.

Objectives:

a) Understand resistor color codes and how to analyze DC networks (Ohm's law, Kirchhoff's law, maximum power transfer)
b) Understand how capacitors and inductors behave in DC networks under transient and steady state conditions
c) Understand operation of different types of switches (e.g., push button, double-pole-double-throw) and relays and how they provide simple ON/OFF control of DC circuits.
d) Understand operation of DC motors and generators.

Learning Outcome 4: Demonstrate an understanding of basic single phase AC networks and components (resistors, inductors, capacitors, transformers) and how they operate in electrical circuits.

Performance Criteria:

a) Understand single phase AC circuits and be able to analyze simple AC circuits with resistors, inductors and capacitors.
b) Understand maximum power transfer in AC circuits.
c) Understand the operation of transformers and know the different types of transformers (e.g., voltage transformers, auto transformers).
d) Understand the operation of three-phase circuits.

2.4.8 **Industrial Electricity II** (Electrical Wiring of Industrial Equipment)

COURSE CODE: KCIEL2-02
Course Title: Industrial Electricity II
Commencement Date: January, 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:
On completion of this course the student will be able to:

1. Demonstrate an understanding of electrical principles pertaining to electrical wiring of industrial equipment (e.g., motors, contactors)
2. Demonstrate an understanding of troubleshooting techniques (e.g., basic schematic reading, use of multimeters, electrical troubleshooting using the Electrical Systems Testing Device (ESTD), troubleshooting AC and DC motors and generators)
3. Demonstrate an understanding of motor troubleshooting and maintenance.

Performance Criteria:

Learning Outcome 1: Demonstrate an understanding of electrical principles pertaining to electrical wiring of industrial equipment (e.g., motors, contactors)

Objectives:

a) Identify contactors and overloads for various applications
b) Be able to wire a direct-on-line starter and connect an AC motor to it.
c) Be able wire a three-phase reversing starter and connect the starter to a motor.
d) Be able to wire a sequence starting circuit.
e) Be able to wire a fully automatic star-delta starter.
f) Be able to wire a fully automatic auto-transformer starter.
g) Be able to connect a single-phase motor to reversing contactors.
h) Be able to connect a DC motor and starter.
i) Be able to connect a ward-Leonard speed control system
j) Be able to connect a liquid resistance starter to a slip-ring motor.

Learning Outcome 2: Demonstrate an understanding of troubleshooting techniques (e.g., basic schematic reading, use of multimeters, electrical troubleshooting using the Electrical Systems Testing Device (ESTD), troubleshooting AC and DC motors and generators)

Objectives:

a) Understand how to troubleshoot in a safe environment (i.e., understanding safety rules).
b) Understand how to read schematic and wiring diagrams while troubleshooting the circuit
c) Understand how the Electrical Systems Testing Device (ESTD) works.
d) Understand how to perform troubleshooting activities just like on a real equipment

Learning Outcome 3: Demonstrate an understanding of motor troubleshooting and maintenance

Objectives:

a) Be able to test a three-phase motor
b) Be able to identify general maintenance procedures for industrial motors.
c) Be able to use the following in troubleshooting, as appropriate:
    - a megohmeter,
    - a clampmeter,
    - a magnetic compass (used to quickly identify field coil polarities),
    - Digital multimeter (Minimum 600V, CAT III true RMS rating, with low resistance (0.01 ohms or lower) featuring a cycle function and capacitance test.
d) Be able to fault-find basic electrical circuits
e) Be able to fault-find live electrical circuits

2.4.9 Industrial Electricity III (Advanced Controls and Panel Building)

COURSE CODE: KCIEL3-02
Course Title: Industrial Electricity III
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:
On completion of this course the student will be able to:

1. Demonstrate an understanding of industrial control panel building
2. Demonstrate course knowledge by completing a distribution panel

Performance Criteria:

Learning Outcome 1: Demonstrate an understanding of industrial control panel building

Objectives:

a) Understand standards used in the construction of industrial control panels (e.g., NEC standards, UL 508A, "Standard for Industrial Control Panels, and NFPA 79, "Electrical Standard for Industrial Machinery." IEEE standards for design, installation, testing, and/or maintenance
b) Understand selection of type of enclosure based on the intended environment
c) Understand sizing of supply conductors (calculating the ampacity for the supply conductors, etc.)
d) Understand overcurrent protection, short current rating and grounding methods
e) Understand how to construct / wire the distribution panel
f) Understand industrial field wiring and interfacing with industrial panel

Learning Outcome 2: Demonstrate course knowledge by completing construction of a distribution panel

Objectives:

This course should be completed by demonstrating competence in the construction of a distribution panel-building project.

2.4.10 Practical Electronics

COURSE CODE: KCPREL-02
Unit Title: Practical Electronics
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:

On completion of this course the student will be able to:

1. Demonstrate an understanding of how diodes and transistors work – concepts of diode rectification, and the transistor as amplifier or as a switch.
2. Demonstrate an understanding of the operational amplifier and various electronic designs based on it (e.g., instrumentations amplifiers, oscillators, filters)
3. Demonstrate an understanding of electronic noise in instrumentation and industrial systems and how to deal with it.
4. Demonstrate an understanding of the Electronic Laboratory Virtual Instrument System (ELVIS II) and ways it can be used as a laboratory electronics test measurement system.

Performance Criteria:

Learning Outcome 1: Demonstrate an understanding how diodes and transistors work – concepts of diode rectification, and the transistor as an amplifier or as a switch.

Objectives:

a. Be able to describe the operation of the diode; forward and reverse diode curves; Zener diodes; switching diodes, etc.
b. Be able to use a multimeter to check the condition of a diode by checking the forward and reverse resistances
c. Be able to design simple DC power supplies using half wave and full wave diode rectifications
d. Be able to describe the operation of the bipolar junction transistor (BJT) as an amplifier; NPN and PNP transistors; common emitter, common base, and common collector configurations.
e. Be able to explain common emitter transistor characteristics
f. Be able to describe the operation of the transistor as a switch; OFF condition and SATURATED condition.
g. Be able to use a multimeter to check the condition of a BJT by checking the forward and reverse resistances between the three leads.

Learning Outcome 2: Demonstrate an understanding of the operational amplifier and various electronic designs based on it (e.g., instrumentations amplifiers, oscillators, filters)

Objectives:

a. Be able to describe the basic characteristics of an operational amplifier (very high open loop gain, very high input impedance, single rail and double rail power supply configurations.
b. Be able to describe the basic configurations of an operational amplifier (e.g., inverting, non-inverting, voltage follower, differential amplifier.
c. Be able to describe practical operational amplifiers and configurations, including offset nulling, differential amplifier or analog subtractor, inverting analog adder or audio mixer, high pass and low pass filters, Wien-bridge sine wave oscillator, sine/square wave function generator.

Learning Outcome 3: Demonstrate an understanding of electronic noise in instrumentation and industrial systems and how to deal with it.

Objectives:

a. Understand the types of noise coupling (common mode and differential or normal mode noise)
b. Be able to identify various noise sources (Variable frequency drive (VFD) motor cables, switch mode power supply conductors, fluorescent lights, squealing bearings, and other inductively coupled noise sources.
c. Understand methods for reducing noise (e.g., shielded cables, twisted pair cables, signal isolation, differential measurements, anti-aliasing filters).

Learning Outcome 4: Demonstrate an understanding of the Electronic Laboratory Virtual Instrument System (ELVIS II) and ways it can be used as a laboratory electronics test measurement system.

Objectives:

a. Be able to describe the ELVIS prototype board and how it works in conjunction with a laptop and dedicated software to function as various laboratory test instruments
b. Understand the ELVIS software and be able to use to make various measurements including:
    i. As an oscilloscope to measure frequency and voltage in electronic circuits.
    ii. As a digital multimeter (DMM) to identify, test, and utilize resistors, capacitors, and inductors in the design of electronic circuits.

2.4.11 Fundamentals of Digital Electronics

Statement Criteria:

COURSE CODE:	KCFDEL-03
Unit Title:	Fundamentals of Digital Electronics
Commencement Date:	August 2018
Post-Secondary	Diploma in Industrial Skills, Automation and Mechatronics
Credit Value:	3.0

Learning Outcomes:

On completion of this course the student will be able to

1. Understand and be able to use basic combinational and sequential logic.

Performance Criteria:

Learning Outcome 1: Understand and be able to use basic combinational and sequential logic.

Objectives:

a. Understand the difference between digital electronics and analog electronics and the voltage levels usually encountered in both domains.
b. Understand the number systems (decimal number system and binary number system) and advantages of the binary number system.
c. Understand Logic gates and related devices (positive and negative logic; OR, AND, NOT, EXCLUSIVE OR, NAND, NOR, EXCLUSIVE NOR, and INHIBIT gates);
d. Understand that all logic expressions, whether simplified or not, can be implemented using AND, OR, & Inverter gates.
e. Understand that all logic expressions can be expressed as either the sum of products (SOP) or products of sum (POS).
f. Understand the use of Karnaugh Mapping as a graphical technique for simplifying logic expressions containing two, three, and four variables.
g. Understand the NAND gate as a universal gate because it can be used to implement an AND gate, OR gate, and a NOT gate, and that any combinational logic expression can be implemented using only NAND gates.

h. Understand the NOR gate as a universal gate because it can be used to implement an AND gate, OR gate, and a NOT gate, and that any combinational logic expression can be implemented using only NOR gates.
i. Design a practical project: use the seven-segment display (common cathode and common anode types) to demonstrate how programmable logic devices can be used to implement combinational logic circuits. (Use push buttons and combinational logic to sequence through numbers 1 through 10.
j. Understand sequential logic: Flip flop types (R-S flip flop, J-K flip flop, D flip flop; edge-triggered and level-triggered flip flops); Counters (synchronous and asynchronous)
k. Understand the use of simple state machines as a circuit design method that sequences through a set of predetermined states controlled by a clock and other input signals.
l. Be able to describe various machine designs used to control common everyday devices such as elevator doors and traffic lights.

2.4.12 Introduction to Process Instrumentation and Measurement Techniques

COURSE CODE:	KCIPRI-04
Course Title:	Introduction to Process Instrumentation and Measurement Techniques
Commencement Date:	August 2018
Post-Secondary	Diploma in Industrial Skills, Automation and Mechatronics
Credit Value:	4.0

Learning Outcomes:
On completion of this course the student will be able to
1. describe and use in specific applications, various sensors used for measurement of typical process variables such as temperature, flow, pressure, level, and weight.

Performance Criteria:

Learning Outcome:	On completion of this course the student will be able to describe and use in specific applications, various sensors used for measurement of typical process variables such as temperature, flow, pressure, level, and weight.

Objectives:
Process variables

Be able to describe some example processes (e.g., steam plant) and mention some of the variables that are important to measure.

Temperature and sensors for process temperature measurements

Properties and temperature changes, temperature scale, resistance temperature detectors (RTDs), Measuring resistance (wire-wrapped RTDs, thin-film RTDs, filled thermal systems), thermowells, Thermocouples (operation, types of thermocouples, using conversion tables, multiple thermocouples, thermocouple construction)

Weight, mass and their measurement

Mass and weight, density, strain gage load cells (beam design, S-shaped design, compression-based design), load cell applications (using multiple load cells), pneumatic and hydraulic load cells

Pressure and process pressure measurements

Pressure and force, units of pressure, atmospheric pressure, gauge pressure, vacuum and absolute pressure, absolute pressure, barometric pressure, calculating the amount of pressure, differential pressure, pressure transducers, strain gages, capacitance pressure sensors, measuring differential pressure, applications

Flow and process flow measurements

Flow rate, units of flow, effect of energy, standard and actual readings, flow of gases, flow of liquids, flow rate (volume flow rate and mass flow rate) and flow velocity, factors to consider (pressure/velocity relationship, viscosity, density, friction, patterns of flow (laminar and turbulent flow), differential pressure sensors, vortex sensors, magnetic flow sensors, positive displacement sensors, turbine flow sensors, mass flow sensors (Coriolis-based and thermal-based)

Level measurements

Types of level sensors, use of differential pressure for level sensing, floats (magnetic floats, floats with levers, floats with switches), capacitance measurements, conductivity probes, ultrasonic and radar sensors

2.4.13 Basic PLC Programming

COURSE CODE: KCBPLC-02

Course Title: Basic PLC Programming
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:
On completion of this course the student will be able to:

1. Understand PLC hardware and be able to connect real world devices to it.
2. Understand ladder logic and ladder programming

Performance Criteria:

Learning Outcome 1: Understand PLC hardware and be able to connect real world devices to it.

Objectives:

a) Be able to describe the various components of a PLC (controller, input/output modules, power supply modules, communication modules, etc.).

b) Be able to identify at least two PLC manufacturers (e.g., Allen Bradley and Siemens) and their line of products.
c) Be able to compare a general purpose computer to a PLC and identify the differences
d) Be able to identify some of the various input and output devices generally used with PLCs (sensors, switches, motors, valves, etc.).
e) Be able to describe the PLC mode of operation
f) Understand sinking and sourcing concepts and how to make basic input and output connections to the PLC.
g) Be able to make I/O connections to a PLC

Learning Outcome 2: Understand ladder logic and ladder programming.

Objectives:
a) Understand the basic building blocks of ladder logic (NORMALLY OPEN (EXAMINE IF CLOSED); NORMALY CLOSED (EXAMIN IF OPEN), sealed-in-logic, etc.).
b) Understand PLC programming standards (IEC 1131); ladder diagrams, sequential function charts, function blocks, instruction list programming, etc.).
c) Understand how to convert electrical schematics to ladder logic

2.4.14 Intermediate PLC

COURSE CODE: KCIPLC-02
Course Title: Intermediate PLC Programming
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Learning Outcomes:
On completion of this course the student will be able to:
1. Understand Timers and timer representations in PLC programmes
2. Understand how to programme timer functions
3. Understand Counters and counter representations in PLC programmes
4. Understand how to programme counter functions)
5. Understand how to design an automated traffic control system with a PLC
6. Understand batching processes

2.4.15 Introduction to Process Control

COURSE CODE: KCIPRC-02
Course Title: Introduction to Process Control
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Course Description:
This is a basic course on process control components and how they work. It is designed for entry level control and instrument technicians. Elements of a control loop such as various transmitter types, current-to-pressure (I/P) transducers, actuators, etc., are studied in this course. Learn why some devices fail much more often than others and why some functions are not allowed or are range is limited. Study how measurement, feedback, lead and lag functions work.

Course Curriculum

Basic function of control systems
- control steps, control loops, input and output, signal transfer, transfer medium, types of signals

Basic elements of control loops
- sensors, indicators and recorders, fundamentals of process instrumentation, flow transmitters, controllers, final control elements

Transmitters and their function in the control loop
- Pneumatic transmitters (standard signal range, operation, calibration, zero adjustment, range adjustment,
- electronic transmitters (adjusting electronic 'transmitters, power supply, input and output)

Transducers and converters
- I/P and P/I converters, I/I converter

Controllers
- Function of controllers (direct- or reverse-acting, considering time, types of control modes)

Control modes
- On-off control, proportional band control, reset or integral mode, derivative or rate mode, tuning

Programmable logic controllers
- (Treatment of this topic is only at a high-level in this course)

Final control elements
- Function of final control elements

Actuators
- Diaphragm design, adding a valve positioner, hydraulic piston actuators, motor actuators

Performance characteristics

Other final control elements
- Single element control loops, cascade control, feed-forward control, ratio control

2.4.16 Industrial Power Electronics

COURSE CODE:	KCIPEL-02
Course Title:	Industrial Power Electronics
Commencement Date:	August 2018
Post-Secondary	Diploma in Industrial Skills, Automation and Mechatronics
Credit Value:	2.0

Course Description:
This course discusses the practical circuit symbols and functional behaviour of electronic components involved in power electronics systems. It provides hands-on experience in testing power components and provides the techniques of applying the concepts in troubleshooting variable speed drives. All coursework is accompanied by actual hands-on work.

Course Curriculum:
The course will explain to the students the

1. Theory of operation and applications of silicon controlled rectifiers
2. Theory of operation and applications of triacs
3. Functional behaviour and applications of bipolar junction transistors
4. Operating principle of field-effect transistors
5. Operating principles and applications of unijunction transistors
6. Effects of voltage transients in power circuits (with a demonstration of the effects)
7. Operation of power control triggering circuits
8. Methods for testing power electronic components.

2.4.17 Variable Speed Drives

COURSE CODE:	KCVSDR-02
Course Title:	Variable Speed Drives
Commencement Date:	August 2018
Post-Secondary	Diploma in Industrial Skills, Automation and Mechatronics
Credit Value:	2.0

Course Description:
This course provides training on variable frequency drives (VFDs). It includes "hands-on" demonstrations for skills improvement and is specifically designed for maintenance technicians and others working in industrial plants or wherever variable speed control applications are found. It also provides great refresher training for experienced electricians and engineers.

Course Curriculum:
VFD safety review
Electrical hazards, lockout-tagout, personal protective equipment and insulated tools
Functions of VFD
Motion control/motor speed, air flow/liquid flow/pressure control, eliminating the need for variable transmission or sheave, variable vanes or dampers on fans, variable valves on pumps
Benefits of using a VFD
Energy savings, easier maintenance, enhanced system monitoring
Load types
Constant torque–conveyors, positive displacement pumps, superchargers, variable torque– centrifugal fans or pumps, saws, routers, planers
VFD options

Bypass—two or three contactor style, disconnect switch style, soft starter, fusing VFD or bypass protection, motor overload device, transient protection, auxiliary relays, powerline phase reversal detection

Installation of a VFD

Environmental concerns, clearances, conduit entry

Customer connections

Safety circuit, start/stop, jog, status indication, fault indication, remote speed reference, monitoring of motor parameters)

Wiring and grounding VFDs

Induced signals, inductive, capacitive, incoming powerline wiring, motor (load) wiring, control wiring, proper grounding methods

Controlling a VFD

Keypad controls, terminal strip control (automatic and manual),bus communication control, open loop control, manual operation, automatic operation, sensor-less flux vector, closed loop control, Pi loop configuration, sensor or transducer feedback, motor shaft encoder feedback

VFD setup, programming and troubleshooting

The importance of monitoring the VFD, maintenance, considerations for a VFD, identifying and isolating a VFD problem from a motor problem, troubleshooting the most common VFD problems.

2.4.18 Advanced PLC with Electro-pneumatics

COURSE CODE:	KCAPLE-02
Course Title:	Advanced PLC with Electro-pneumatics
Commencement Date:	August 2018
Post-Secondary	Diploma in Industrial Skills, Automation and Mechatronics
Credit Value:	2.0

Course Description:
This is an advanced PLC programming course that is tailor-made to use electro-pneumatic systems for all practical applications. Trainees undertake programming GRAFCET with function block diagram (FBD) and sequential function chart (SFC) programming languages, as well as reading and analyzing PLC-based electro-pneumatic circuit diagrams, assembling and making adjustments of electro-pneumatic systems, troubleshooting, detection, and repairs of faults.

Prerequisites:
Students should have some experience operating pneumatic systems or equipment. They should also have taken the course Intermediate PLC (KAIPLC-050201).

Course Curriculum

1. Basic elements of fluid mechanics
2. Elements of pneumatics and electro-pneumatics
3. Sequence, timing, and phase diagrams
4. GRAFCET reading and generation
5. Programming GRAFCET with function block diagram (FBD) and SFC languages

6. Jump and subroutine programming instruction
7. Identification of electro-pneumatic system units/components
8. Reading and analyzing PLC-based electro-pneumatic circuit diagrams
9. Assembling and making adjustments of electro- pneumatic systems
10. Troubleshooting, detection, and repairs of faults
11. PLC programming, testing, debugging, and commissioning of complex control tasks
12. System documentation of control tasks
13. Industrial visit

2.4.19 Advanced PLC with HMI

COURSE CODE: KCAPLH-02
Unit Title: Advanced PLC with HMI
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Course Description:
This course provides a practical, hands-on experience the WinCC Flexible software and hardware terminals, Siemens HMI (Human-Machine Interface) product. Students will learn how to launch, navigate, create, and make use of the help files. Students will get to know the application, gather data, plan the tag database, design graphic screens, plan alarms, and gain information that is required to operate the system. Students will be able to create and configure new graphic displays and be able to navigate between windows. In addition, students will learn about the Enhanced Screen objects, such as Sliders, Gauges, and Trends, and will be able to incorporate them into an operator screen to control and monitor a proportional-integral-derivative (PID) loop running in the processor. Finally, students will also learn how to use such WinCC Flexible utilities as the Status-Force Monitor, System Screens, Alarming, and Security. Students will design a complete PLC-HMI application (an S7 300 or S7 1200 will be used for this project).

Course Curriculum
1. Introduction to WinCC and its applications
2. Creating a Project, Tags, Screens - Simple Objects
3. Enhanced Screen Objects
4. Status-Force Display
5. Alarms, Multiplex Tags, System Screens
6. Transferring the Application
7. Security
8. Practical project

2.4.20 Advanced PLC with PROFIBUS Communication and Networking

COURSE CODE: KCAPCN-02
Course Title: Advanced PLC with PROFIBUS Communication and Networking

Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Course Description:
This course describes PROFIBUS industrial fieldbus networks and shows how to configure and analyze PROFIBUS networks. Various concepts such as PROFIBUS-DP and PROFIBUS-FMS are discussed.

Course Curriculum

1. PROFIBUS as open fieldbus system – relationship to the ISO/OSI model
2. Transmission medium: RS485, fibre-glass and/or IEC 1158-2 technology
3. Physical characteristics and installation details
4. PROFIBUS services: FDL, DP, FMS and PA
5. Data link functions: SDA, SRD, SDN, and CSRD
6. Token passing principle: TTH, TTR, TRR parameters
7. Addressing: PROFIBUS address (FDL) and Service Access Point (SAP)
8. Active versus passive PROFIBUS partners
9. FMS service details:
    - Client server model
    - Virtual Field Device (VFD)
    - Object Dictionary (OD)
    - Communication Relations List (CRL)
    - Standard and user defined data types
10. DP service details:
    - Master-slave model
    - Remote I/O system: distributed peripheral
    - Multi-DP sub-network on one cable
11. Configuration software: Siemens COM-PROFIBUS, Siemens STEP 7, SST-PROFIBUS configuration tool
12. Remote I/O diagnostics

2.9.21 Workplace Safety, Health and Supervisory Skills

COURSE CODE: KCOSHS-02
Couse Title: Workplace Safety, Health and Supervisory Skills
Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Course Description:
This course is designed to ensure that an entry-level technician will be familiar with the group of moral principles and standards of behavior; and exhibit the set of values regarding proper conduct at the workplace.

Course Curriculum

Workplace Safety:

- Definition of hazards
- Safety as a category of hazards
- Classification of hazards
- Identifying hazards in the workplace
- Management of safety hazards

Workplace Health:

- Definition of hazards
- Health as a category of hazards
- Classification of hazards
- Specifics of hazards
- Management of health hazards

Factory Floor Supervisory Skills

- Responsibilities of factory floor supervisor
- Workplace Cooperation and Management
    - Importance of good communication
    - Effective forms of workplace communication
    - Procedures for resolving disputes
    - Grievance procedures
- Managing People
    - Relationship building and teamwork
    - Influencing skills and bringing out the best in your workers (motivation and attitude improvement)
- Preventing Sexual Harassment
    - Rights and responsibilities.
    - Procedures for protecting your workers from sexual harassment and avoiding indecent behaviour yourself.
    - Procedures for dealing with allegations of sexual harassment.

2.4.22 Introduction to LabVIEW Programming

COURSE CODE:	KCLVP1-02
Course Title:	Introduction to LabVIEW Programming
Commencement Date:	August 2018
Post-Secondary	Diploma in Industrial Skills, Automation and Mechatronics
Credit Value:	2.0

Course Description:

LabVIEW software provides comprehensive tools that you will need to build any measurement or control application in dramatically less time than conventional programming methods. This training is suitable for engineers, technicians, researchers, students or anyone interested in LabVIEW programming. Participants will go through both LabVIEW programming theory,

practical hands-on programming, and hands-on hardware/software projects. The course will prepare you to do the following:

1. Become comfortable with the LabVIEW environment and data flow execution
2. Understand front panels, block diagrams, icons, and connector panes
3. Use LabVIEW to create applications
4. Ability to use LabVIEW to solve problems
5. Work with data types, such as arrays and clusters
6. Displaying and printing results
7. Use built-in LabVIEW functions

This course is equivalent to LabVIEW Core 1 (Successful completion of LabVIEW Core 1 and Core 2 in the KERSL curriculum will ensure that you will be successful when you take the Certified LabVIEW Associate Developer (CLAD) certification offered by National Instruments.)

Course Curriculum:

a. Virtual instruments (Vis)
b. Parts of a VI
    I. Front panel, block diagram
c. Searching for controls, Vis, and functions
d. Elements of a simple VI
e. Troubleshooting and debugging Vis
f. Best practices in implementing a VI
    I. Front panel design, LabVIEW data types (While loops, FOR loops, Timing a VI, Plotting data, Case structures)
g. Relating data
    I. Arrays, clusters, type definitions
h. Managing resources
    I. Understanding file I/O (Understanding high- and low-level I/O, DAQ programming, instrument control programming, using instrument drivers)
i. Projects using myDAQ and myRIO

2.4.23 Intermediate LabVIEW Programming

COURSE CODE:	KCLVP2-02
Unit Title:	Intermediate LabVIEW Programming
Commencement Date:	August 2018
Post-Secondary	Diploma in Industrial Skills, Automation and Mechatronics
Credit Value:	2.0

Course Description:
This is essentially LabVIEW Core 2 and is an extension of the LabVIEW Core 1 course. It teaches students how to use common design techniques (e.g., state machine, producer-consumer) to develop LabVIEW applications for research, engineering, and testing

environments. [Successful completion of LabVIEW Core 1 and Core 2 in the KERSL curriculum will ensure that you will be successful when you take the Certified LabVIEW Associate Developer (CLAD) certification offered by National Instruments.]

Course Curriculum:

1. Use of event-driven programming,
2. Implementing design patterns:
    a. State machine design (polling)
    b. State machine design (event-based)
    c. Producer/consumer design pattern
3. Error handlers
4. Programmatic control of user interface,
5. Techniques to optimize reuse of existing code,
6. Use of file I/O functions
7. Tools to create executables and installers

.

2.4.24 Introduction to Data Acquisition and Measurement with LabVIEW

COURSE CODE:	KCDAQM-02
Course Title:	Introduction to Data Acquisition and Measurements with LabVIEW
Commencement Date:	August 2018
Post-Secondary	Diploma in Industrial Skills, Automation and Mechatronics
Credit Value:	2.0

Course Description

LabVIEW is a comprehensive development environment that contains all the tools engineers and scientists need to design and deploy measurement and control systems. This course teaches the fundamentals of graphical system design and data acquisition with LabVIEW. The course teaches the essential concepts of data acquisition and ways to combine software and hardware into an integrated measurement system.

Course Curriculum:

1. Data acquisition basics and terminology
2. Strain measurements
3. Voltage, current, and power measurements
4. Load, pressure, and torque measurements
5. Position and frequency measurements
6. Sound and vibration measurements
7. Temperature measurements
8. Practical data acquisition project

2.4.25 Solar Power Design, Installation, and Maintenance

COURSE CODE:	KCSPDI-02
Course Title:	Solar Power Design, Installation, and Maintenance

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Commencement Date: August 2018
Post-Secondary Diploma in Industrial Skills, Automation and Mechatronics
Credit Value: 2.0

Course Description:
In this course, you will learn how to design, install, and maintain a solar power system either as backup power for home use or for small commercial applications.

Course Curriculum:

1. The pros and cons of solar power.
2. The features, applications, and components of the following systems: DC direct, Stand-alone, Grid-direct, and Grid-tied with battery backup.
3. The pros and cons of different mounting systems (ground, pole, roof, and trackers).
4. How to assess the power needs for your home or small commercial enterprise.
5. How to design (i.e., assemble and construct) a residential stand-alone system, including the array, inverter, batteries, and overcurrent protection.
6. How to define equipment grounding, system grounding, and components and conductors used for grounding.
7. How to identify potential safety hazards of grid-direct or stand-alone PV solar power systems.
8. How to maintain a PV solar power system.