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CARIBBEAN JOURNAL OF EDUCATION AND DEVELOPMENT

Constructing a Blended Delivery Model for TVET: Implementing Blended Learning in the Diploma Electrician Programme at the NESC Technical Institute

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Abstract

The NESC Technical Institute (NESC–TI), a non–profit institution in Trinidad and Tobago established in 1997, offers 10 technical diploma programmes. In 2021, following the COVID–19 pandemic, the institution implemented a blended model for the delivery of its suite of diploma programmes. The opportunity and drive to develop this case history, documenting implementation of the blended model, its challenges and interventions, was provided through the 6th International Conference on TVET in the Caribbean—TVET Blended Challenge, which aimed to showcase exemplary practices of blended learning in TVET. NESC–TI's implementation of a blended learning model for its electrician course on Alternating Current Circuit Properties was selected for the challenge. The institution applied a medium blend of 50% online and 50% face–to–face delivery. To support application of the blend, the Blackboard LMS and Multisim software was used. This was intended to aid self–directed active learning, aligned with a constructivist, learner–centered approach that follows the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) instructional design framework (Stapa & Mohammad, 2019). Challenges of inadequate learner devices, copyright issues, and traditional teaching were overcome through institutional resources, content assimilation, and faculty development. Despite marginal success initially, NESC–TI has adapted its evaluation process as it continues with the blended model to equip learners with AC circuit knowledge and competencies.

Keywords: Blended Learning, TVET, Electrician

Introduction

Prior to the COVID-19 pandemic in 2020, blended learning, which combines classroom and workshop instruction with online learning, could be considered a luxury in the regional vocational training landscape — with few institutions anticipating the need for online learning tools and strategies. Within the global tertiary education sector however, blended learning was fast becoming a fundamental part of 21st century education (Kebualemang & Mogwe, 2017) with the approach being used to improve knowledge construction and analytical skills (Kintu et al., 2017). Given that COVID–19 forced all educational institutions into some form of distance learning, Chinengundu (2021) notes the importance of TVET institutions embedding blended learning as the new normal in the post–pandemic era, ensuring that balance

Received 14 June 2024
Accepted 12 December 2024
Electronically published 19 June 2025

https://doi.org/10.46425/cjed201044170

Caribbean Journal of Education and Development,
Vol. 1 No. 4, 2025
 • ISSN 0799-6977

is maintained between quality teaching and learning practices and innovation. Importantly for the NESC Technical Institute (NESC–TI), its affiliation with Red Deer Polytechnic of Alberta, Canada proved integral in successfully navigating the remote learning challenges of the pandemic. Beyond COVID-19, the polytechnic's online learning infrastructure aided in facilitating the implementation of a sustained blended learning approach at the NESC–TI.

The opportunity to document and showcase the NESC–TI's process, successes, and challenges in navigating the shift to blended learning was made possible through the 6th International Conference on TVET in the Caribbean — TVET Blended Challenge (See Appendix A). Noting the magnitude of the conference, NESC–TI recognized and seized the opportunity to present a detailed account of the transition of one of its Diploma Electrician courses to blended learning. By participating in the conference, the institution aimed to contribute to the broader conversation on blended learning in the TVET sector and engage with regional and international stakeholders. Through sharing its experiences, the NESC–TI hoped to contribute to the body of knowledge surrounding blended learning in the TVET sector, as well as offer insights and lessons learned that could benefit other institutions facing similar challenges. Further, the conference provided an opportunity for NESC–TI to receive valuable feedback and constructive criticism from academic and industry experts that could facilitate continuous improvement at the institution.

Kebualemang and Mogwe (2017) describe blended learning as a modern way of teaching that integrates online and traditional face-to-face modalities and provides benefits to the learner. Alvarez (2020) listed these benefits as unhindered access to course content, increased educational affordability, and the facilitation of improved student engagement. Alvarez (2020) also highlighted challenges such as increased preparation time for teachers and gaps in technological skills as drawbacks to implementing blended learning. To create an effective blended learning environment, Kintu et al. (2017) suggest instructional design and appropriate learning outcomes as key components of the system. The ADDIE model of instructional design aids in the integration of online and face-to-face teaching through the consideration of learning outcomes across the model's phases of analysis, design, development, implementation, and evaluation (Stapa & Mohammad, 2019). Adri and Zakir (2020) in their study on designing blended project based learning using the ADDIE model, conclude an increase in the attainment of student learning outcomes through use of the model.

The NESC–TI has the strategic intent to be a world–class technical training institution. In keeping with this vision, implementation of its blended learning model for the Diploma Electrician programme aligns with SDG 4, "Quality Education". The institution's blended model focuses on active learning, student engagement, and the use of technology — empowering students to develop the knowledge and skills necessary for the 21st century workforce, with a specific focus on digital literacy. Further, the programme's emphasis on practical, hands–on learning aligns with the United Nations' SDG 4 goal of developing the relevant skills for sustainable development (https://sdgs.un.org/goals/goal4).

Overview of the NESC Technical Institute

The NESC Technical Institute (NESC–TI) is a non–profit institution incorporated on July 15, 1997, with the primary purpose of building the human capital in the Republic of Trinidad and Tobago (T&T). The NESC–TI has its genesis in a Trust Deed between the Government of the Republic of Trinidad and Tobago (GoRTT) and the Atlantic Liquified Natural Gas Company Limited (ALNG). The institution was created to address the demand for skilled personnel to work in the ALNG, Train 1 Project.

NESC–TI was then envisaged as the solution to the need for a premier training provider to lead national training initiatives. This vision was based on the projected demand for certified craftsmen, arising out of the growth in the energy sector and consequently, the construction sector and related industries. Over the past 25 years, NESC–TI has evolved into a multi–campus institution with campuses located across Trinidad and Tobago.

The NESC–TI (whose operations fall under the purview of the Ministry of Education) is currently authorized by the Accreditation Council of Trinidad and Tobago (ACTT) to offer tertiary level technical training through 2–year Diploma programmes in the occupational areas of Automotive Services, Drilling Rig Operations, Electrician, Fabricator, Heavy Equipment, Information Technology, Instrumentation, Millwright, Refrigeration and Air Conditioning, and Welder. The institution has graduated over 15,000 skilled craftsmen and technicians over its 25-year history.

The programmes offered are geared towards satisfying industry demand for entry–level technical skills. NESC–TI works closely with industry stakeholders to ensure that programmes are tailored to meet specific competency requirements. Programmes utilize a mix of theoretical instruction and practical shop training to produce well–rounded graduates. As the energy sector has evolved, NESC–TI has continuously expanded its programme offerings to support emerging occupations. This helps reduce T&T's dependence on foreign skilled labor while providing students with pathways to sustainable careers. The course and credit structure of the programmes are described in Table 1.

Table 1

NESC–TI Diploma Programme Course and Credit Structure

Course Type	Number of Courses	Duration	Credits	Passing Score	Delivery Mode	Assessment
Full Courses	18	90 hours	6	70%	Blended	Coursework & Final Exam
Project Courses	6	60 hours	4	70%	Workshop Only	Final Assessment

NESC–TI's Blended Initiative

The history of the NESC–TI's blended initiative began through its partnership with Red Deer Polytechnic (RDP). Currently, NESC–TI has an affiliation agreement with RDP where students are simultaneously enrolled in both institutions, with graduates receiving dual certification. The agreement also gives NESC–TI's students and faculty access to the Blackboard learning management system licensed to RDP. NESC–TI's first interaction with this online platform emerged in 2018 when RDP used it to conduct examinations for NESC–TI students online, eliminating the need for RDP invigilators to be physically present in Trinidad and Tobago. During the COVID–19 pandemic when (as was the case with educational institutions globally), the NESC–TI was forced into the online environment to facilitate learning continuity for its students. The experience of online delivery yielded benefits such as reduced travelling costs for students, increased opportunities for collaboration, and uninhibited access to course materials — encouraging the institution to develop its own blended model of delivery in all its diploma courses, including the Diploma Electrician programme.

NESC–TI's blended model is first driven by a constructivist perspective, building on the constructivism learning theory that suggests knowledge is acquired through active cognitive engagement, that the learning environment influences behavior, and that creating context improves learning (Dewey, 1916/1980; Garrison, 1997; Larochelle, Bendnarz, & Garrison, 1998; Gergen, 1995, as cited in Singh & Athavale, 2008). This theory, linked to the blended model through the adoption of a learner-centered approach to delivery and the inclusion of active learning and self–directed learning mechanisms, is applied to each of the institution's Diploma Programme courses based on the learning outcomes and objectives identified in the curriculum.

The instructional design approach applied to the blended model considers the ADDIE framework, as well as Vygotsky's Zone of

Proximal Development (ZPD) and scaffolding concepts. ZPD and scaffolding are integrated into the design by first establishing the current competence of the learner and what development could be achieved with instructor support; then constructing lessons and learning activities in attainable chunks. Additionally, tools for active learning and self–directed learning are embedded into the design. The NESC–TI Instructional Design tool (NID) was developed in alignment with these concepts to facilitate the transition from the traditional instructor-led behaviorist classroom approach to the learner-centered blended delivery model. The ADDIE approach is a framework method for developing courses and restructuring learning materials created in 1975 by Florida State University to improve the effectiveness and efficiency of educational programmes run by the United States army (Bouchrika, 2022). While the ADDIE framework can be seen as a behaviorist approach, its application in this blended context was selected to ensure the delivery of clear learning outcomes and objectives, facilitated by relevant activities using the appropriate digital and physical resources (Hill & Jordan, n.d.).

The NID applies the first 3 ADDIE stages: analysis, design, and development. The tool facilitates analysis by identifying the learner's previous knowledge, determining the resources required, and establishing the teaching objectives in relation to the learning outcomes and objectives. The teaching objectives are created through the application of the ZPD and scaffolding concepts. Vygotsky's ZPD can be defined as the gap between a learner's current competence and the potential level of development that can be acquired through teacher support (Eun, 2018), while scaffolding refers to the teacher creating tasks for the development of competences that are within the learner's proximity for achievement (Puntambekar, 2022). The NID captures the application of these concepts, demonstrating a visible path from the learner's previous knowledge, scaffolded through the ZPD, towards attainment of the unit/course learning outcome.

In keeping with the requirements of the framework, the NID design stage identifies the methods to be used in achieving the learning outcomes and objectives (Bouchrika, 2022) through the application of the NESC–TI's blended model. At this stage, the course blend is determined, placing instruction into the categories of online face-to-face, online asynchronous, and workshop/classroom — specifying the teaching approach to be used. The assessment mix is also applied, identifying formative and summative assessment evidence and tools to be created. The development phase involves the construction of the various elements identified in design. Appendix B — NESC–TI Instructional Design for ELEC–06001, demonstrates the application of the theories outlined.

Prior to implementation of NESC–TI's blended model, a traditional teacher-centered approach to delivery existed, where students were provided with textbooks that contained the basics of course instruction which involved two components: lectures focused on the coverage of underpinning knowledge embedded in course learning objectives and the practice of skills towards the attainment of competence. The instructional plan was rigid, and teachers were expected to deliver according to conditions outlined in the text. Additionally, assessment involved only two methods, final examinations for theoretical concepts facilitated by RDP and practical assessments to determine skill attainment. Application of the blended model allowed for the construction of knowledge through active learning methods; varied assessment strategies for the demonstration of learning; and student agency and self–directedness through an environment supporting both independent and collaborative learning.

The Diploma Electrician Programme and Course ELEC–06001

The NESC–TI's Diploma Electrician programme aims to prepare a cadre of electricians with the requisite competence (knowledge, skills, abilities, and attitudes) to perform, adapt, and innovate in domestic, commercial, and industrial environments in accordance with local and international codes and standards.

This case history is based on the blended model implemented for the 6th course of the NESC–TI's Diploma Electrician programme: Alternating Current (AC) Circuit Properties (ELEC–06001); which seeks to equip learners with the knowledge and competencies required to connect and analyze AC circuits involving capacitors and inductors. The course learning outcomes and objectives are shown in Table 2.

Table 2

ELEC–06001: Alternating Current (AC) Circuit Properties — Course Learning Outcomes and Objectives

Unit	Learning Outcome	Objectives
A	Perform math calculations	1. Perform arithmetic operations in sequence using BEDMAS. 2. Transpose equations to make any stated term the subject. 3. Perform arithmetic operations using squares and square roots. 4. Perform calculations using scientific notation. 5. Perform calculations involving SI prefixes. 6. Perform calculations using Pythagorean Theorem. 7. Perform calculations using trigonometric functions. 8. Perform calculations involving the addition of phasors. 9. Perform calculations using ratio and proportion.
B	Describe the fundamentals of Alternating Current (AC)	1. Describe the generation of an AC sine wave. 2. Determine the output frequency of an AC generator. 3. Calculate standard AC sine wave values. 4. Describe the relationship between sine waves and phasor diagrams. 5. Describe the factors affecting impedance in an AC circuit
C	State and analyze the characteristics of AC circuits	1. Describe the three circuit properties: resistance, inductance and capacitance, with respect to their current limiting effects. 2. Describe the effects of AC on the resistance of a circuit.
D	Connect and analyze inductors in circuits	1. Describe an inductor (coil) and its characteristics. 2. Describe inductance and the factors that affects it. 3. Describe induction and its effects. 4. Describe the effects of an inductor in a DC circuit. 5. Describe the effects of an inductor in an AC circuit. 6. Describe the characteristics of an AC inductive circuit. 7. Describe the power relationships in an inductive circuit. 8. Connect and analyze AC circuits containing inductance.
E	Connect and analyze capacitors in circuits	1. Describe capacitor construction, types and applications. 2. Describe capacitance and factors that affect it. 3. Describe the effects of a capacitor in a DC circuit. 4. Describe capacitive reactance. 5. Describe the characteristics and effects of an AC capacitive circuit. 6. Describe the power relationships in a capacitive circuit. 7. Connect and analyze AC capacitive circuits. 8. Connect and analyze DC capacitive circuits.
F	Calculate power, reactive power and apparent power in ac circuits	1. Compare reactive power due to inductance and capacitance. 2. Determine the power, apparent power, reactive power and power factor angle in an AC circuit. 3. Connect and analyze reactive power in an AC circuit

Description of the Learners

The typical age range of students enrolled at the NESC–TI is 17–25 years. The entry requirements for admission into the Diploma Electrician programme are 3 Caribbean Secondary Education Certificate (CSEC) subjects (Grades I–III); inclusive of Mathematics and English A, and Information Technology or any science subject. This combination of subjects ensures that students have the requisite foundation from which future learning can be constructed. The NESC–TI does, however, accept students with lower or alternate qualification through successful navigation of an in–person interview and entrance examination. This is designed to determine the potential agency and capacity of such candidates and provide them with a tertiary education opportunity which may otherwise not exist. This admission criteria, however, mandates the NESC–TI to ensure that its instructional design is in keeping with the requirements of such learners; and this has influenced the course's blended design through increased formative assessment, varied learning activities to support diverse learning styles and abilities, and scaffolding to break down complex tasks into smaller, manageable steps.

The ELEC–06001 course had 124 students enrolled, all within the typical age category of the NESC–TI. Students were expected to have prior knowledge of circuits, inductance, and capacitance having previously completed courses covering these areas.

Type of Blend

The Organization for Economic Co-operation and Development describes e–learning as integral for individuals in the modern world to improve their competence and guard against becoming professionally stagnant in the current global environment (OECD, 2015, as cited in Boehner, 2017). This consideration, added to the NESC–TI's commitment to advanced teaching and learning methodologies and the realities recognized through the COVID-19 pandemic, encouraged the institution to implement a system of blended learning for its diploma programmes. The institution conceptualized a blended course design for its diploma programme, adaptable by course, with learning outcomes and delivery modes influenced by cognitive learning requirements such as application of knowledge and critical thinking, and psychomotor learning requirements such as manual dexterity and accuracy. This blended course design is represented in Figure 1.

The blended course design was envisioned and developed by NESC–TI's Curriculum and Teaching department in January 2021 and approved by the institution's executive for implementation starting in September 2021. Blended delivery at the institution was made possible using the Blackboard Learning Management System (LMS), which the NESC–TI faculty and students access through an affiliation agreement with Red Deer Polytechnic. Implementation of the new design required phased instructional redesign for all NESC–TI diploma courses, including ELEC–06001, which adopted a medium blend for the delivery of learning content and realization of its learning outcomes. This medium blend is represented in Table 3.

Figure 1

NESC–TI Blended Course Design

Table 3

NESC–TI Blended Delivery Plan for ELEC–06001

Unit	Learning Outcome	Planned Training Hours		
		Online Face-to-face	Online Asynchronous	Workshop/ Classroom Face-to-face
A	Perform math calculations	12	3	0
B	Describe the fundamentals of alternating current (AC)	6	0	9
C	State and analyze the characteristics of AC circuits	6	0	9
D	Connect and analyze inductors in circuits	3	3	9
E	Connect and analyze capacitors in circuits	3	3	9
F	Calculate power, reactive power and apparent power in AC circuits	3	3	9
	Blend Hours	45		45
	Blend Percentage	50%		50%

Between September and December 2021, the NESC–TI's Subject Matter Expert (SME) and instructional leader for the Diploma Electrician programme, through consultation with the programme's faculty, formulated the blend identified in Table 3 through application of the institution's Instructional and Content Design Process (Appendix C). Through this approach, an instructional design analysis was conducted to determine the prior knowledge and scaffolding necessary to achieve the learning outcomes of each course unit; to map the related learning objectives to the most suitable mode of delivery; and to create the blend. This was followed by the design and development of course literature (see Appendix D) and learning activities and assessments (see Appendix E). All learning content was uploaded to the Blackboard LMS.

In the online environment the medium blend selected for ELEC–06001 sought to develop the underpinning knowledge required for the connection and analysis of circuits containing capacitors and inductors through sessions guided by course instructors. In determining the time required for underpinning knowledge, faculty noted the importance of this course's content for future reference and application, thus dedicating half of the allotted delivery time to online learning. Additionally, the circuit design software (Multisim 14 — which is available via the internet and is free to use for educational purposes), was employed as a learning tool in the online environment to simulate required circuit connections and verify calculations and analysis. This formed the basis for asynchronous online sessions in units D–F, with learners involved in self-directed, active, and collaborative learning. Learning activities involving the physical connection of circuits for devices using inductors and capacitors were assigned to face-to-face workshop sessions. Large class sizes (approximately 20 students per instructor) mandated that sufficient hours be allocated to facilitate adequate competency development, hence 45 hours were assigned.

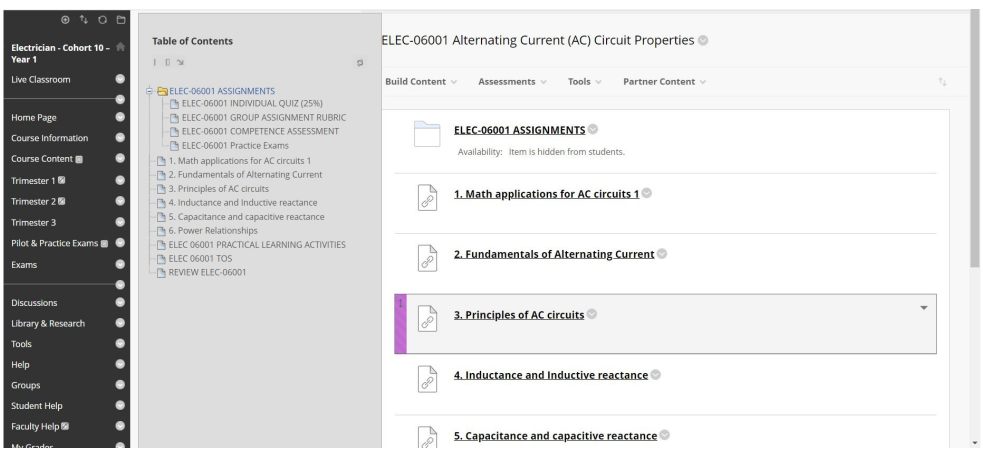
In relation to cost, the NESC–TI incurred no additional financial burden in the implementation of this blended design for ELEC–06001 as the physical resources required already existed within the institution. Further, the use of open resources such as Multisim and the revision of content by faculty to produce online content negated the need to purchase eLearning materials. Additionally, costs related to the Blackboard LMS were absorbed in the affiliation agreement between NESC–TI and RDP.

Integration of Blackboard LMS and Multisim 14

The ELEC–06001 course was taught for the first time using NESC–TI's new blended model from February 4–24, 2022. All content created was uploaded to the Blackboard LMS, giving students unrestricted access to course resources. In keeping with the institution's blended model, the three forms of assessment (individual, group, and competence) were created using the LMS with the requisite rubrics and submission folders developed. This gave students the opportunity to proactively plan and manage their learning journey. Online classes were conducted using the Blackboard Collaborate feature of the LMS, with students participating in classes through personal devices inclusive of smartphones, tablets and laptop/desktop computers. All faculty at the NESC–TI had access to a desktop computer and web–camera for online delivery using the LMS. Multisim 14 provided the bridge between knowledge and skill for ELEC–06001. Students were provided with a link to download and install the simulation software, and it was also installed on instructor systems. Instructors were required to demonstrate to students Multisim's use and applicability in completing course learning activities and assignments.

Figure 2

RDP/NESC–TI Screenshot of Blackboard LMS for ELEC–06001



The blended learning approach adopted for ELEC–06001 is aligned to the principles of a flipped classroom model. A flipped classroom is an instructional strategy where traditional learning environments are inverted, and students are first exposed to courseware outside of the traditional classroom space (Garrison & Kanuka, 2004). Specifically, for ELEC–06001, the allocation of half the delivery time to online learning, focusing on theoretical concepts, mirrors this core principle as students seek to engage with the material independently at their own pace and with the assistance of the course instructor. Garrison and Kanuka (2004) contend that this approach allows for more interactive and hands–on learning during class, as students attend physical classes with a good grasp of the topics and can focus on applying their knowledge. Additionally, the use of online resources like Multisim 14 mirrors the flipped classroom's reliance on technology to deliver content, while the allocation of significant time to face–to–face workshops for practical application of concepts aligns with the flipped classroom's emphasis on active learning.

The use of Multisim 14 also increased student engagement through active learning as students were engaged in circuit design testing. The NESC–TI blended design's mix of assessment methods, including final exams and coursework to assess student learning in online and face–to–face settings is another key feature of the flipped classroom model.

Challenges and Solutions

The implementation of the blended approach for ELEC–06001 encountered several challenges. One significant hurdle was the reliance on mobile devices for accessing course content and completing assignments. Over 40% of students accessed the course content using their smartphone. This proved problematic in the completion of learning activities and assignments as students were unable to use the software effectively with their smartphones. To remedy this issue, Multisim 14 was installed on computers in campus labs where ELEC–06001 was delivered and students were granted access for the practice of activities and submission of assessments. While this diminished the remote learning nature of the blended design, it provided relief for students who otherwise would not have been able to participate effectively.

A direct consequence of adopting a blended learning approach was the need to make content available in a digital format. Previous cohorts of ELEC–06001 used specialized textbooks as the body of knowledge for the course. Copyright restrictions prevented the sharing of this material online. As a solution and in keeping with the new scaffolding approach integrated into the blended design, faculty assimilated textbook content and other related research into PowerPoint presentations for student use. Within these presentations, the Universal Design for Learning (UDL) principles of varied methods of engagement, representation, and expression (Rose & Meyer, 2002, as cited in Dalton et al., 2019) were employed.

The ability of faculty to function effectively in the online environment remained an ongoing challenge, as it was during the delivery of ELEC–06001. Faculty often relied to teacher–centered practices such as protracted lectures to ensure the coverage of course content by students. This practice existed across diploma programmes at the NESC–TI and prompted the enrollment of all faculty in an eLearning Instructor Certificate programme hosted by RDP. This programme covered the following courses: Approaches to Teaching and Learning; Quality Course Design; Assessment and Evaluation; Context of Online Education; Synchronous Teaching and Tools; and Creating Community Asynchronously. Training for faculty began in March 2022 and ended in November 2022. Through learner evaluations conducted at the end of the training, faculty indicated the e-learner programme was effective in helping them gain important skills such as the importance of formative and summative assessments, evaluation methods for the online environment, various teaching methods, and UDL concepts. They also admitted to gaining skills in emotional intelligence, empathy, and new methods of engaging students, particularly in online environments.

Additional challenges surfaced around student readiness for online learning. Though students indicated high levels of self–efficacy on the pre–course survey, this did not translate during the blended implementation. Issues with time management, self–regulation, and technical skills were prevalent. To address this gap, a student orientation session was hosted at the start of the January 2022 semester. Focus was placed on the key competencies for online learning success. Students also had to complete a mandatory online student readiness course hosted on the LMS. This has now been formalized as part of the NESC-TI's student orientation process. This has proven to be effective with students demonstrating increased awareness of their academic responsibilities as well as improved competency in navigating the LMS.

From a technology standpoint, limitations in the LMS and inconsistent internet connectivity impacted faculty and students. For the LMS, advanced features for synchronous sessions, gamification, and multimedia integration were lacking. These features were not included as part of the affiliation agreement between Red Deer Polytechnic and the NESC-TI for use of the Blackboard LMS. The result was reliance on third–party tools such as Zoom and Padlet to bridge gaps. Internet connectivity on campus was also unstable, resulting in students sometimes getting booted from live sessions. Upgrades to the LMS and internet infrastructure have been approved by the Ministry of Education as priorities for the 2023/2024 financial year. Implemented in 2024 were improvements to NESC-TI's internet bandwith and increased student WiFi access. This has significantly reduced connectivity challenges and improved the online experience at campuses. Upgrades to the LMS however, have yet not occurred.

On the positive side, student engagement and collaboration increased with the online components. The use of discussion forums and Padlet allowed students to interact more with their peers, strengthening communication skills in the process. Critical thinking skills also improved ,as seen from online debate participation and the quality of forum postings. The blended approach provided more opportunities to develop these soft skills. Student feedback at the end of the course confirmed the benefits gained from blending face–to–face instruction with online learning activities.

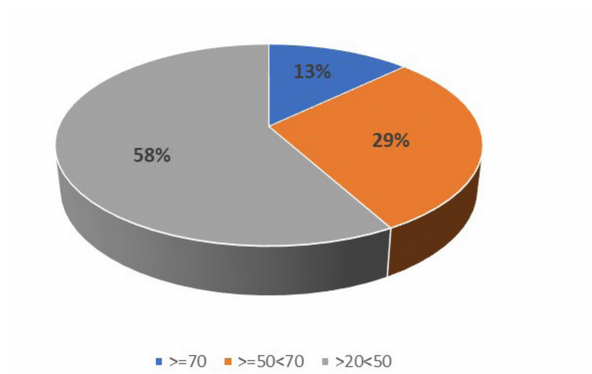
Training Outcomes for Adaptation

The implementation of the blended learning approach for ELEC–06001 revealed several positive outcomes. The use of online platforms and digital tools facilitated increased student engagement and collaboration, as evidenced by active participation in online discussions and group projects. Additionally, the flexibility of the blended model allowed for more personalized learning experiences, as students could access course materials and complete assignments at their own pace. Further, the blended model exposed learners to digital tools and technologies, enabling enhancement of their digital literacy skills. The integration of practical, hands–on activities with online theory also provided a well–rounded learning experience, strengthening learners' understanding and application of the electrical concepts.

One of the most significant measures of learning is assessment results. For ELEC–06001, 16 of the 124 enrolled students were successful at scoring 70% or above in both coursework and the final examination, earning 6 credits. A total of 72 students scored between 20% and 50% while 36 students scored above 50% but below the passing score of 70% (see Figure 3).

Figure 3

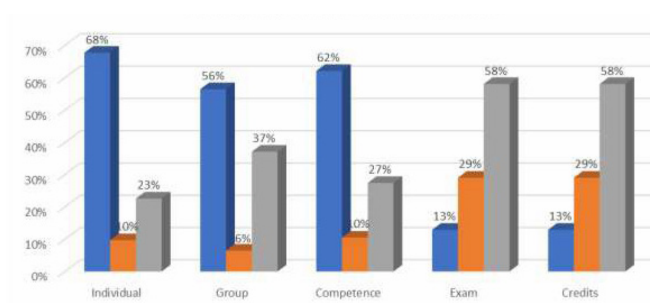
Student Assessment Results for ELEC–06001



A deeper analysis of learner performance beyond the credits awarded suggests that, despite only 13% of learners being awarded course credits, students were well engaged during the course delivery. Students performed significantly better in the coursework elements of the course (individual, group, and competence assignments), indicating high engagement during delivery. Figure 4 shows the comparative assessment scores.

Figure 4

Assessment Performance for ELEC–06001



The disparity in the results proved concerning for the institution, indicating that several other factors impacted teaching and learning. The increased workload associated with course preparation for online instruction potentially affected the quality of teaching and, consequently, student performance — with faculty members required to balance their increased workload with maintaining high–quality instruction. Additionally, faculty technical proficiency and comfort with online tools are crucial for effective blended learning. While professional development was implemented, more targeted training may be necessary to address specific needs and enhance faculty effectiveness in this new modality. A continuous approach to professional development may be necessary to keep faculty in tune with the latest blended teaching approaches as well as training in instructional design and assessment methods. Faculty must also be kept up–to–date with improvements in technology from both occupational and teaching and learning perspectives.

The incongruity between the coursework and final exam results also raises questions of the effectiveness of assignments in preparing students for the summative exams. Alignment of the examination and coursework elements against the curriculum and established learning outcomes must be established. Additionally, feedback on coursework performance geared towards building readiness for exams must be given effectively to ensure positive learner results.

Student support for blended learning is also critical to the achievement of learning outcomes and to ensuring that learners have a positive academic experience. Support services may need to be enhanced through the implementation of tutoring and mentoring programmes, to addressing the challenges of poor exam performance, time management, and self-regulation.

Addressing the technological challenges is crucial to improving quality in blended learning systems. The NESC–TI must develop methods of ensuring reliable internet connectivity for both faculty and students. The institution should also consider investing in a more robust and user–friendly LMS with advanced features that would enhance the online learning experience. Technical support is also needed to urgently address learner and teacher challenges.

Other important lessons were learnt throughout the implementation of this blended approach. The first was related to planning. A blended approach requires the management of technological resources, faculty competencies, and learner readiness. Adequate consideration and preparation for each of these elements is needed to reduce instances of unrealized learning outcomes. Another significant lesson was in the area of culture. At the NESC–TI, pockets of resistance to the blended approach remained, with groups of faculty, students, and administrators opposed to the use of online learning in the TVET landscape. Mitigating against perceived drawbacks and highlighting the benefits of blended learning is needed to combat this resistance. The final realization was that tools for evaluation and continuing improvement must be determined, developed, and commissioned prior to the implementation of a blended learning approach to obtain timely feedback from classes and to use data for the continuous enhancement of learning.

A further course evaluation was conducted to appraise student feedback, instructor methods, and resource allocation; the results showed 67% of students were satisfied with both instructor delivery in online classroom and availability course resources. Beyond ELEC–06001, the NESC–TI continued its blended approach into the 2022/23 academic year. The institution has recently specified the Kirkpatrick model of evaluation for its diploma programmes, developing appraisal tools and metrics for the model’s 4 levels of evaluation: reaction, learning, behaviour, and results.

Conclusion

The transition of the ELEC–06001 to a blended course design at the NESC–TI was a significant step towards embracing modern teaching and learning methodologies. While the integration of technology and flexible learning modalities has shown promise, the low overall student success rate raises concerns about the effectiveness of the current approach. To improve future outcomes, a more comprehensive study of the programme is needed. This evaluation must consider factors such as instructor preparedness, student support, the quality of course materials, and the alignment of assessment strategies with learning outcomes. Additionally, addressing technological challenges and improving internet connectivity issues are crucial for the development of a positive blended learning experience. Through addressing these challenges and implementing strategies based on an evaluation of data evidence, NESC–TI can improve its blended learning model and achieve greater student success. The NESC–TI should also collaborate regionally with other TVET institutions and stakeholders on a comparative analysis of blended systems in the Caribbean.

Glossary of Abbreviations and Technical Terms

Acronym /Term	Full Form
ACTT	Accreditation Council of Trinidad and Tobago
ADDIE	Analyze, Design, Develop, Implement, Evaluate
ALNG	Atlantic Liquified Natural Gas Company Limited
Asynchronous sessions	Online sessions where participants can access and participate at their own pace
Blended learning	Combining online and face–to–face learning
Constructivism	Learning theory emphasizing knowledge construction through active engagement
Copyright restrictions	Limitations on using copyrighted material
E–learning	Learning delivered electronically
Formative assessment	Assessment used to monitor learning progress and inform instruction
In–person interview	Interview conducted face–to–face
LMS	Learning Management System (Blackboard in this case)
Multisim	Circuit design software
NESC–TI	National Energy Skills Center (now NESC Technical Institute)
NID	NESC–TI Instructional Design tool
RDP	Red Deer Polytechnic
Rubrics	Scoring guides used to assess student work
Scaffolding	Providing temporary support to learners to help them achieve a learning goal
Self–directed learning	Learning initiated and guided by the learner
Summative assessment	Assessment used to evaluate learning outcomes at the end of instruction
Synchronous sessions	Online sessions where participants are all online at the same time
TVET	Technical and Vocational Education and Training
UDL (Universal Design for Learning)	A framework for creating learning experiences accessible to all learners
ZPD (Zone of Proximal Development)	The gap between a learner’s current competence and what they can achieve with support

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References

Adri, M., & Zakir, S. (2020). Using ADDIE Instructional Model to design blended project-based learning based on production approach. *International Journal of Advanced Science and Technology*, *29*(6), 1899–1909.

Alvarez, A. V. (2020). Learning from the problems and challenges in blended learning: Basis for faculty development and program enhancement. *Asian Journal of Distance Education*, *15*(2), 112–132. https://www.asianjde.com/ojs/index.php/AsianJDE/article/view/433

Boehner, M. M. (2017). *High quality teaching and assessing in TVET: The road to enhanced learning outcomes.* Tertiary and Vocational Education Commission.

Bouchrika, I. (2022, September 26). *The ADDIE model explained: Evolution, steps, and applications*. Retrieved from https://research.com/education/the-addie-model

Chinengundu, T. (2021). Four strategies for blended learning in TVET: A South African post-pandemic perspective. In M. Makgato, & G. Afeti (Eds.), *New models for Technical and Vocational Education and Training* (pp. 74–90). IGI Global. https://doi.org/10.4018/978-1-7998-2607-1.ch005

Dalton, E. M., Lyner–Cleophas, M., Ferguson, B. T., & McKenzie, J. (2019). Inclusion, universal design and universal design for learning in higher education: South Africa and the United States. *African Journal of Disability*, *8*(a519). https://doi.org/10.4102/ajod.v8i0.519

Eun, B. (2018). The zone of proximal development as an overarching concept: A framework for synthesizing Vygotsky's theories. *Education Philosophy and Theory*, *51*(1), 18–30. https://doi.org/10.1080/00131857.2017.1421941

Garrison, D. R., & Kanuka, H. (2004). Blended learning: Uncovering its transformative potential in higher education. The *Internet and Higher Education*, *7*(2), 95–105.

Hill, J., & Jordan, L. (n.d.). *Experiential learning in instructional design and technology.* Creative Commons Attribution. https://pressbooks.pubexperientiallearningininstructionaldesignandtechnology/

Kebualemang, G. K., & Mogwe, A. W. (2017). An empirical investigation into blended learning effects on tertiary students and students' perceptions on the approach in Botswana. *International Journal of Advanced Computer Science and Applications*, *8*(6), 187-197.

Kintu, M. J., Zhu, C., & Kagambe, E. (2017). Blended learning effectiveness: The relationship between student characteristics, design features and outcomes. *International Journal of Educational Technology in Higher Education*, (*14*)7. https://doi.org/10.1186/s41239-017-0043-4

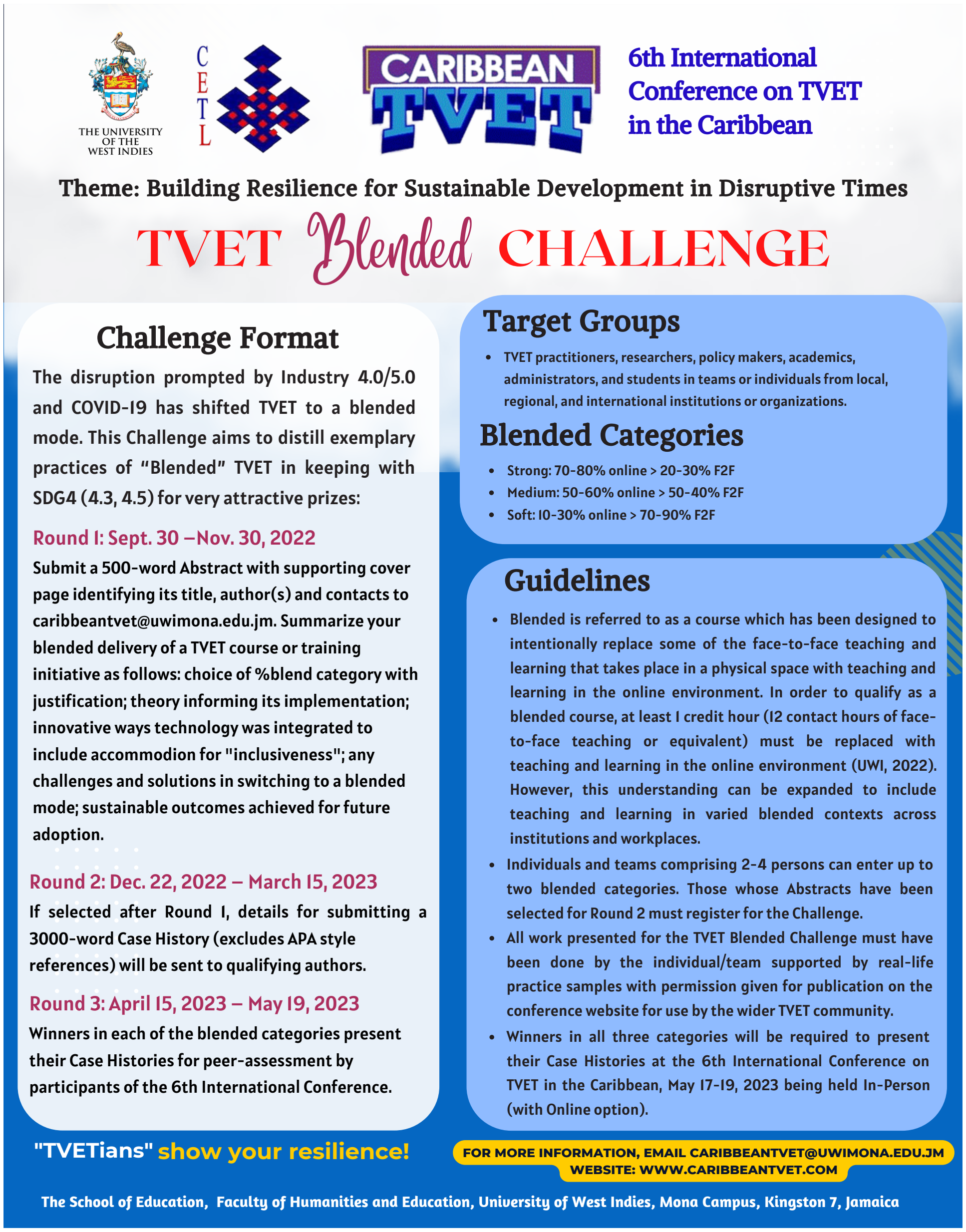
Puntambekar, S. (2022). Distributed scaffolding: Scaffolding students in classroom environments. *Educational Psychology Review*, *34*(1), 451–472.

Singh, T., & Athavale, V. A. (2008). Constructivist perspective on technical and vocational education. *The Journal of Educational Research*, *11*(1), 75–92.

Stapa, M. A., & Mohammad, N. (2019). The use of ADDIE model for designing blended learning application at vocational colleges in Malaysia. *Asia–Pacific Journal of Information Technology and Multimedia*, *8*(1), 49–62.

Appendix A

6th International Conference on TVET in the Caribbean 2023 — TVET blended challenge flyer



Appendix B

ELEC 06001 NID

NESC Technical Institute - Instructional Design (NID)	Programme:	Diploma Electrician
Curriculum and Teaching Services Department	Course Learning Outcomes	1. Perform second period math applications 2. Describe the fundamentals of alternating current (AC). 3. State and analyze the characteristics of AC circuits. 4. Connect and analyze inductors in circuits. 5. Connect and analyze capacitors in circuits. 6. Calculate power, reactive power and apparent power in AC circuits
Instructional Design for Course:	Course/Unit (Hrs):	A. Math Applications for AC Circuits I 15 Hours
RFAC-06001 - ALTERNATING CURRENT (AC) CIRCUIT PROPERTIES	Unit Learning Outcomes:	Perform second period math applications

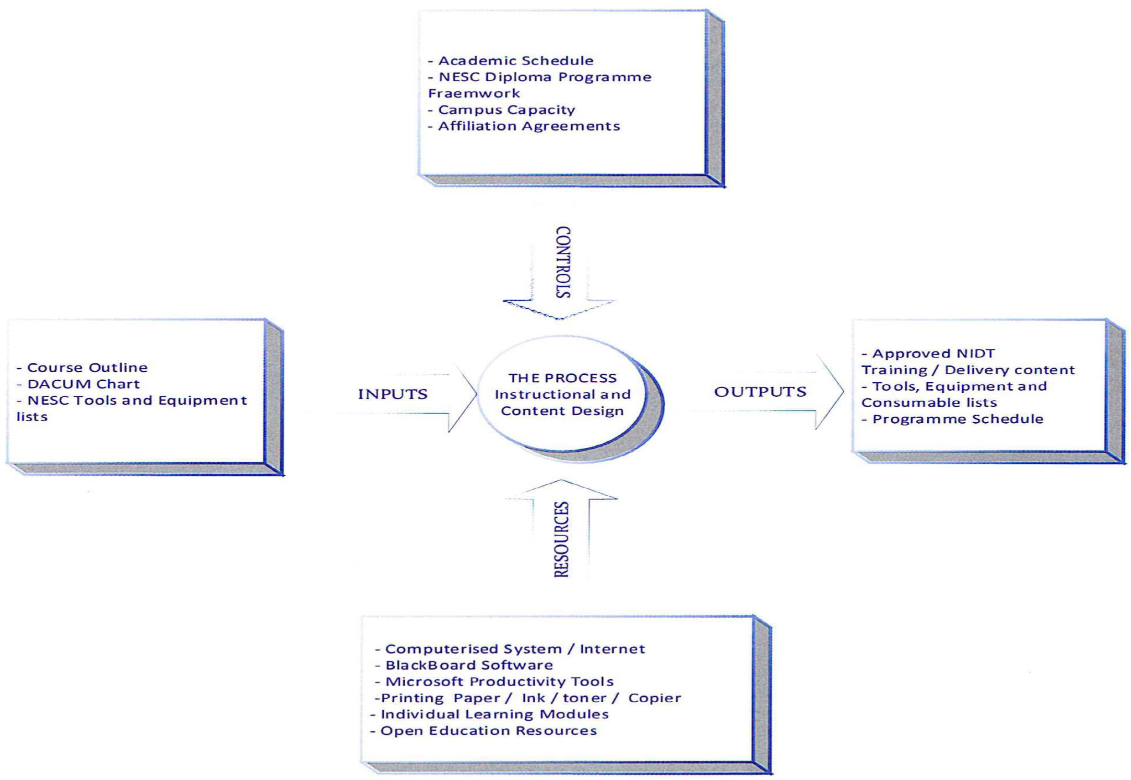
Unit Learning Objectives	Analysis			Design					
				Assessment		Teaching Format / Instructional Strategies			
	Learner's Previous Knowledge	Required Resources	Teaching Objectives	Formative Assessment Methods	Graded Assessment Methods	Online Class	Asynchronous (In Campus / Online)	Asynchronous (Self Directed)	Workshop
1. Perform arithmetic operations in sequence using BEDMAS.	Students are required to recall basic math applications at CSEC level.	PowerPoint, Online teaching tools, Work sheets, Math simulations, videos	Instructors are required to: 1. Show students how to perform addition, subtraction and multiplication. 2. Demonstrate how to calculate exponents. 3. Demonstrate how to perform mathematical operation in brackets.	Students are required to complete the work sheet provided	Final Exam / Coursework	Lecture and learning activities as per teaching objectives identified	Students are required to complete math work sheets in groups of three and discuss their answers.	Students are required to complete their invidividual quiz for 25%	Not Required
2. Transpose equations to make any stated term the subject.	Students are required to recall basic math applications at CSEC level.	PowerPoint, Online teaching tools, Work sheets, Math simulations, videos	Instructors are required to: 1. Define an equation 2. Discuss the importance of transposition. 3. Demonstrate how to perform ohms law calculations with squared variables.	Students are required to transpose the ohms law formula to solve electrical values.	Final Exam / Coursework	Lecture and learning activities as per teaching objectives identified	Students are required to complete math work sheets in groups of three and discuss their answers.	Students are required to complete their invidividual quiz for 25%	Not Required
3. Perform arithmetic operations using squares and square roots.	Students are required to recall basic math applications at CSEC level.	PowerPoint, Online teaching tools, Work sheets, Math simulations, videos	Instructors are required to: 1. Demonstrate how to use a scientific calculator. 2. Point out how squared numbers are expressed. 3. Demonstrate how to transpose the ohms law equations	Students are required to apply the power equation	Final Exam / Coursework	Lecture and learning activities as per teaching objectives identified	Students are required to complete math work sheets in groups of three and discuss their answers.	Students are required to complete their invidividual quiz for 25%	Not Required
4. Perform calculations using scientific notation.	Students are required to recall basic math applications at CSEC level.	PowerPoint, Online teaching tools, Work sheets, Math simulations, videos	Instructors are required to: 1. State why numbers are expressed in scientific notation 2. Demonstrate how to convert numbers in scientific notation.	Students are required to convert numbers in scientific prefixes.	Final Exam / Coursework	Lecture and learning activities as per teaching objectives identified	Students are required to complete math work sheets in groups of three and discuss their answers.	Students are required to complete their invidividual quiz for 25%	Not Required

Appendix C

Instructional and Content Design

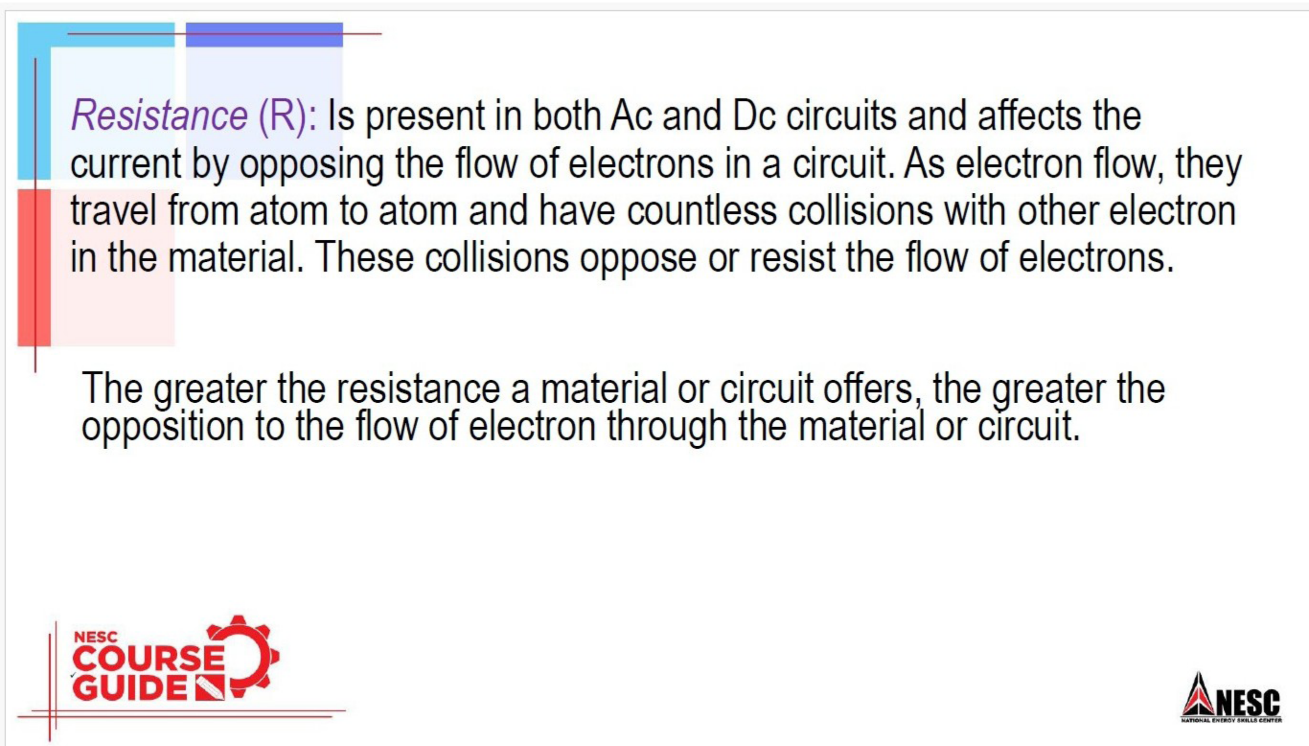
NESC NATIONAL ENERGY SKILLS CENTER	Quality Management System Documentation Instructional and Content Design	NESC-2015-SSD-005 Revision No.: 1 Page 5 of 10 ISO 9001:2015 Risk-based thinking

7.0 Input, Control, Output And Resource



Appendix D

ELEC-06001 Sample Course Literature



Appendix E

ELEC-06001 Practical Learning Activites

B – Fundamentals of alternating current (9 PR hours)

Objective 4 - Describe the relationship between sine waves and phasor diagrams.

Activity 1 - Using Multisim 14 students are to construct a circuit with one 1kΩ resistor in series to a 120v RMS power source and observe its sine wave.

Resources
1 – Laptop / tablet / desktop
1 – installed copy of multi-sim 14

Step by step procedure

1	Construct a circuit with one 1kΩ resistor in series
2	Connect in the resistor to a 120v RMS power source
3	Ground channel A's negative terminal of the oscilloscope
4	Connect channel A's positive terminal to view the source voltage sine wave
5	Double click on the oscilloscope to obtain the virtual display
6	Set the scale to 200 v/div and observe the sine wave
7	Place the circuit in run mode
8	Write a 100 word report on your observations

Activity 2 - Using Multisim 14 students are to construct a circuit with one 1kΩ resistor in series to a 120v RMS power source and observe its sine wave.

Resources
1 – Laptop / tablet / desktop
1 – installed copy of multisim 14

Step by step procedure

1	Construct a circuit with two 1kΩ resistor series
2	Connect the resistor to a 120v RMS power source
3	Ground the negative terminal for channel A and B of the oscilloscope
4	Connect channel A positive terminal to view the source voltage sine wave
5	Connect channel B to the middle of the voltage divider (between R1 and R2)
6	Double click on the oscilloscope to obtain the virtual display
7	Set channel A to 200 v/div
8	Set channel B to 50 v/div
9	Set the time base to 10 ms/div
10	Place the circuit in run mode
11	Hold the slider bar on the oscilloscope and observe the relationship between the two waveforms
12	Write a 100 word report on your observations