COMMONWEALTH *of* LEARNING

Commonwealth Educational Media Centre for Asia

Enhancing the Efficacy of ITI Electrician Course in India

DISCUSSION PAPER

DECEMBER 2023

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CEMCA

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The Commonwealth Educational Media Centre for Asia (COL-CEMCA) is an international organisation established by the Commonwealth of Learning (COL), Vancouver, Canada, to promote the meaningful, relevant and appropriate use of ICTs to serve the educational and training needs of Commonwealth member states of Asia. COL-CEMCA receives diplomatic privileges and immunities in India under Section 3 of the United Nations (Privileges and Immunities) Act, 1947.

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This study maps the Electrician trade curriculum offered by Industrial Training Institutes (ITIs) in India to evaluate how innovative blended learning practices could improve the quality of training and enhance the learning experience, particularly for students aiming to become entrepreneurs. Through a comprehensive literature review and consultations with key stakeholders, the study examined the vocational education landscape and the current state of blended learning. It identified gaps and opportunities within the existing ITI Electrician programme and proposed a transition to a blended learning model to boost its effectiveness and student engagement.

We invite you to share your valuable insights on this study, which provides a roadmap for improving the course and its implementation. Designed to impart vocational skills, the proposed ITI Electrician Blended Programme envisions a balanced combination of online and face-to-face learning, rather than a fully online approach. As there is significant room for refinement, we would greatly appreciate your feedback and look forward to your input.

Please send your comments to admin@cemca.org.

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Part B – Enhancing the Efficacy of the ITI Electrician Course

List of Acronyms

AAs	Assessment Agencies
ABs	Awarding Bodies
AI	Artificial Intelligence
AICTE	All India Council for Technical Education
AITT-CBT	All India Trade Test Computer Base Test
AR	Augmented Reality
autoCAD	Computer-aided design and drafting
Blend4VET	Blended Learning for Vocational Education Sector
CBSE	Central Board of Secondary Education
CEC	Consortium for Educational Communication
CEMCA	Commonwealth Educational Media Centre for Asia
CIET	Central Institute of Educational Technology
CIFP	Canadian Institute of Financial Planning
CITS	Crafts Instructor Training Scheme
CRM	Customer Relationship Management
CSTARI	Central Staff Training and Research Institute
CTS	Craftsman Training Scheme
DC and AC Motors	Direct Current and Alternate Current Motors
DGT	Directorate General of Training
DIKSHA	Digital Infrastructure for School Education
EdTech	Educational Technology
EQF	European Qualifications Framework
ERP	Enterprise Resource Planning
F2F	Face-to-Face
FAQ	Frequently Asked Questions
GD	Group Discussions
GIF	Graphics Interchange Format
GoI	Government of India
IIMB	Indian Institute of Management, Bangalore
IIT	Indian Institute of Technology
ILT	Instructor-led training
IMP	Instructional Media Packages
ITC	Imperial Tobacco Company of India Limited
ITIs	Industrial Training Institutes
LMS	Learning Management System
MG	Motor Generator

MIS	Management Information System
MOOCs	Massive Open Online Courses
MSDE	Ministry of Skill Development and Entrepreneurship
NCERT	National Council of Educational Research and Training
NCrF	National Credit Framework
NCVET	National Council of Vocational Education and Training
NCVT	National Council for Vocational Training
NDEAR	National Digital Education Architecture
NEP 2020	National Education Policy 2020
NIMI	National Instructional Media Institute
NIOS	National Institute of Open Schooling
NITTTR	National Institute of Technical Teachers Training and Research
NPTEL	National Programme on Technology Enhanced Learning
NSDA	National Skill Development Agency
NSDC	National Skills Development Corporation
NSQF	National Skills Qualification Framework
NVSK	NDEAR Vidya Samiksha Kendra
OJT	On-the-job training
PDF	Portable Document Format
PLC	Programmable Logic Controllers
PPP	Public Private Partnership
RPL	Recognition of Prior Learning
SSO	Single Sign-on
SWAYAM	Study Webs of Active Learning for Young Aspiring Minds
ToT	Training of Trainers
UGC	University Grants Commission
VETS	Vocational Education, Training, and Skilling
VILT	Virtual Instructor-led Training
V-lab	Virtual Lab
VR	Virtual Reality
XR	Extended Reality

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Foreword

Commonwealth of Learning (COL) supports formal, non-formal and informal education and training to equip learners for livelihoods. Through its regional centre, the Commonwealth Educational Media Centre for Asia (CEMCA), COL has been tackling issues around unemployment among the youth, persons with disabilities, and women by reinforcing the need for in-demand skills. Through high quality curriculum delivered through blended learning techniques, CEMCA believes that high demand skills can be honed; thus, technical, vocational and professional competencies of our learners in every educational system can be brought at par with those trained in developed economies. For a long time, there has not been any pedagogical innovation in the way vocational training was being imparted at the Industrial Training Institutes (ITIs) of India, especially in the area of technology-enabled learning practices. When these institutions work collaboratively with industry and labour market to offer equitable online, blended and work-based learning opportunities, not only can these institutions scale-up, but also reduce the cost of the provision of training.

During 2023-24, CEMCA undertook to map the curriculum of Electrician trade skills to understand if and how innovative blended learning practices would enhance the quality of training at the ITI level; thus, enhancing the learning experience of learners who pursue the course for livelihoods, especially by becoming entrepreneurs. This exploratory study helps us to understand if gender-responsive learning opportunities could be developed and offered in a blended manner where learners are mentored and linked to online learning resources, preferably in partnership with the labour market.

The study demonstrates that access to and use of resources can contribute to improved skills and competencies for employment, entrepreneurship and the promotion of gender equality, which, in turn, contributes to the improvement of learners' lives and livelihoods. The critical components of the success are: the course is of high quality, modes of delivery are appropriate and accessible, learners have access to basic infrastructure, time and resources to participate in and complete courses / programmes offered in a blended manner, and eventually, by becoming lifelong learners, they are able to continue learning and have the support to apply their knowledge for career advancement or further education or becoming entrepreneurs in their own right.

I thank our expert, Mr. George C Varughese for his efforts in bringing this publication for the attention of our stakeholders responsible for the provision of training and skilling at the ITIs in India. I congratulate the entire team at CEMCA and our governmental partners such as the Sector Skill Councils, National Instructional Media Institute, Central Staff Training and Research Institute, National Institute of Open Schooling and the Principals of ITIs who have supported us in this research effort.

The research highlights the innovative methods of utilising the existing e-content while also encouraging us to look at the ways of using technology-enabled learning practices for providing 21st century learning experiences for our learners. I am hopeful that the report will be useful to all those who are looking to reform the ITIs and the way skills are imparted there.

B. Shadrach
Director
Commonwealth Educational Media Centre for Asia
Commonwealth of Learning

Acknowledgements

The author wishes to acknowledge all those who contributed during the field consultations including ITI principals, instructors, students, alumni, etc. Several other public and private institutions and employers also contributed to enriching the understanding of the Vocational Education, Training, and Skilling (VETS) ecosystem in India. Considerable secondary information and examples were sourced from the internet; and their contribution is duly acknowledged.

This study would not have been possible without the strident support of colleagues at CEMCA. Initially with Mr. Saurabh Mishra, former Programme Officer – Skills, and throughout the study, Dr B Shadrach, Director, led from the front with intellectual support and guidance. Ms. Monica Sharma, Programme Coordinator, and her team provided all the logistical and administrative support. Ms. Saptaparni Banerjee provided the research support during the field consultations, literature review, and analysis; and editorial support during the finalisation of the document. Their cooperation and support is appreciated and acknowledged.

George C Varughese
Strategic Advisor

Executive Summary

As part of the Commonwealth of Learning's strategic plan 2021-27, its regional centre in New Delhi – the Commonwealth Educational Media Centre for Asia (CEMCA) embarked on a study in November 2022 to explore ways in which the efficacy of the Electrician Course offered by the Industrial Training Institutes (ITIs) in India can be enhanced.

The study was initiated with a literature review and consultations with key stakeholders to understand the vocational education and blended learning ecosystem in India. It then analysed and identified the gaps and potentials of the ITI Electrician programme within the context of blended learning initiatives in the public education space and policy framework in India. It further goes on to suggest the ways of transforming and transitioning the ITI Electrician course into a blended curriculum and assessment framework to enhance its efficacy and improve the overall learning and teaching experience.

The report is divided into two parts. Part A provides an overview of the vocational education and training (VET), and blended learning landscape in the country. Part B outlines the possibilities, framework and process required to transform the ITI Electrician course into a blended learning programme.

Some of the key observations while reviewing the *electrician vocational education courses in India* are as follows:

- The ITI Electrician Course offered at Level 4 of the National Skills Qualification Framework (NSQF Level-4) under the Craftsman Training Scheme (CTS) is one of the most popular courses garnering approximately 30 per cent of total 26 lakh available seats across all the ITIs in India. The popularity is essentially due to better job and self-employment opportunities, coupled with better earning potential when compared to other courses.
- At the same time, the ITI Electrician course is also affected by several of the challenges obtaining in the overall skilling and entrepreneurship landscape of the country. These include the quality of trainers, lack of training infrastructure, and the overall impression that vocational education is meant for weaker students who cannot cope with the 'mainstream'.
- Currently, the ITI Electrician Course is designed and delivered as a traditional face-to-face programme, with some content and curriculum material available online. The latest revision in July 2022 is robust and updated, catering to the needs of the industry. It also provides broader job prospects compared to other public VET or private courses. However, the programme needs to address the issues of quality of instructors/trainers, infrastructure, industry linkages, and interaction especially in the rural areas. Some of these challenges can be partially addressed through a carefully crafted digitally enabled blended learning programme.
- Over the last few years, the ITI Electrician Course material is available on the Bharat Skills platform – including updated NSQF curricula, CTS course content, Question Banks, mock/practice papers, learning videos, etc. Relevant e-books are available, and there are about 180 lecture videos organised into 99-week lessons over two years. Similarly, the National Council of Vocational Education and Training (NCVET) provides content that enables students to prepare for the ITI examinations. These include Mock Tests by NCVT, National Instructional Media Institute (NIMI) online, All India Trade Test Computer Base Test (AITT-CBT), etc.
- More recently, NIMI initiated Blended Learning programmes in 12 skill sectors, most of them with one-two courses to improve the learning experience of trainees. The Power sector has two courses – Electrician and Wireman. 'NIMI online learning' uses Rock Star trainers, who present the topics of

their speciality in native languages. This selective crowd sourcing has been quite effective in generating interest, participation, and building upon what is available. The Weekly Lesson Plan for over 80 weeks has been prepared. Most of the content available is still essentially lectures and textbooks, with attempts at e-books and interactive e-books. Much more needs to be done on interactive forums, and virtual laboratories. At this stage, the focus appears to be on Content Development. The initiatives by NIMI and Central Staff Training and Research Institute (CSTARI), both for students and instructors, respectively, is a very good starting point for blended learning in the ITI system.

- A key public-private initiative providing skills training in several domains including the Electrician course is the network of the National Skill Development Corporation (NSDC) with about 25 courses for the electrician trade in ten sectors. These are typically three to four months (300 to 450 hours) certificate courses at NSQF levels 3 or 4. The course content is very relevant since they are prepared under the oversight of the Sector Skills Councils, which are dominated by professionals and business leaders from the concerned industrial sectors. The courses are also well crafted – each with a Qualifications Pack, Facilitator Guide and Model Curriculum. Most courses are delivered using traditional face-to-face methods. Some enterprising partners have been experimenting with a 50: 50 hybrid mode using both online learning and contact practical classes for the Construction Sector Assistant Electrician Course over a 16-week period. NSDC also runs the e-Skill India portal – an e-learning aggregator platform that consolidates B2C e-learning portals operating over the internet in the skilling ecosystem.
- Besides the ITI system, the other major public institutions offering Electrician Courses are the Central Board of Secondary Education (CBSE) and several state boards, National Institute of Open Schooling (NIOS) and some state institutes of open schooling, the polytechnics and the skill universities that have come up more recently, and the Indira Gandhi National Open University (IGNOU) and some of the other 18 odd open universities in India. There are also several smaller private Educational Technology (EDTech) institutes.

Any attempt to embark on a blended learning approach in the ITI courses needs to be seen in the broader context and experience in India with other online initiatives especially in the public education space.

- The PM *e-Vidya* Programme is probably the most advanced in thinking and action to unify efforts at a national scale on digital/online/on-air education and enable multi-mode access to education. The building blocks are rapidly being consolidated or built and integrated under the overall framework of the National Education Policy 2020 (NEP-2020). Some of the key components of the PM *eVidya* programme include:
  - NDEAR – National Digital Education Architecture – is a global pioneering effort to create a unifying national digital infrastructure to energise and catalyse the education ecosystem.
  - E-learning platforms such as DIKSHA – Digital Infrastructure for School Education; SWAYAM – Study Webs of Active Learning for Young Aspiring Minds – A Massive Open Online Courses (MOOCs) Platform designed to cater to from school to post-graduate, and technical and management education; NISHTHA – National Initiative for School Heads' and Teachers' Holistic Advancement – an integrated training programme aimed at holistic development of teachers and school heads.
  - Multi-channel learning continuum including Television – SWAYAMPRABHA; Radio, Community Radio, and Podcasts; *ePathshala* mobile applications.

- NDEAR *Vidya Samiksha Kendra* (NVSK) – a comprehensive system to effectively collect, monitor, correlate, analyse, and visualise data.

- Several of the initiatives under the PM *e-Vidya* programme are globally pioneering. The Central Institute of Educational Technology (CIET) is a store house of knowledge and experience on the technological aspects of strategising, structuring, and developing a large-scale public education system. They have understood what it takes to build an open system at scale that enables a diverse range of stakeholders.
- While most of the content currently available is still static materials, it is important to note the advances being made in their collaborations for Virtual Labs, and experiments in creating content using Augmented Reality (AR) and Virtual Reality (VR). Particularly important will be learning from these experiences so that together with the advances in Metaverse, cost-effective interactive content can be created for more practice-oriented VET courses.
- The CIET experience also provides learning on the use and integration of various media like internet, radio, television, mobile applications; different languages, tools for communities with special needs, etc. to effectively reach different sections of the vast and diverse Indian society. DIKSHA has a fairly good 'content management system'. The 4-quadrant system of organising and managing content is useful and quite widely used, though some experts do not find it relevant.
- Similarly, NVSK is also a reasonably good education 'programme management system,' catering to diverse autonomous stakeholders. The missing piece seems to be a 'learning management system' (LMS) that is intuitive and user friendly for both the student and teacher. SWAYAM also has been focussing more on content development rather than LMS. This is where the smaller scale initiatives by EdTech companies have been much more nimble footed. It would be useful to learn from their experiences while developing the LMS.
- It will be useful for NIMI and CSTARI to interact with CIET/NCERT, learn from their experience and explore areas of possible collaboration. This can avoid re-inventing the wheel and enable a much smoother and faster learning and operationalisation trajectory in the VET domain.

There are broadly four approaches or a combination that are adopted globally for blended learning. There are Flipped Classroom, Blended Face-to-Face (F2F)/Blended block, Blended Online/Online driver, and Self-blend – completely student driven. A combination can be adapted for transforming the ITI programme.

Some of the key challenges experienced globally while implementing blended learning programmes involve people, infrastructure, systems, and resources. While students adapt quickly, instructors take time to culturally transition from being a teacher to facilitator, and also acclimatise with the digital tools and techniques. Blended programmes also require digital infrastructure and facilities which may not be readily available. Creating a blended learning programme that both engages and supports learners requires considerable planning and design. It is not just a matter of transforming curriculum material into digital content. It requires a systems approach to design and implement a whole new experience of learning and teaching. This may not be feasible in situations where there is limited time, resources, and/or expertise.

Fortunately, the overall policy environment in India today is very conducive towards vocational education, training, and skilling (VETS). The NEP 2020 by the Ministry of Education, promotes and encourages VETS as a parallel opportunity for students rather than considering it as a last option for dropouts from mainstream education channels. The NEP 2020 also encourages blended and self-paced learning, depending on the aptitude and circumstances of different types of students.

At the same time, the NCVET Guidelines for Blended Learning for Vocational Education, Training and Skilling released in July 2022, provides a structural framework and guidance for designing and operationalising the blended ITI courses.

The experiences at the school level by NCERT/CIET, and at the higher education level by the University Grants Commission (UGS) documented in their respective policy documents – CIET/NCERT Guidelines for Development of E-content for School and Teacher Education, UGC Concept Note on Blended Mode of Teaching and Learning 2021, and UGC (Online Courses or Programmes) Regulations, 2018 are also very relevant while designing the blended ITI courses.

The time is opportune to systematically transition and transform the ITI (Electrician) programme through the blended learning approach. The policy and regulatory environment is conducive, and the basic building blocks for transitioning the ITI course are in place. At the same time, the overall public education ecosystem in India is trying and testing various aspects of transitioning to online and/or blended programmes. Hence the ITI system will not be alone in this critical transformative initiative.

To explore the possibilities of transitioning to a Blended Learning programme, the ITI Electrician Course curriculum is analysed a little deeper.

- The current ITI Electrician Curriculum, structured as a two-year programme with 1200 notional training hours of coursework and 150 hours of on-the-job training (OJT) each year, is market relevant, robust, and up-to-date. The curriculum itself does not require any change but the methods, tools and techniques of teaching, learning, assessments, etc. can be significantly improved.
- Three categories of content have been identified for the ITI Electrician course. These include:
  - Theory – Understanding Concepts and Theory
  - Practical – Performing Measurements and Tests
  - Core Practical
    - Assembling/Constructing Circuits and Boards
    - Installing, Repairing and Maintaining Machines

  It is relevant to note that about 35-40 percent of the two core practical components involve the tasks of performing measurements and tests. In short, the ITI Electrician course is approximately 30 percent Theory, and 35 percent of Practical Measurements, and another 35 percent Core Practical Work on Circuits and Machines.
- Adapting the NCVET Guidelines for Blended Learning with the current ITI Electrician course curriculum, the transition to a blended mode of learning is possible as follows:

ITI Electrician Course Transition to Blended Learning

Effective Hours %	Content Category	Possible Transition		Effective Transition	
		Online	Face2Face	Online	Face2Face
30	Theory - all aspects	80 :	20	24 :	06
35	Practical - measurements & tests	60 :	40	21 :	14
35	Core Practical - circuits & machines	20 :	80	07 :	28
100	Total			52 :	48

Thus, it is quite easily possible to transition and transform the current ITI Electrician course curriculum to a blended programme with 50:50 ratio of online and face-to-face elements. This will also mean that if structured carefully through a synchronous cum asynchronous system, a student will be able to complete the course in one to two years or more, depending on his/her circumstances, ability, and interest.

- For a significant portion of the course (approximately two-thirds of theory and practical measurements), it will not be very complex, time-taking, or expensive since they can be manged with lectures and good demonstrative and illustrative videos, and supported by other interactive tools. The core practical experience of circuits and machines will be complex and expensive since it will require immersive tools like virtual reality (VR), gamification, simulators, etc. Hence it is proposed that a major part of the core practical continues to be taught in the workshops and laboratories.

There are broadly *three categories of online tools and experiences* used for blended learning. These include:

- Audio-visual tools – *to explain, illustrate and demonstrate better*
  - Lectures
  - Illustrations and Process demonstrations
- Interactive tools – *to stimulate lively engagement*
- Immersive tools – *to provide a better feel of the process*

Adapting the NCVET Guidelines for Blended Learning, the applicability of online tools and experiences for the ITI Electrician Course may be visualised as follows:

Applicability of Online Tools and Experiences to ITI Electrician Course

Content Category	Online Tools and Experiences			
	Audio-Visual		Interactive	Immersive
	Lectures	Illustrations / Demos		
Theory – all aspects	●	●	●	
Practical – measurements & tests	◐	●	●	◐
Core Practical – circuits & machines	◐	●	●	●
● High Applicability		◐ Medium Applicability		

Maximum focus and emphasis during the transformation needs to be placed on designing and developing audio-visuals for illustrations and process demonstrations. Simultaneously, interactive tools need to be creatively incorporated so that students can participate at their time and pace; yet always being part of a lively learning environment. Immersive tools may be incorporated gradually on a priority basis as these are relatively expensive and take time to develop.

The ITI Electrician Craftsman Training Scheme (CTS) is governed by the National Skills Qualification Framework (NSQF) Implementation Manual 2018. The trainee is tested for skill, knowledge, and attitude during the period of the course through formative assessment and at the end of the training programme through summative assessment. Since the NSQF is both very well structured and has detailed implementation guidelines, the transformation of the assessment process into an automated online system is possible without much difficulty. It is further enabled by the NCVET Guidelines for Blended Learning.

With the proposed blended curriculum having a 50:50 ratio of online and face-to-face elements, it is proposed that 75 percent of the assessments can be done through the application of automated technology as follows:

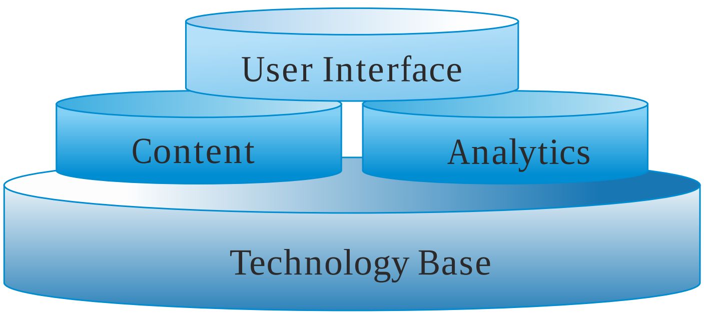
- All content delivered online will be assessed online – 50 percent of ITI Electrician content
- Half of the content delivered face-to-face will be assessed online – 25 percent content
- The balance 25 percent content to be assessed face-to-face primarily during the summative assessments and partially during the periodic formative assessments will be as follows:
  - Theory – all aspects : 3%
  - Practical – measurements and tests : 5%
  - Core Practical – circuits and machines : 17%

By applying the NSQF and NCVET Guidelines together through an automated system:

- Assessment Principles – *are better served by blended process*
- Assessment Process – *can be made more student friendly and yet systematic*
- Marking Process – *can be made more objective and transparent*

The *Learning Management System (LMS)* is one of the most important aspects of transitioning to a blended learning approach that has not received the requisite attention it deserves, especially in the public education space. Most public institutions have rightly tended to focus initially on 'Content Management,' and, in this, basic access to textbook pdfs and lecture videos.

The Learning Management System for the ITI Blended Programme to be initiated with the Electrician Course is visualised as follows:



Proposed ITI Learning Management System

The foundational underpinnings will include all the technological features, over which will be the content in the four quadrants, together with the assessment and analytical tools. On top of this will sit the user-friendly and flexible interface, which enables the student, instructor, and other stakeholders a much richer learning, teaching, and management experience.

The proposed ITI learning management system is not visualised as an enterprise resource planning (ERP) or customer relationship management (CRM) package for the ITIs. It focusses on enabling the learning and teaching experience with easier access to content, a flexible blended learning opportunity, supported by the latest of analytics and information technology tools.

As a course imparting vocational skills, the proposed ITI Electrician Blended Programme is clearly visualised as an online cum face-to-face programme rather than a purely online initiative. The imperative of practical exposure and skilling practice is recognised; both in the laboratories and workshops, and during on-the-job training. Further, human interaction in classrooms and workshops is seen as an integral part of the student acquiring social and employability skills.

The *overall aim of the proposed ITI Electrician Blended Programme* is to enhance its efficacy and efficiency. The operational design and implementation will attempt to:

- *Provide a significantly better learning and teaching experience* – which is educative and empowering – lively, engaging and rewarding
- *Reduce time and provide flexibility to the student* – to learn at their pace and time depending on their circumstances in a synchronous or asynchronous manner. Depending on the interest and capability of student, it should be possible to complete the course as follows:
  - Highly motivated student : 1.0 year
  - Normal student : 1.5 years
  - Average student : 2.0 years
  - Learning while working : > 2.0 years
- *Enable and empower instructors as Course Facilitators* – rather than attempting to have 'good' instructors across the country, especially in the rural ITIs. Students anywhere in the country will have access to the best instructors and industry experts with the support of technology.
- *Provide more effective training with available infrastructure and equipment.* – The online preparatory exercises with simulation, virtual reality (VR), digital twinning, and gamification tools and experiences will significantly reduce the time required on the expensive machines. It is envisaged that the equipment available currently will be able to serve the needs of double the number of students; making the overall programme much more cost effective.

It is not worthwhile to implement the proposed blended programme in a piece-meal manner. Operationalising the bended course requires an integrated systems approach to provide the fulfilling experience envisaged. The Learning Management System will play a critical role in providing this seamless experience.

The document also outlines the key operational issues of – Talent Mobilisation and Capacity Building, Infrastructure and Technological Challenges, Budgeting and Financial Resources, and Phasing of Activities and how to address them.

Part A

Vocational Education and Blended Learning Ecosystem in India

1.0

Introduction

As part of the Commonwealth of Learning's strategic plan 2021-27, its regional centre in New Delhi – the Commonwealth Educational Media Centre for Asia (CEMCA) embarked on a study in November 2022 to explore ways in which the efficacy of the Electrician Course offered by the Industrial Training Institutes (ITIs) in India can be enhanced. The study attempts to understand the requirements of employers (industry), review the current system of curriculum development and delivery, and suggest ways of enhancing the efficacy of curricula development, and the learning and teaching experience through a blended learning approach.

The study process included:

- Detailed desk review of the
  - ITI Electrician course and other Electrician courses being offered in India
  - Blended courses and online initiatives in India, especially in the public education domain and also the private education (EdTech) space
  - Global practices in vocational education and training (VET)
  - Indian Policy Framework for vocational education and blended learning
- Consultations with key stakeholders including employers, ITI principals and instructors, ITI alumni, public organisations and private EdTechs involved in curriculum development and online initiatives.
- Analysing the gaps and potentials of the ITI Electrician programme within the context of blended learning initiatives in the public education space and policy framework in India
- Suggesting ways of transforming and transitioning the ITI Electrician course into a blended curriculum and assessment framework; to enhance its efficacy and improve the overall learning and teaching experience.

Over the years, the Electrician course has been a pioneering programme in the ITI system. The transitioning process suggested to transform into a blended programme can be adapted for other courses based on the experience gained.

2.0

Review of the Electrician Vocational Education Courses in India

India has a variety of vocational education courses available for the electrician trade. A significant part of this is offered through the public education system – including the Industrial Training Institutes (ITIs), the National Institute of Open Schooling (NIOS), Central Board of Secondary Education (CBSE), state boards, Indira Gandhi National Open University (IGNOU), etc. The National Skills Development Corporation (NSDC) promoted by the Ministry of Skill Development and Entrepreneurship (MSDE) is a public-private platform that aggregates private sector initiatives in vocational education and training based on standard qualification frameworks and model curriculum. The NSDC system offers about 25 courses for the Electrician trade in ten sectors. Besides these, there are several smaller EdTech players offering electrician programmes, which are mostly of less than one year duration.

2.1 The ITI Electrician Course

a. Popularity of the ITI Electrician Course

The *ITI Electrician Course* offered at Level 4 of the National Skills Qualification Framework *(NSQF Level-4)* under the Craftsman Training Scheme (CTS) is one of the most popular courses garnering approximately 30 percent of total seats available (782,980 of 26,04,055) across all the ITIs in India in 2022.The popularity is essentially due to better job opportunities – moving up from assistant electrician, electrician, to electrical foreman, electrical supervisor, etc. in the construction, power, automotive, manufacturing, electronics, capital goods and infrastructure sectors. There are also better opportunities for self-employment and graduating into contractors. The earning potential after this course is also relatively better when compared to other courses.

The other ITI course offered – *Wireman (NSQF-4)* also under the CTS in not as popular since the scope for employment is comparatively limited and the earning potential is also not as high.

b. Affected by the challenges in the skilling landscape of the country

At the same time, as per the (National Council for Vocational Training (NCVT) MIS ITI Dashboard, only 54 percent (4,25,170 out of 7,82,980) of the Electrician course seats were occupied in Academic Year 2022. This is similar to the overall 47 percent utilisation of the 26.04 lakh total available ITI seats in all the courses across 36 states and Union Territories. This underutilisation of ITI seats was noted in the Standing Committee Report on Industrial Training Institutes and Skill Development Initiative Scheme in 2018.

The ITI Electrician course is also affected by several of the challenges obtaining in the overall skilling and entrepreneurship landscape of the country. The Annual Report for the year 2021-22 of the Ministry of Skill Development and Entrepreneurship (MSDE) enumerates some of them as follows: (Ministry of Skill Development and Entrepreneurship, 2021-22)

- Public perception that views skilling as the last option meant for those who have not been able to progress/have opted out of the formal academic system. Limited mobility between skill and higher education programmes and vocational education.
- Skill development programmes of the Central Government are spread across more than

20Ministries/Departments without any robust coordination and monitoring mechanism to ensure convergence. Narrow and often obsolete skill curricula. Multiplicity in assessment and certification systems that leads to inconsistent outcomes and causes confusion among the employers.

- Paucity of trainers, inability to attract practitioners from industry as faculty. Lack of updated infrastructure and equipment in several institutes. Mismatch between demand and supply at the sectoral and spatial levels.
- Pre-dominant non-farm, unorganised sector employment with low productivity, but no premium for skilling. Lack of assured wage premium for skilled people. Declining labour force participation rate of women.
- Non-inclusion of entrepreneurship in formal education system. Lack of mentorship and adequate access to finance for start-ups. Inadequate impetus to innovation driven entrepreneurship.

The India Skill Report 2019 (Wheebox, 2019) observes that ITI pass-outs saw a steep 30 percent drop in employability between 2017-18. It further notes that the quality assurance in ITIs have taken a major hit stemming from archaic curriculum, sub-quality trainers, lack of training infrastructure, non-standardisation of assessment and certification, and alignment of skills training with demand tending to play catch-up.

2.1.1 ITI Electrician Course Content and Structure

The previous update in 2019 of the two-year ITI Electrician CTS course was conforming to NSQF Level-5. The current update in July 2022 reclassified the course as conforming to NSQF Level-4; not because of course being downgraded, but due to revision of the NSQF classification system (Ministry of Skill Development and Entrepreneurship, Directorate General of Training, 2022). Being a very popular course, the ITI Electrician curriculum has had the benefit of regular updates.

With the involvement of industry, the course has, over time, been sharpened to cater to their requirements. The evidence of this is further available when the ITI course is compared with those offered by the NSDC system. Many of them are modules very similar to components of the ITI Electrician course offered as shorter term focussed courses. The NSDC developed courses have the involvement of the relevant Sector Skills Councils with members drawn from stakeholder industries and businesses.

The intensity of the ITI Electrician course coupled with the wider exposure it provides, enables the student to be ready for a broader range of sectors; with better job prospects and opportunities.

Table 2.1: ITI Electrician CTS Course(NSQF Level-4)–Notional Training Hours

Sl. No.	Course Element	Notional Training Hours			
		2019 Version		2022 Version	
		Year1	Year2	Year1	Year2
1	Professional Skill (Trade Practical)	1000	1000	840	840
2	Professional Knowledge (Trade Theory)	280	360	240	300
3	Workshop Calculation & Science		80	8	
4	Engineering Drawing		80	8	
5	Employability Skills160	80	120	60	
	Total	1600	1600	1200	1200
6	On the Job Training (OJT)/Group Project			150	150

The ITI Electrician course is currently *structured* as a two-year programme with 1200 notional training hours of course work and 150 hours of on-the-job training (OJT) each year. In the latest 2022 revision, the notional training hours was reduced from 1600 to 1200 hours each year to align with other vocational education and training programmes in the public education system.

Seventy percent emphasis of the course is on practical skills. This makes the course application oriented and very useful from a practical and employment perspective. Modules on Workshop Calculation and Science, and Engineering Drawing have been compressed and subsumed in the Professional Knowledge (Trade Theory) component.

In view of the background of the students and also the ability of the instructors, teaching and learning of Employability Skills still remains a challenge. The formalisation of On-the-Job Training (OJT) indicates the emphasis being given from a policy perspective. However, in practice, many rural ITIs are unable to provide the linkages; they are only able to mobilise Group Projects among students.

The ITI Electrician Course is assessed using the National Skills Qualification Framework at Level 4 of the competency expected. It includes a series of continuous Formative Assessments based on evidence recorded in the trainee portfolio. This evidence includes: Job carried out in laboratories/workshops, record book/daily diary, answer sheets of assessments, viva-voce, progress chart, attendance and punctuality, assignments, project work, computer based multiple choice question examination, practical examination, etc. On completion of all the formative assessments, and on the student having 80 percent attendance, the *Summative Assessment* is carried out for both Theory and Practical competencies expected.

Currently, the ITI Electrician Course is designed and delivered as a traditional face-to-face programme, with some content and curriculum material available online. The latest revision in July 2022 is robust and updated catering to the needs of industry. It also provides broader job prospects compared to other public VET or private courses. However, the programme needs to address the issues of quality of instructors/trainers, infrastructure, and also industry linkages and interaction, especially in the rural areas. Some of these challenges can be partially addressed through carefully crafted digitally enabled blended learning programme.

2.1.2 Bharat Skills Platform– Providing ITI course material online

The Directorate General of Training (DGT) in the Ministry of Skill Development and Entrepreneurship (MSDE) launched the Bharat Skills platform in October 2019 in collaboration with Microsoft and

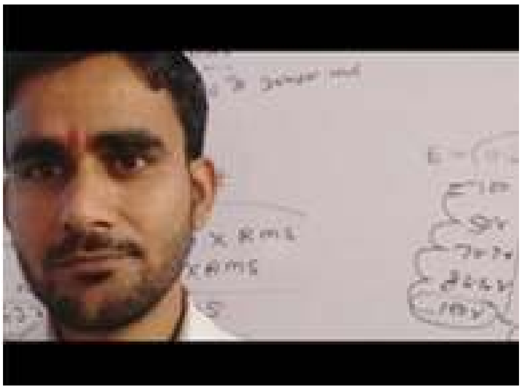
Fig. 2.1 - Directorate General of Training (DGT), MSDE, GoI, 2023

NASSCOM Foundation. It is a Central Repository for skills providing easy access for the trainees and trainers of the ITI ecosystem, to access updated NSQF curricula and course content of all courses under the Craftsmen Training Scheme (CTS), Question Banks, mock/practice papers, learning videos, etc., hence enabling anytime, anywhere learning outside the classrooms.

It essentially has three components: Craftsmen Training Scheme (CTS), Crafts Instructor Training Scheme (CITS), and Apprenticeship Training. It also includes the ITI Blended Learning, and Training of Trainers (ToT) Blended Learning (please see nimilearningonline.in Section 2.1.4 below). The Bharat Skills Forum enables stakeholders to interact with each other.

The CTS has material uploaded for about 150 courses of which about 50 are relatively more mature with e-books (including curriculum, study materials, etc.), e-learning videos, and question bank. There is also a link to the NIMI learning online mock tests. (Please see below).

The Electrician course (link to the electrician course material) is one among the more mature courses with most of the materials already uploaded. All the relevant e-books are available. There are about 180 lecture videos organised into 99-week lessons over two years. These have been primarily sourced from an ITI in Haryana prepared by one instructor. (Refer Annex 2).Unfortunately, the question bank is a static display of pages from the book.



(Fig.2.2 - Typical Electrician Course Lecture Video available on Bharat Skills)

The CITS has material uploaded for 36 courses, including the Electrician and Wireman courses. Components of each course include – Study Materials, Question Bank, Mock Tests, and Curriculum. Material for most of the Apprenticeship Courses, including electrician, lineman, and wireman are yet to be uploaded.

The most important contribution of the Bharat Skills platform at this stage is that the portal has made available ITI study material much more accessible to students across the country.

2.1.3 NCVT Online – Online support to prepare for ITI examinations

The National Council of Vocational Education and Training (NCVET), notified in December 2018, has been set up as an overarching regulator establishing regulations and standards to ensure quality in the TVET space, subsuming the responsibilities of National Skill Development Agency (NSDA) and the erstwhile National Council of Vocational Training (NCVT). The major functions of NCVET include:

- Recognition and regulation of Awarding Bodies (ABs), Assessment Agencies (AAs) and Skill related Information Providers
- Approval of qualifications as per the NSQF (National Skills Qualification Framework)
- Monitoring, Evaluation and Supervision of recognised entities
- Grievance Redressal of the varied stakeholders

Fig. 2.3 - NCVTonline.com

As part of its range of activities, the online platform of NCVET provides content that enables students to prepare for the ITI examinations. These include Mock Tests by NCVT, NIMIonline, All India Trade Test Computer Base Test (AITT-CBT), etc. Study material from different sources is also provided and the NCVT MIS Result Portal for All India Trade Test is readily accessible. Timely information on different examinations is provided through the tickers.

Currently, content is available for about a dozen ITI courses including the Electrician programme.

2.1.4 NIMI Online – Attempts at blended learning

National Instructional Media Institute (NIMI) is an autonomous institute under the Directorate General of Training (DGT), Ministry of Skill Development and Entrepreneurship (MSDE). It is a premier institute for providing content/instructional material for the vocational ecosystem to a wide range of institutions, especially the ITIs and a host of skill development institutes. NIMI is the nodal organisation for the development of Instructional Media Packages (IMP), including digital content, Question Banks for assessment, for different vocational courses. To reach the unreached, NIMI also provides its e-content free through the Bharat Skills portal.

a. NIMI Online learning

To improve the learning experience of trainees, virtual online classrooms have been introduced by 'NIMI online learning' using Rock Star trainers, who present the topics of their speciality in native languages. This selective crowd sourcing has been quite effective in generating interest, participation, and building upon what is available.

Blended learning programmes have been initiated in 12 skill sectors, most of them with one-two courses, and the Advanced Diploma in IT sector having the maximum of eight courses.

(National Instructional Media Institute)

The Power sector has two courses – Electrician and Wireman. The Electrician course has had over 1.29 lakh visitors since 22 March 2021 when it was uploaded, while the wireman course has had over 19,000 visitors since 23 March 2021.

The Electrician course being popular, is one of the better developed programmes. The Course Features include:

- What will we learn this week
- Reading Material – E Book
- Lesson Plan
- Videos – 2 Videos (12 to 15 Mins)
- Explore more via Game – 20 Mins
- Assignment – Ques = 15+ (30 Mins)
- Judge yourself via quiz – 20 Mins
- Let's chat for further clarification
- Zoom Class

A Weekly Lesson Plan for over 80 weeks has been prepared. (Refer Annex 3). The material for each week is presented as follows:

- What will we learn this week – File
- Reading Material - E Book – File
- Reading Material - E Book – Hindi – File
- What will we learn this week – Hindi – File
- Lecture – VideoURL
- Lesson Plan
- Let's chat for further clarification
- Fill in the blanks – Interactive Content
- Assignment
- Discussion Forum
- Quiz
- Your views on this e-learning content–Feedback
- Lecture Videos - Hindi - 07:52 mins – URL

Fig.2.4 -http://www.nimilearningonline.in link to the electrician course

b. Training of Trainers – Blended Learning

The DGT/MSDE has partnered with the Central Staff Training and Research Institute (CSTARI) and NIMIto roll out the Training of Trainers programme, aimed to equip the Trainers with the latest training technologies for blended after learning (Directorate General of Training, nimionline ToT).

c. NIMI Online – The starting point for blended learning in the ITI system

The initiatives by NIMI and CSTARI, both for students and instructors, is a very good starting point for blended learning in the ITI system. The idea of crowd sourcing from 'rockstar' instructors can be developed further. The weekly lesson plan in one way makes the programme very structured and systematic. However, it will be useful to re-look at it with a view to enable asynchronous learning at the student's pace and time.

Most of the content available is still essentially lectures and textbooks, with attempts at e-books and interactive e-books. Much more needs to be done on interactive forums, and virtual laboratories. At this stage, the focus appears to be on Content Development. For effective blended learning, the Leaning Management System also needs to be designed and developed.

2.2 Other Electrician Courses in India

Besides the ITI system, the other major public institutions offering Electrician Courses are:

- The Central Board of Secondary Education (CBSE) and several State Boards
- National Institute of Open Schooling (NIOS) and some State Institutes of Open Schooling
- The polytechnics and the skill universities that have come up more recently
- Indira Gandhi National Open University (IGNOU) and some of the other 18 odd Open Universities in India

A key public-private initiative providing skills training in several domains including the Electrician course is the network of the National Skill Development Corporation (NSDC). There are also several smaller private Educational Technology (EDTech) Institutes.

Their programmes are outlined below:

a. National Skill Development Corporation (NSDC) Network

The National Skill Development Corporation (NSDC) is a not-for-profit Public Private Partnership (PPP) corporation promoted by the Ministry of Skill Development and Entrepreneurship (MSDE). NSDC promotes skill development by catalysing the creation of large, quality and for-profit vocational institutions. Further, the organisation provides funding to build scalable and profitable vocational training initiatives. Its mandate is also to enable support systems, which focus on quality assurance, information systems and train the trainer academies either directly or through partnerships. It focusses on skill development initiatives in 37 sectors.

NSDC has about 25 courses for Electrician trade in ten sectors. These are typically three to four months (300 to 450 hours) certificate courses at NSQF levels 3 or 4.Most courses are in the construction and automotive sectors. They are also in the sectors of Electronics and Hardware, Capital Goods, Power, Infrastructure Equipment, Mining, Iron and Steel, and, more recently, as Solar PV Installer – Electrical - SGJ/Q0102 in the Green Jobs Sector.

In the construction sector, a trainee can start as Helper Electrician – CON/Q0601, and progress on to Assistant Electrician – CON/Q0602, Construction Electrician – LV CON/Q0603, Foreman – Electrical Works – CON/Q0604, and Supervisor – Electrical Works – CON/Q0605. The course content is very relevant since they are prepared under the oversight of the Sector Skills Councils which are dominated by professionals and business leaders from the concerned industrial sectors.

The courses are also well crafted; each with a Qualifications Pack, Facilitator Guide and Model Curriculum. For example, in the case of Assistant Electrician course in the construction sector:

- QUALIFICATIONS PACK – OCCUPATIONAL STANDARDS FOR CONSTRUCTION INDUSTRY - Assistant Electrician (from NSDC website)
  https://nsdcindia.org/sites/default/files/QP_CON-Q0602_Assistant-Electrician-.pdf
- Assistant Electrician – Facilitator Guide – good
  https://nsdcindia.org/sites/default/files/FG_CONQ0602_Assistant%20Electrician_21.03.2018.pdf
- Model Curriculum – Assistant Electrician (NSQF Level – 3)
  https://nsdcindia.org/sites/default/files/MC_Rev_CON-Q0602_Assistant-Electrician_20-07-2017.pdf

The courses are developed and delivered by NSDC Training Partners, some of whom are also supported with soft loans.Most courses are delivered using traditional face to face methods. Some enterprising partners like LabourNet have been experimenting with a 50: 50 hybrid mode using both online learning and contact practical classes for the Construction Sector Assistant Electrician - CON/Q0602 Course over a 16-week period. The break-up is as follows:

- Virtual Class – 160 hours
- Online Self Learning – 40 hours
- Contact Classes – 200 hours
- Total – 400 hours

NSDC also runs the *e-Skill India portal* (link to the website) – an e-learning aggregator platform that consolidates B2C e-learning portals operating over the internet in the skilling ecosystem. These portals further create and source e-learning content in a hub and spokes manner. The initiative enables multiple e-learning players, strong in specific skilling sectors, to share their strengths as part of this aggregation exercise.

As part of this initiative, for the Assistant Electrician – CON/Q0602 course, the portal has aggregated three video modules ranging between 4-6 hours each in English/Hindi; some of which are also available in regional languages. These are essentially explanation cum demonstration videos.

b. Other Public Electrician VET Programmes

At the school level, the National Institute of Open Schooling (NIOS) offers a NSQF Compliant (601,701,602,702) Electrical Technician Course in English and Hindi (https://www.nios.ac.in/online-course-material/vocational-courses.aspx). Currently, the PDFs of documents are available online, making it easier for students to access textbooks and other materials. The Central Board of Secondary Education (CBSE) and State Boards also offer Electrician courses.

At the college level, the Indira Gandhi National Open University (IGNOU) also offers a six-month Electrical Technician course (link to the course). Some of the other 18 Open Universities, several colleges, and polytechnics also offer electrician courses. Most of these are not able to match the quality, breadth, and intensity of the ITI programme; especially in terms of practical exposure and relevance. The skill universities started more recently are coming up with interesting programmes.

c. Other Private EDTech Institutes

Most of the better private EdTech institutes are already collaborating in some form or other with the NSDC programme. The smaller players providing electrician courses are in an ecosystem of their own. These have their niche role in reaching out to specific audiences.

What is interesting are the individual enthusiasts who upload content on their YouTube channels. Some of the content and the way they explain concepts and procedures is excellent. However, the overall quality of the video is normally very crude. Just like the NIMI online programme crowd sourcing rockstar instructors, a system could be devised to tap into this resource and provide them access to selected ITI workshops and recording studios – to improve the quality of their outputs and make them available in the public domain through a structured system.

Some private players like ITI guru (https://www.youtube.com/@ITIguru) and electrician funda (link to the website) are already aggregating available material from these individual enthusiasts or proctoring their own content. Some meta-aggregators like EduBull (link to the website) use these materials and provide their value added overlays like resume writing skills, interview skills, presentation skills, communication skills, internship skills, group discussion skills, etc. Some of these are also linked to the NSDC programme.

2.3 Key Observations/Inferences

The two-year ITI Electrician CTS course is the most respected, broad based, and industry-oriented programme, providing wider job prospects when compared to any other course. The NSDC electrician courses are shorter and more tuned to the requirements of specific sectors. Each have their respective roles.

There is an opportunity to upgrade content from individuals and smaller operations and aggregating them on Bharat Skills platform. Currently Bharat Skills portal has aggregated primarily from the ITI network.

Both the Open Schooling and Open University programmes in the public domain are comparatively smaller than the public ITI system or the public-private NSDC system.

3.0

Overview of Blended Courses and Online Initiatives in India

Any attempt to embark on a blended learning approach in the ITI courses needs to be seen in the broader context and experience in India with other online initiatives, especially in the public education space.

3.1 Public Education – PM *e-Vidya* Programme Initiatives

The PM *e-Vidya* Programme is probably the most advanced in thinking and action to unify efforts at a national scale on digital/online/on-air education and enable multi-mode access to education. The building blocks are rapidly being consolidated or built and integrated under the overall framework of the National Education Policy 2020 (NEP-2020).

Fig. 3.1 - Ministry of Education, GoI, 2023

Some of the key components of the PM *eVidya* programme include:

- *NDEAR – National Digital Education Architecture*

  (Ministry of Education, Department of School Education and Literacy, GoI, 2022)

  – It is a globally pioneering effort to create a unifying national digital infrastructure to energise and catalyse the education ecosystem.

- *E-learning platforms*, such as

  DIKSHA – Digital Infrastructure for School Education

  (Ministry of Education, GoI, 2023)

  - Visualised as digital public goods, it is conceptualised as 'One Nation, One Digital Platform,' and developed on the core principles of open architecture, open access, open licensing, diversity in choice, and autonomy. The platform is built on open-source technology, which integrates internet-scale technologies and enables several use-cases and solutions for teaching and learning.

» It is a store house of Energised books, E-Courses, Interactive Activities, Assessment Questions, Guidelines/Handbooks, Quizzes and Online Events, Infographics, Videos, Audios, AR and VR, and Worksheets.

» It supports more than 36 languages (22 Scheduled Indian Languages and 7 foreign languages) including Indian sign language.

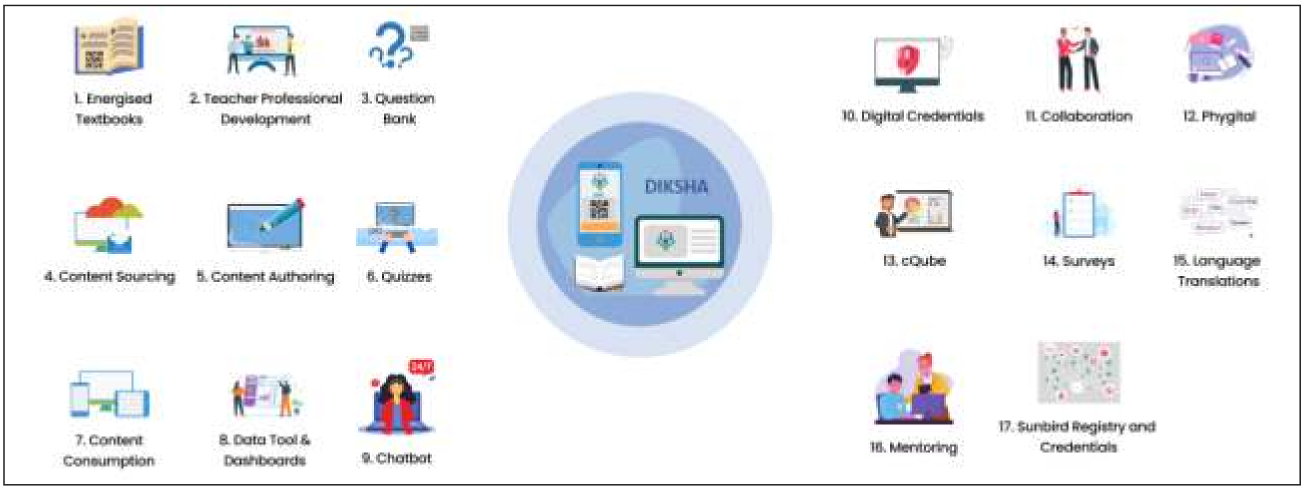


Fig. 3.2 - Some of the features of DIKSHA, (Source: https://www.ndear.gov.in/diksha-infrastructure.html)

» There are dedicated verticals for:
- Foundational Literacy and Numeracy
- Education for All
- Virtual Labs

Fig. 3.3 - An example of the virtual lab taken during CIET visit

- Vocational Education
- Children with Special Needs (CWSN)

Fig. 3.4 - DIKSHA, GoI, vocational education, 2023.

Picture taken during visit to CIET

» Progress till date
  - > 6570 educational textbooks by states and Union Territories
  - > 3 lakh e-content
  - > 8960 e-courses
  - > 3 crore hits on a daily basis

SWAYAM – Study Webs of Active Learning for Young Aspiring Minds

(Ministry of Education, GoI, 2023)

– A Massive Open Online Courses (MOOCs) Platform

- It is designed to achieve the three cardinal principles of the Education Policy – access, equity, and quality.
- The objective is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy.
- The programme is designed from school to post-graduate, and technical and management education. In order to ensure that best quality content is produced and delivered, nine National Coordinators have been appointed. They are:
  » AICTE (All India Council for Technical Education) for self-paced and international courses
  » NPTEL (National Programme on Technology Enhanced Learning) for Engineering
  » UGC (University Grants Commission) for non technical post-graduation education
  » CEC (Consortium for Educational Communication) for under-graduate education
  » NCERT (National Council of Educational Research and Training) for school education
  » NIOS (National Institute of Open Schooling) for school education
  » IGNOU (Indira Gandhi National Open University) for out-of-school students
    - IIMB (Indian Institute of Management, Bangalore) for management studies
    - NITTTR (National Institute of Technical Teachers Training and Research) for Teacher Training programme
  » The courses hosted on SWAYAM are in 4 quadrants (see UGC guidelines below)

NISHTHA – National Initiative for School Heads' and Teachers' Holistic Advancement (CIET, NCERT, 2019)

– This is an integrated training programme aimed at holistic development of teachers and school heads.

- *Multi-channel learning continuum*
  » Television – SWAYAMPRABHA
  » Radio, Community Radio, and Podcasts
  » ePathshala mobile applications

NDEAR Vidya Samiksha Kendra (NVSK) (Ministry of Education, GoI, 2021)

– This is a comprehensive system to effectively collect, monitor, correlate, analyse, and visualise data. Stakeholders at various levels can track the progress and adoption of various educational programmes throughout the country.

Fig.3.5 - Implementation of the DIKSHA initiative on the NDEAR Vidya Samiksha Kendra (NVSK) dashboard.

3.2 Other Online Learning Initiatives

The National Institute of Open Schooling (NIOS) Virtual Open School

(National Institute of Open Schooling, 2021)

– It is an online programme in collaboration with Microsoft where students can

- Attend Live Interactive Classes
- Watch Recorded Sessions and Videos
- Take Assignments, Assessments and Exams
- Get Certifications to Enhance Employability
- Have access to Job Boards and Job Portal
- Secure Jobs
- Have access to Venture Capital, and
- Become Entrepreneurs

There is also a whole host of private educational technology (EdTech) institutes like Khan Academy, upGrad, Unacademy, Next Education, etc. that are much smaller in scale than the online/blended public education initiatives.

What is relevant, however, is that their online 'learning management systems' are much more integrated, intuitive, and user friendly. Students, teachers, and managers seamlessly navigate through the online portal from scanning, admission, milestone payments, learning, assessments, certification, and job linkages, where applicable. They have tended to focus much better on integrated systems due to the commercial implications.

3.3 Learnings from Online/Blended initiatives in India

Several of the initiatives under the PM e-Vidya programme are globally pioneering. The Central Institute of Educational Technology (CIET) (CIET, NCERT, 2023) is a store house of knowledge and experience on the technological aspects of strategising, structuring, and developing a large-scalepublic education system. They have understood what it takes to build an open system at scale that enables a diverse range of stakeholders.

While most of the content currently available is still static materials, what is important to note are the advances being made in their:

- Collaborations for Virtual Labs
- Experiments in creating content using Augmented Reality (AR) and Virtual Reality (VR).

Particularly important will be learning from these experiences so that together with the advances in Metaverse, cost-effective interactive content can be created for more practice-oriented VET courses.

Fig. 3.6 - The AR initiative Source: https://epathshala.nic.in/

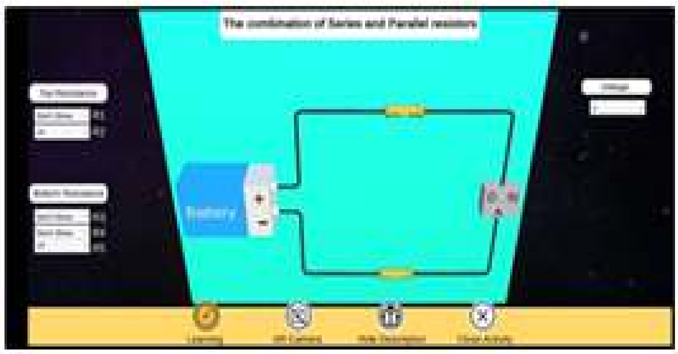


Fig.3.7 - An example of series and parallel resistors (an AR example) in NCERT

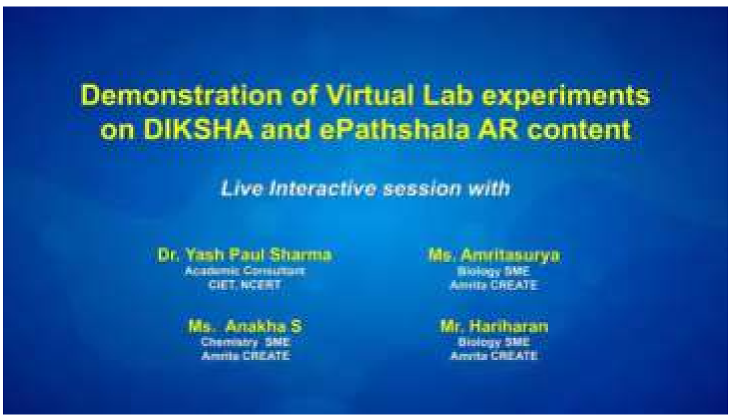


Fig. 3.8 - Source: https://www.youtube.com/watch?v=TuKDsnDKkhc

The CIET experience also provides learning on the use and integration of

- various media like internet, radio, television, mobile applications, etc.
- different languages
- tools for communities with special needs to effectively reach different sections of the vast and diverse Indian society.

Use and integration of various media - (CIET, NCERT, 2023)

DIKSHA has a fairly good 'content management system'. Similarly, NVSK is also a reasonably good education 'programme management system,' catering to diverse autonomous stakeholders. The missing piece seems to be a 'learning management system' (LMS) that is intuitive and user friendly for both the student and teacher. SWAYAM also has been focussing more on content development than LMS. Some work on LMS has been initiated by CIET.

This is where the smaller scale initiatives by EdTech companies have been much more nimble footed. It would be useful to learn from their experiences while developing the LMS.

The 4-quadrant system of organising and managing content is useful and quite widely used, though some experts do not find it relevant.

It will be useful for NIMI and CSTARI to interact with CIET/NCERT, learn from their experience and explore areas of possible collaboration. This can avoid re-inventing the wheel and enable a much smoother and faster learning and operationalisation trajectory in the VET domain.

4.0

Global Practices/Experiences at Blended Vocational Education

The 12th Five-Year Plan (2012–2017) estimated that only a very small percentage of the Indian workforce in the age group of 19–24 (less than 5%) received formal vocational education; whereas in countries such as the USA the number is 52 percent, in Germany 75 percent, and South Korea it is as high as 96 percent. These numbers only underline the urgency of the need to hasten the spread of vocational education in India (Ministry of Human Resource Development, Government of India (2020). National Education Policy 2020).

Given the importance of vocational education in these countries, they have also experimented much more with blended learning approaches. A 2013 survey of more than 800 teachers from the United States, United Kingdom, and Australia found that more than half of participating teachers felt that blended learning had met their expectations in terms of improved student engagement and learner outcomes. Similarly, a 2014 survey of over 1000 teachers from the United States and Australia reported similar statistics, with most teachers noting an overall improvement in academic performance for their students.

This section discusses:

- Four broad approaches adopted globally for blended learning
- Some of the key challenges in implementing blended learning
- Selected examples and experiences in blended learning

4.1 Blended Learning Practices

There are broadly four approaches or a combination that are adopted globally for blended learning. These have been summarised in the July 2022 NCVET Guidelines for Blended Learning for VET. They include:

- *Flipped Classroom*

  In this approach, students initially view podcasts or other online resources independently, followed by classroom-based tutorials or seminars, group learning, etc.

- *Blended Face-to-Face (F2F)/Blended block*

  This approach has 'blocks' of – intensive F2F + online study and tutorials + F2F or group presentations; typically alternating between online and face-to-face blocks. The class time is used for higher-order learning activities such as discussions and group projects.

- *Blended Online/Online driver*

  This approach also referred to as the 'online driver model' is primarily online, with some required in-person activities such as lectures, laboratory, or workshop activities. It incorporates both synchronous and asynchronous learning opportunities.

- *Self-Blend*

  This is a completely student driven approach where learners are enrolled in a school or work but take online courses in addition to their traditional face-to-face courses or work. The learner may choose to rotate between various modalities of the course, such as classroom, laboratory, industry, parts of which is online learning.

4.2 Challenges in Implementing Blended Learning

Some of the key challenges experienced globally while implementing blended learning programmes are as follows:

- The transition from a traditional to a blended learning approach requires a significant cultural change that can become difficult to manage. It is also important to consider the many logistical considerations, such as infrastructure, facilities, and technology needs, that are necessary to implement and sustain a successful blended learning programme.
- Creating a blended learning programme that both engages and supports learners requires considerable planning and design. It is not just a matter of transforming curriculum material into digital content. It requires a systems approach to design and implement a whole new experience of learning and teaching. This may not be feasible in situations where there is limited time, resources, and/or expertise.
- The lack of professional development and support for teachers in blended learning can become the biggest hurdle since teachers are often left to figure out on their own how to combine online and face-to-face learning. A 2017 study conducted in the UK found that almost half of teachers felt that they lacked the support and resources necessary to successfully transition from a traditional to a blended learning environment. Additionally, almost a third of teachers felt that they lacked the necessary skills to effectively use technology in the classroom.

These challenges and how to address them in the Indian context have been kept in mind while proposing the transition to a blended ITI Electrician programme in Part B of this report from Section 6 to 9.

4.3 Examples of Implementing Blended Learning

Three examples and experiences of implementing blended learning in the engineering streams are described below to provide a feel of what to expect during the transition.

a. *Blended Education at Delft University of Technology, Netherlands*

   (International Journal of Engineering Education, 2016)

   The "Propulsion and Power" course of the Aerospace Engineering programme at Delft University of Technology (TU Delft) was done according to the blended learning principles.

   The first instructor decided to "pull" the students by proposing several videos available on the internet as a support and complement to the material taught in the class. To further increase the interest of students, a "fun video of the week" was suggested.

   The second instructor using the "push" method decided to completely move the theoretical topics to online content, using the contact time in class almost exclusively for exercises and practical applications. The results from both the methods were as follows:

   - The student feedback showed enthusiasm about the new blended course; with only a minority still preferring the previous, more traditional approach.

- There was a clear improvement in the average examination grades and pass rates. However, just a slight improvement in the number of attending students was observed.
- There seemed to be a slight preference of students towards the "push" strategy. However, the "pull" approach was also widely appreciated.

b. *Blended learning in the Electrical Circuits course at Missouri University of Science and Technology*

(ASEE Midwest, 2018)

The course was changed from a traditional lecture format to a blended format – a blend of flipped classroom and face-to-face class meetings for better utility of in-class time, better preparation for students, and sufficient time in the class to cover relevant applications.

The course went from three class meetings to two meetings per week. Almost one-third of the material was made available to students via video lessons. The in-class meetings were changed from three 50-minute meetings every week to two 50-minute meetings with one lecture worth of material covered by video lessons.

The students were assigned a video lesson before an appropriate lecture. Each video lesson consisted of multiple short videos. For each concept, one video is used to introduce the content to students, another video lesson then covered a direct example of the concept. Each module included an associated quiz.

The results from the approach were as follows:

- The student feedback on the experience was generally positive; the only negative feedback was in terms of the length of some of the modules.
- The performance of the students was not negatively impacted; however, it is hard to discern what worked since multiple factors were involved in the process.
- The format was not only helpful for students by providing self-paced learning that aided their understanding and prepared them for the classes better but also allowed more in-class time for the instructor to discuss topics in-depth and to bring in real-world examples.
- The opportunities provided by the blended model facilitated better interactions in class between students and the instructor since the students were exposed to the learning materials before coming to the classes.
- The blended learning model also allowed enough flexibility to aid the different learning styles of the students.
- Students also got exposed to the changing technological environment and its tools through the model.

c. *Blended Learning in Higher VET in Energy Efficiency and Solar Thermal Energy*

(ErasmusProgramme of European Union,2018)

As part of the Europa Erasmus project on Blended Learning for the VET Sector (Blend4VET), the Centre of Vocational Excellence focused on renewable energy. Funded by the Spanish National Government (CIFP Usurbil LHII), it introduced a blended learning model to learners completing the Higher VET degree EQF (European Qualifications Framework) level 5 in Energy Efficiency and Solar Thermal Energy.

Two different models of blended learning were used:

- *Station Rotation Model:* This approach entailed students working on certain contents online and sequentially moving to face-to-face learning of problem-solving contents in the classroom.
- *Enriched Value Model:* This approach entailed students having, at their disposal, supplementary material for enriching basic content through home-recorded videos.

The basic tool used for implementing the project was Moodle, and Movie Maker was used to record the videos.

The results from the approach were as follows:

- The diverse materials, which were available for the course suited the various learning requirements of the students; however, there was a need for a unified structure.
- In general, student responses were positive since the blended learning approach enabled them to work interactively with the teacher as well as gave them the choice to work at their pace.
- Individual preferences and situations decide which model of blended learning suits them. However, from the pilot experience, it was deduced that Flipped Classroom model works better with more complex contents and/or contents which demand the development of practical skills and usage of the workshop.

5.0

Indian Policy Framework for Vocational Education and Blended Learning

It is an opportune moment when the policy and regulatory framework is very conducive and supportive of vocational education and training (VET), and the transition towards blended learning at all levels in the country. The key relevant documents include:

- The National Education Policy (NEP) 2020 released recently, which is path breaking, and provides the overall policy context. It is useful to note that National Policy for Skill Development and Entrepreneurship 2015 prepared by MSDE exists, but is dated (Ministry of Skill Development and Entrepreneurship, 2015).
- NCVET Guidelines for Blended Learning – July 2022, contextualised within the NEP 2020, learned from global and Indian experiences, and provides detailed guidance for blended VET.
- Some of the other relevant documents include:
  - CIET/NCERT Guidelines for Development of E-content for School and Teacher Education (DIKSHA)
  - UGC Concept Note on Blended Mode of Teaching and Learning 2021
  - UGC (Online Courses or Programmes) Regulations, 2018

5.1 National Education Policy (NEP) 2020

The National Education Policy (NEP) 2020 (NEP_Final_English_0.pdf (education.gov.in) released recently emphasises the need to re-imagine vocational education. It intends to take affirmative action and change the perception that vocational education is inferior to mainstream education and meant largely for students who are unable to cope with the latter. It aims to overcome the social status hierarchy associated with vocational education and requires integration of VET into mainstream education in all education institutions in a phased manner.

Further, the NEP 2020 recognises the importance and need to accelerate the opportunities for online learning. It envisions extensive use and integration of technology in teaching, learning, and assessment, to transform India into a digitally empowered society and knowledge economy.

5.2 NCVET Guidelines for Blended Learning in Vocational Education, Training and Skilling, 2022

Apart from the NEP 2020, this is the most relevant policy document in the context of this exploratory study (Guidelines-for-Blended-Learning-for-Vocational-Education-Training-Skilling.pdf (ncvet.gov.in). Based on a literature survey, the document summarises the four approaches or a combination that are typically adopted globally for blended learning. These are:

- Flipped Classroom
- Blended Face-to-Face (F2F)/Blended block
- Blended Online/Online driver
- Self-Blend– completely student driven

These approaches have been described in Section 4.1 earlier in this document.

The Guidelines list out the seven major components of VET and the skilling ecosystem. They include:

- Theory/ Lectures, Imparting theoretical and conceptual knowledge
- Imparting Soft Skills and Life Skills/ Employability Skills, Mentorship to learners
- Showing Demonstrations to the learners
- Imparting Practical Skills, Imparting skills for working with hands, Lab Work
- Tutorials, Assignments, Drills and Practice
- Proctored Monitoring/Assessment, Evaluation, Examinations; and
- On the job training (OJT), Internship, and Apprenticeship Training options

For each of these components, guidance is provided on:

- Major Activities covered under this component
- Options/methods/tools for face-to-face teaching and learning
- Online course/Methodology for online training
- The ratio of learning hours between online and offline
- Specific sectors where higher percentage of offline learning may be recommended

The guidance table provided is very useful for transitioning an ITI course to a blended programme.

5.3 Other Relevant Policy and Guidance Documents

a. *CIET/NCERT Guidelines for Development of E-content for School and Teacher Education* (NCERT, 2023)

Prepared as part of the DIKSHA programme, the CIET/NCERT Guidelines for Development of E-content for School and Teacher Education adopts the common and popular approach for instructional design – ADDIE – Analyse, Design, Develop, Implement, Evaluate. In the Design Step, it introduces Visual Design and Universal Design of Learning (UDL) as a Framework for Creating Accessible Material for All Children. In the Develop Step, guidance is provided on metadata and file formats. Overall, the document provides useful tools and techniques for developing e-content.

b. *UGC Concept Note on Blended Mode of Teaching and Learning 2021* (UGC, 2021)

This UGC Concept Note, also based on the path-breaking NEP 2020, starts with the student centricity and flexibility as the foundational underpinnings of a blended mode, which enables the learner to gradually build an Academic Bank of Credit (ABC). The document elaborates on the new role of teacher and student in the blended mode, and outlines two scenarios of Blended Learning possible in Indian Higher Education system.

The section on ICT tools and innovative initiatives is very useful and informative. It then goes on to specific aspects of implementing Blended Learning including assessment and evaluation. The UGC Concept Note proposes the IPSIT model for BL, though suggested for higher education in India.

- Identify Resources and Learner-centred Activities
- Provide resources and announce activities on LMS
- Scaffolding and Support to learners
- Identification of learning gaps and feedback
- Testing

This model is worth exploring in more detail while designing the blended approach for the ITI system.

c. *UGC (Online Courses or Programmes) Regulations, 2018* (UGC, 2018)

The UGC (Online Courses or Programmes) Regulations – 2018, suggests a four-quadrant approach to organising the online content:

- Quadrant-I – e-Tutorial

  - Video and Audio Contents, animation, simulations, virtual labs.

- Quadrant-II – e-Content

  -Portable Document Format (PDF) or e-Books or Illustration, video demonstrations, documents, and interactive simulations, wherever required.

- Quadrant-III – Web Resources

  - Related Links, Open Content on Internet, Case Studies, Historical development of the subject, Articles.

- Quadrant-IV – Self-Assessment

  - MCQ, Problems, Quizzes, Assignments and solutions, Discussion forum topics and setting up the FAQ, Clarifications on general misconceptions.

The learners' engagement will be monitored via participation in asynchronous/synchronous discussions, assignment, activities, and programme involvement. The analytics of Learning Management System shall be used for ensuring the learner's participation at least for two hours every fortnight. It is important to note that the document emphasises the importance of the learning management system.

5.4 Summary of Policy Guidance

The overall policy environment is very conducive towards vocational education, training, and skilling; and the National Education Policy 2020 intends to take affirmative action and change the perception that vocational education is inferior to mainstream education. It also provides an enabling framework for accelerating towards a more systematic and well thought out process of blended learning.

The detailed guidelines by NCVET provide the structural logic for transitioning and transforming the ITI CTS courses into blended programmes. The experiences at the school level by NCERT/CIET, and at the higher education level by UGC, documented in their respective policy documents are, also very relevant while designing the blended ITI courses.

With the preliminary experiences and guidance in place, this is an opportune time to act.

Part B

Enhancing the Efficacy of the ITI Electrician Course

The review of the ITI Electrician Course and the current ecosystem clearly indicates that while the course is good, the effectiveness and efficacy of the teaching/training and learning processes need to be improved.

The experiences of the public education system and private EdTechs in India, and the experiences overseas indicate that a good part of this efficiency and efficacy enhancement is possible through a carefully crafted and operationalised blended learning programme.

6.0

Towards a Blended Curriculum and Assessment Framework

It is important to note that the time is opportune to systematically transition and transform the ITI (Electrician) programme into a blended learning approach.

As indicated in Section 5, one cannot ask for a better policy and regulatory environment. The NEP 2020 by the Ministry of Education, promotes and encourages VET as a parallel opportunity for students rather than considering it as a last option for dropouts from mainstream education channels. The NEP also encourages blended and self-paced learning, depending on the aptitude and circumstances of different types of students. At the same time, the NCVET Guidelines for Blended Learning for Vocational Education, Training and Skilling released in July 2022, provides a framework and guidance for designing and operationalising the blended ITI courses.

In the case of the ITI system, some of the basic digital building blocks like PDF documents, lecture videos, and some e-books and question banks are already in place on the Bharat Skills and NIMI Online platforms. The ITI Electrician course being a popular front runner has most of the basics in place. These foundational rubrics can be built upon.

At the same time, the overall public education ecosystem in India is trying and testing various aspects of transitioning to online and/or blended programmes. These include the NCERT/CIET, NIOS and State Boards at the level of school education. The UGC and other state and central institutions are also trying out several online/blended experiments at the higher education level.

With all these initiatives going on in parallel, there is a lot to learn from each other, even among institutions in the public education space. Hence the ITI system will not be alone in this critical transformative initiative.

6.1 Transitioning to a Blended ITI Electrician Programme

As mentioned in Section 2, the current ITI Electrician Curriculum is market relevant, robust and up-to-date. The curriculum itself does not require any change but the methods, tools and techniques of teaching, learning, assessments, etc. can be significantly improved.

To explore the possibilities of enhancing the effectiveness and efficiency of the course through a blended approach, the ITI electrician course curriculum is analysed a little deeper. Please refer Table 6.1 ITI Electrician Course Analysis and Content Categorisation. Some of the key observations are as follows:

Table 6.1: ITI Electrician Course Analysis & Content Categorisation

Yr./ Sl. No.	Salient Components of Learning Outcomes	Notional Training Hours (currently all in offline mode)				Content Category
		Theo	Prac	Total	Key Practical Activities	
Year 1						
1	Safety	6	18	24	Identify / Practice	S/T
2	Trade Tools	4	22	26	Identify / Practice	S/T
3	Electrical Wiring Joints	20	95	115	Practice / Test	C/B
4	Electrical & Magnetic Circuits	36	160	196	Measure	M/T
5	Batteries & Solar Cells	10	50	60	Prepare/ assemble & practice	C/B
6	Wiring System	42	200	242	Prepare/ assemble & practice	C/B
7	Earthing Installation	7	25	32	Prepare and test	C/B
8	Illumination System	10	45	55	Prepare/ assemble & practice	C/B
9	Measuring Instruments	8	50	58	Measure	M/T
10	Calibrate Instruments	5	25	30	Measure	M/T
11	Domestic Appliances	10	75	85	Install, detect faults, repair	E/M
12	Transformer	12	75	87	Test & maintain	E/M
13	Engineering Drawing	40	0	40	Read & apply	D/C
14	Workshop Calculations	30	0	30	Understand & apply	D/C
15	Employibility Skills	120	0	120	Understand & apply	E/S
	Total Year 1	360	840	1200		
	On -the -Job Training / Project Work		150	150		OJT
Year 2						
1	DC Machine	9	35	44	Commission & Test	E/M
2	DC Machine	24	77	101	Test & Maintain	E/M
3	DC Motor Wiring	9	35	44	Perform / Practice	E/M
4	AC 3 -phase motor	26	80	106	Commission / Test	E/M
5	AC 3 -phase motor winding	9	23	32	Perform / Practice	E/M
6	AC 1 -phase motor	12	39	51	Commission / Test	E/M
7	AC 1 -phase motor	12	50	62	Test & Maintain	E/M
8	Alternator / MG set	22	75	97	Install & test	E/M
9	Electronic Circuits	31	99	130	Construct & test	C/B
10	Control Cabinet Wiring	24	82	106	Construct & test	C/B
11	AC & DC Motor - Speed Control	11	50	61	Test	M/T
12	Invertor/Stabilizer/UPS	10	50	60	Construct, test, maintain	E/M
13	Power Plant Layout	4	23	27	Draw, visit	E/M
14	Solar Panel	7	25	32	Draw, assemble	
15	Overhead Domestic Service Line	10	50	60	Draw, install, measure	C/B
16	Circuit Breaker	4	25	29	Test	M/T
17	EV Charging Station	4	22	26	Install and test	E/M
18	Engineering Drawing	40	0	40	Read & apply	D/C
19	Workshop Calculations	32	0	32	Understand & apply	D/C
20	Employibility Skills	60	0	60	Understand & apply	E/S
	Total Year 2	360	840	1200		
	On -the -Job Training / Project Work		150	150		OJT
	Grand Total	720	1680	2400		

Legend

S/T Safety / Trade Tools
M/T Performing Measurements & Tests
C/B Assembling Circuits and Panel Boards
E/M Installing, Repairing, Maintaining Equipment & Machines
D/C Engineering Drawing & Workshop Calculations
E/S Employability Skills

- As already observed in Section 2, the current ITI Electrician course is completely offline, spread over two years having 1200 hours of coursework each year, with a 70 percent emphasis on practical trade skills and 30 percent on theoretical knowledge accompanied by 150 hours of on-the-job training (OJT) or project work each year.
- The curriculum, after initially exposing the student to trade tools, safety equipment and precautionary protocols, then focuses on the core of the electrician course. This core which is approximately 70 percent of the course can be categorised into three major components:
  - *Performing Measurements and Tests*

    This includes introduction to analogue and digital instruments like Multi-meter, Watt meter, Energy meter, etc. and how to calibrate and use them. It further includes performing diagnostic tests and measurements to ascertain working efficiencies, detect faults, etc. It is relevant to note here that about 35-40 percent of the other two core components outlined below include the activity of performing measurements and tests.
  - *Assembling Circuits and Panel Boards*

    This includes preparing, assembling, or constructing circuits and panel boards, be it electrical and magnetic circuits; wiring systems including control cabinet wiring; earthing installations, etc.; testing and then powering them on for use. When a circuit or panel board is not working – testing to detect faults, repairing, and re-powering for use.
  - *Installing, Repairing, Maintaining Equipment and Machines*

    In case of equipment and machines, the course includes – installing, testing and commissioning DC and AC Motors, transformers, alternators and motor generator (MG) sets, domestic appliances, etc. When a machine is not working – dismantling, diagnostic testing, detecting faults, repairing, and then re-assembling, installing, and commissioning.

  The bulk of the course on circuits and panel boards is introduced in Year 1 while most of the course on equipment and machines is covered in Year 2. This is topped up with 140 hours (or approximately 6% time) on engineering drawing and workshop calculations equally divided in Year 1 and Year 2.

Table 6.2 below provides an overview of the ITI course curriculum. The Notional Training Hours is based on the current curriculum. Since 35-40 percent of the measurement and testing practice is in the other two practical components of assembling circuits, and installing and repairing machines, the effective training hours change as given below.

Table 6.2: Overview of the ITI Electrician Course Curriculum

Content Category	Notional Training Hours		Effective
	Hours	%	Hours %
Theory (360+360 hours over 2 years)	720	30	30
Professional Knowledge/Trade Theory		20	20
Engineering Drawing & Workshop Calculation		3	3
Employability Skills		7	7
Practical (840+840 hours over 2 years)	1680	70	70
Performing Measurements & Tests		17	35
Assembling Circuits and Panel Boards		30	20
Installing, Repairing, Maintaining Equipment & Machines		23	15

In short, the ITI Electrician course is approximately 30 percent Theory, and 35 percent of Practical Measurements, and another 35 percent Core Practical Work on Circuits and Machines.

Adapting the NCVET Guidelines for Blended Learning for Vocational Education, Training and Skilling released in July 2022, and reviewing the ITI Electrician course curriculum in further detail, the transition to a blended mode of learning is possible as given in Table 6.3.

Table 6.3: ITI Electrician Course Transition to Blended Learning

Effective Hours %	Content Category	Possible Transition		Effective Transition	
		Online	Face2Face	Online	Face2Face
		Online	Face2Face	Online	Face2Face
30	Theory - all aspects	80 :	20	24 :	06
35	Practical - measurements & tests	60 :	40	21 :	14
35	Core Practical - circuits & machines	20 :	80	07 :	28
100	Total			52 :	48

The analysis indicates that it is quite easily possible to transition and transform the current ITI Electrician course curriculum to a blended programme with 50:50 ratio of online and face-to-face elements. This will also mean that if structured carefully through a synchronous cum asynchronous system, a student will be able to complete the course in one to two years or more, depending on his/her circumstances, ability, and interest.

For a significant portion of the course (approximately two-thirds of theory and practical measurements), it will not be very complex, time-taking, or expensive since they can be manged with lectures and good demonstrative and illustrative videos, and supported by other interactive tools. The core practical experience of circuits and machines will be complex and expensive since it will require immersive tools like virtual reality (VR), gamification, simulators, etc. Hence, it is proposed that a major part of the core practical continues to be taught in the workshops and laboratories.

The application of this transition framework in the ITI Electrician curriculum is discussed and illustrated with examples in Section 7.

6.2 Adapting the Assessment Framework

All NCVET courses in India are assessed using the National Skills Qualification Framework (NSQF). Accordingly, the ITI Craftsman Training Scheme (CTS) is also governed by the NSQF Implementation Manual issued in 2018.

6.2.1 National Skills Qualification Framework (NSQF) – *Key Features*

The NSQF organises qualifications according to a series of levels of knowledge, skills, core skills and responsibility. These levels are represented in terms of learning outcomes, which the learner must possess regardless of whether they were acquired through formal, non-formal or informal learning.

Each level of the NSQF is described by a statement of learning outcomes in five domains, known as level descriptors. For example, students successfully completing the ITI CTS Electrician Course are expected to achieve NSQF level 4 competence. The descriptors at this level include:

- *Process required* – ability to work in familiar, predictable, routine, situation
- *Professional knowledge* – factual knowledge in the field of knowledge or study

- *Professional skills* – ability to recall and demonstrate practical skill, routine and repetitive in narrow range of application, using appropriate rule and tool, using quality concepts
- *Core skills* – language skill to communicate with clarity in written and oral form, ability to apply basic arithmetic and algebraic principles, basic understanding of social political and natural environment
- *Responsibility* – responsibility for own work and learning

Under the NSQF, the ITI training is imparted based on Learning Outcomes and Assessment criteria. The lesson plan/demonstration plan for training on skill and knowledge components is prepared based on each Learning Outcome visualised. The delivery of the training is planned such that on completion, trainees can demonstrate competencies as per assessment criteria defined.

Learning Outcomes are broadly categorised in two parts. They are Generic Learning Outcomes and Specific Learning Outcomes. The *Generic Learning Outcomes* cover components of Workshop Science and Calculation, Engineering Drawing, and Employability Skills. *Specific Learning Outcomes* are trade specific and cover the various components of the Electrician trade described in Section 6.1 above.

The trainee is tested for skill, knowledge, and attitude during the period of the course through *formative assessment* and at the end of the training programme through *summative assessment*. Continuous (internal) assessment during the period of training is done through formative assessment based on the assessment criteria listed for each learning outcome. The ITI maintains an individual *trainee portfolio* as evidence. The final summative assessment is based on the All-India Trade Test conducted by the Controller of Examinations, DGT. For the two-year ITI Electrician programme, 50 percent weightage is applied to each annual examination. The minimum pass percent for Practical is 60 percent and minimum pass percent for Theory subjects is 40 percent.

6.2.2 Easy Adaptability of NSQF to a Blended Format

Since the NSQF is both very well structured and has detailed implementation guidelines, the transformation of the assessment process into an automated online system is easily possible. It is further enabled by the Guidelines for Blended Learning for Vocational Education, Training and Skilling issued by NCVET in July 2022. A closer review of the NSQF and Guidelines together indicates that through an automated system:

- Assessment Principles – *are better served by blended process*
- Assessment Process – *can be made more student friendly and yet systematic*
- Marking Process – *can be made more objective and transparent*

a. Assessment Principles – *better served by blended process*

The NSQF assessment procedures and practices are governed by principles of objectivity, validity, reliability, sufficiency, currency, authenticity, transparency, and fairness. More than half of these are much better served through an automated system.

For example, most human interfaced assessment and examination systems like the ITI are challenged with issues of subjective biases of instructors and examiners. On the other hand, a faceless system ensures more objectivity, fairness, and transparency. The automated process has much greater validity since it assesses based on the criteria defined rather than other attributes of the trainee. Most important of all is that the sufficiency and currency of the assessment process empowers and enables the student to make timely self-corrections and improve the scores where appropriate.

b. Assessment Process – *more student friendly and yet systematic*

The automated assessment process will be heavily dependent on the *digital footprint* of the student. Besides all the online documentation, it will be useful to have artificial intelligence (AI) enabled recordings of all interactions and activities, especially in the laboratories and workshops.

The *continuous Formative Assessment* as prescribed by the NSQF will be done based on the evidence provided by the *digital trainee portfolio*. This will be built up from the following:

- Job piece/output of the Practical Exercise/Assignments/Project, and Reports, along with their appropriate Evaluation documents. Most of these will be done in the workshops and laboratories. A part may be also done online using tools like simulation, virtual reality (VR), Digital Twin, etc.
- Assignments, tutorials, tests, puzzles will be primarily done online. The assessments will immediately provide feedback to the individual such that corrective measures can be undertaken and formative scores improved.
- Participation in online and face-to-face, individual and group activities, interviews, projects, and competitions will be graded using AI tools to assess the attitude and aptitude of the trainee including attention levels, speed of learning, level of learning, etc.
- Written exams, except the two final exams, will be primarily online. They may be open or closed book examinations. The focus will be on application of knowledge.
- Assessor's Observation reports, including Direct Performance Observation at the work place/Laboratory/Workshop or Simulated Work Environment, assignments and tutorials will be a useful tool to corroborate with the online observations and assessments.
- The online system will also cater for all the documentation and administrative tasks like daily diary, record book, attendance, punctuality, etc.

One of the most important features to be incorporated in the continuous formative assessment is the opportunity for the student trainee to take the tests, tutorials, assignments, etc. at their comfortable time, place, and pace. Only certain milestones that are periodic – say quarterly, half-yearly, annually, etc. – will be specified so that students can be part of defined clusters, batches, etc.

The *Summative Assessment* is to be carried out for Theory and Practical after completion of all the formative assessments, in addition to the requirement of 80 percent attendance. Much of the theoretical knowledge will be tested in its practical application. However, the *theory test* is considered necessary to assess the knowledge, which is essential for a person to do the job.

As part of the *practical tests*, students need to demonstrate their ability to:

- Read and interpret technical parameters/documentation, plan and organise work processes, identify necessary materials and tools.
- Perform task with due consideration to safety rules, accident prevention regulations and environmental protection stipulations.
- Apply professional knowledge, core skills and employability skills while performing the task.
- Check the job as per drawing/assembly for functioning, identify and rectify errors in job/assembly.
- Document the technical parameters related to the task undertaken.

While most of the summative practical tests are envisaged to be done in the workshops and laboratories, in the presence of external examiners, the process will be reinforced with AI enabled video recordings. Some of the practical tests may also be done online as described above supported by simulation, VR, Digital Twinning, etc. tools.

c. Marking Process – *more objective and transparent*

The NSFQ provides a detailed marking pattern and weightage for each assessment parameter and its components as outlined in Table 6.4 below.

Table 6.4: Formative Assessment Parameters & Marks Allocation (NSQF)

Sl. No.	Assessment Parameters / Components	Marks	
1.	Safety Consciousness		15
a	Dress code	2	
b	Use PPE	5	
c	Apply/practice safety	8	
2.	Workplace hygiene & Economical use of materials		10
a	Maintain personal & workplace cleanliness	3	
b	Dispose scrap as per standard practice	2	
c	Select appropriate material & minimize wastage	5	
3.	Attendance / Punctuality		10
a	Initiative	3	
b	Accountability	3	
c	Participative in work	4	
4.	Ability to follow Manuals / Written instructions		5
a	Select right manual	1	
b	Search for appropriate topic	2	
c	Read & interpret the manual	2	
5.	Application of Knowledge		10
a	Plan the work	4	
b	Select appropriate tools & equipment	3	
c	Review the work	3	
6.	Skills to handle Tools & Equipment		10
a	Handle & use tools & equipment	4	
b	Maintain safety in handling	3	
c	Care & maintain	3	
7.	Speed in doing work		10
a	Properly sequence the work	3	
b	Use appropriate technique	5	
c	Review the work during execution	2	
8.	Quality in Workmanship		15
a	Achieve work with high accuracy	7	
b	Conform to requirement	3	
c	Satisfy the purpose	5	
9.	VIVA		15
a	Response with clarity	5	
b	Technical understanding	7	
c	Conscious towards job role	3	
	Total		100

With a minimum pass mark of 60 percent for practical assessments, further guidance is provided for marks to be allocated at three performance levels.

- 60 – 75%
- 75 – 90%
- > 90%

For example, for award of >90 percent marks, the candidate performs tasks with minimal or no support in organisation and execution; and with due regard for safety procedures and practices. The work produced demonstrates attainment of a high standard of craftsmanship.

The evidence required to award this level of marks is as follows:

- High skill levels in the use of hand tools, machine tools and workshop equipment
- Above 80 percent tolerance dimension/accepted limit achieved while undertaking different work with those demanded by the component/job.
- A high level of neatness and consistency in the finish
- Minimal or no support in completing the project

With this level of detailed guidance already provided, it is easily possible to incorporate these weightages and specifications into the automated algorithm enabling the overall system to be much more objective and transparent.

6.2.3 Guiding Ratios for the Blended Assessment

It needs to be re-emphasised that just like the learning and teaching process, the assessment transformation is visualised as blended process rather than a purely automated system. The automation opportunities are highlighted to indicate that the transition is plausible.

Building up from the transition ratios outlined in Table 6.3 and described in Section 6.1 above, while it is proposed to have a blended curriculum with 50:50 ratio of online and face-to-face elements, it is proposed that 75 percent of the assessments can be done through application of automated technology. This is quite easily possible as follows:

- All content delivered online will be assessed online – 50 percent of ITI Electrician content
- Half of the content delivered face-to-face will be assessed online – 25 percent content
- The balance 25 percent content to be assessed face-to face primarily during the summative assessments and partially during the periodic formative assessments will be as follows:
  - Theory – all aspects : 3%
  - Practical – measurements and tests : 5%
  - Core Practical – circuits and machines : 17%

While developing the blended assessment framework, it will be useful to also adhere to the National Credit Framework (NCrF) guidelines so that students can seamlessly migrate and benefit from the various systems of education.

7.0

Transforming the ITI Electrician Curriculum to a Blended Programme

Currently, most of the digital content of the ITI Electrician course available online consists of the following:

- Textbooks, test papers, syllabus and other curriculum documents converted into PDFs
- A few interactive e-books, quizzes, etc.
- Typical black/whiteboard classroom lectures converted into videos, and
- Some lectures with limited illustrations and process demonstrations.

Though most of these are rudimentary, they serve as a very good starting point. The quality can be improved significantly. During the COVID pandemic, these materials enabled students to continue their learning online, even though with severe limitations. At the same time, the digital assets were field tested and all the stakeholders had a first-hand feel of the online processes – its potentials and limitations. This experience is very useful to plan out a more systematic process of transitioning into a blended learning and teaching format.

This section discusses the online tools available and how they can be applied in the context of transforming the ITI Electrician course into a blended curriculum.

7.1 Applicability of Online Tools and Experiences

For a structured transformation, the online tools and experiences may be visualised at three levels:

- Audio-visual tools – *to explain, illustrate and demonstrate better*
- Interactive tools – *to stimulate lively engagement*
- Immersive tools – *to provide a better feel of the process*

Most of what is available currently is the basic use of audio-visual tools. As we move forward to an effective blended programme, the use of interactive and immersive tools will increase significantly. This process will be much more technically complex, requiring a higher level of expertise and skills, more time to develop, and more costs. Fortunately most of the expertise and experience is already available in India. The effort required is to mobilise the collaborative platform for the blended system to be designed and developed. The applicability of each of these tools and experiences is outlined below.

a. Audio-visual Experiences – *Explain/illustrate better*

Besides digitising textbooks and other curriculum documents into PDFs, maximum effort till date has been at converting typical classroom lectures into digital formats using a white or black board.

The transformation process will attempt to reduce the dependence on pure lectures to the bare minimum. Here again, the interactive whiteboard will be used much more imaginatively as shown in the example given in Figure 7.1 below.

Maximum emphasis will be placed on *illustrations and process demonstrations*. These will include:

- Images/Illustrations/Graphics/GIF

iSpring Power Point presentation, 2023

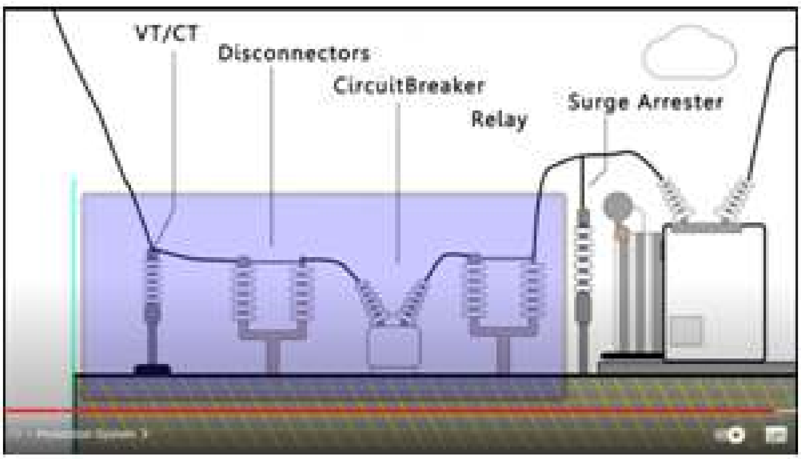
Fig.7.1 - How to create an interactive PowerPoint presentation with iSpring Suite.

- Instructional Videos – example, machine dismantling used in Hero Honda training (See below):

Hero Honda Training Film, 2011

Fig. 7.2 – Engine dismantling – Hero Motors – process demonstration video

- Actual Plant process videos



Visual Electric, 2021

Fig. 7.3 – Basic principles and working of an Electrical Sub-station – process illustration video

Fortunately, a variety of videos are already available on the internet. They can be adapted for the ITI context.

b. Interactive Experience – Stimulate lively engagement

This is the area where maximum emphasis needs to be placed. A little bit of extra creative effort can make all the difference to generate a lively and engaging learning and teaching environment. It is also comparatively not very expensive.

Interactive tools are very relevant for:

- *Group discussions*

  Tools like chatbots, WhatsApp groups, simulated online discussion/GD rooms can be imaginatively used to foster participation and peer learning.

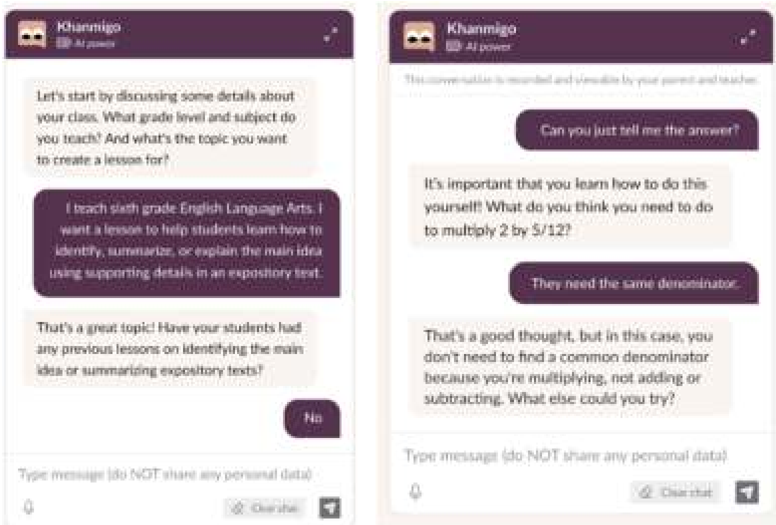


Fig. 7.4 - support.khanacademy.org

Example of chatbot being used by Khan Academy. The Khanmigo chatbot is designed to offer immediate assistance while working on Khan Academy content, offering tailored support during the learning journey.

- *Tutorial, Assignments, Drill and Practice*

  Learning can be reinforced creatively and systematically through

  – Interactive e-books – where one clicks further for details/ animated presentations/ illustrations/demos – example Figure 7.5 below:

  – Specific Software/Apps for Drawings (autoCAD), circuits diagrams, 3D printing, etc.

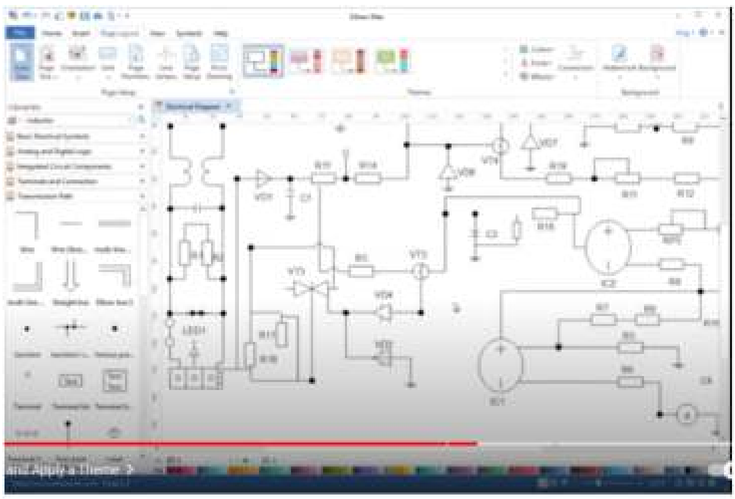


Fig. 7.5 - Wondershare Edraw, 2017

Creating a circuit diagram with online interactive software – Edrawmax

  – Practical learning through virtual laboratories (V-lab) – e.g., circuit construction Kit.

  – Online, standard or proctored, one-to-one or one-to-many tutorials, quizzes, puzzles, tests, e-portfolio submissions, etc. These can be made more interesting and engaging through gamification and rewards. (Please see Fig. 7.6 below – Creating Quiz game with apps like KAHOOT)

Fig. 7.6 – Super Schoolhouse, 2019
An example of how to create a quiz game (topic – electromagnetism) via Kahoot

- Online collaborative/group projects – which may be student led, instructor/teacher led, or even artificial intelligence (AI)/robot led.
- Learning by doing on industry provided problem statements, projects, learning paths, etc.

• *Proctored Monitoring/Assessment/Evaluation/Examinations*

The whole process of continuous assessment and evaluation can be made more real-time, objective, and transparent. The interactive tutorials and assignments outlined above can be further customised as rubric based formative assessments, or summative assessments through project outcomes. Proctored online assessment with built-in controls, biometrics, security, and evaluation of the quality and efficiency of output are fairly well advanced in India. Structured and clear outcome-based hackathons can also be organised.

c. Immersive Experience – provide better feel of the process

Commonly used tools for an immersive experience include:

• Augmented reality (AR), virtual reality (VR), extended reality (XR)

iXRlabs, 2021
Fig. 7.7 – Experience an air-conditioning plant walk-through using Virtual Reality

• Animation/Gamification/Simulation – simulation-based drill and practice

Electrician Simulator, 2022
Fig. 7.8 – Simulation walkthrough and gamification of electrician in a house.

- Digital twinning

[ansys.com, 2023](#)

Fig.7.9 – How to build, validate, deploy a Digital Twin of an electric motor.

- AI assisted robots – for example, students visit labs virtually and perform experiments, including interacting with lab assistants.

[Mobile Remote Shake Table Laboratory, 2017](#)

Fig. 7.10 – An attempt to make laboratories remotely accessible to learners. The mobile remote shake table laboratory (mRSTLab) is developed by harnessing the power of modern mobile technology and Internet of Things to provide users with an opportunity to remotely participate and conduct exciting laboratory shake table experiments through smart portable devices such as smartphones and tablets.

- Real-world problem-solving case studies using simulation

[Civil Contractor, 2018](#)

Fig.7.11 – Top games for civil engineers, where students have fun, and learn through simulation and gamification experiences

Immersive tools and experiences can become time taking and expensive, and should be adopted prudently and gradually. Most ITI students (even in the near future) will not be in a position to afford the headsets, or the more powerful mobile phones or tablets that are often required for these immersive experiences. Hence, they will be useful more within the ITI establishment itself.

7.2 Transforming the ITI Electrician Curriculum with Online Tools and Experiences

In Section 6.1, three categories of content have been identified for the ITI Electrician course. These include:

- Theory – Understanding Concepts and Theory
- Practical – Performing Measurements and Tests
- Core Practical
  - Assembling/Constructing Circuits and Boards
  - Installing, Repairing and Maintaining Machines

  In Section 7.1, three categories of online tools and experiences, and their applications have been discussed. These include:

- Audio-visual tools – *to explain, illustrate and demonstrate better*
  - Lectures
  - Illustrations and Process demonstrations
- Interactive tools – *to stimulate lively engagement*
- Immersive tools – *to provide a better feel of the process*

Combining these and adapting from the NCVET Guidelines for Blended Learning for Vocational Education, Training and Skilling, the applicability of online tools and experiences for the ITI Electrician Course is given in Table 7.1 below.

Table 7.1: Applicability of Online Tools and Experiences to ITI Electrician Course

Content Category	Online Tools and Experiences			
	Audio-Visual		Interactive	Immersive
	Lectures	Illustrations / Demos		
Theory – all aspects	●	●	●	
Practical – measurements & tests	◐	●	●	◐
Core Practical – circuits & machines	◐	●	●	●
● High Applicability		◐ Medium Applicability		

It is evident that the maximum focus and emphasis during the transformation needs to be placed on designing and developing audio-visuals for illustrations and process demonstrations. Simultaneously, interactive tools need to be creatively incorporated so that students can participate at their time and pace; yet always being part of a lively learning environment. Immersive tools may be incorporated gradually on a priority basis as these are relatively expensive and take time to develop.

7.3 Examples of Online Tools and Experiences Possible in the ITI Electrician Curriculum

This Section provides selected examples of how audio-visual, interactive, and immersive tools and experiences can be creatively used for transforming the ITI Electrician course into a blended programme. The examples cover the teaching/learning of theory, practical, tutorials, assignments, assessments, and evaluation. They have been organised under three types of ITI Electrician course content:

- Performing Measurements and Tests
- Assembling/Constructing Circuits and Boards
- Installing, Repairing and Maintaining Machines

7.3.1 Performing Measurements and Tests

a. Audio-visual experience

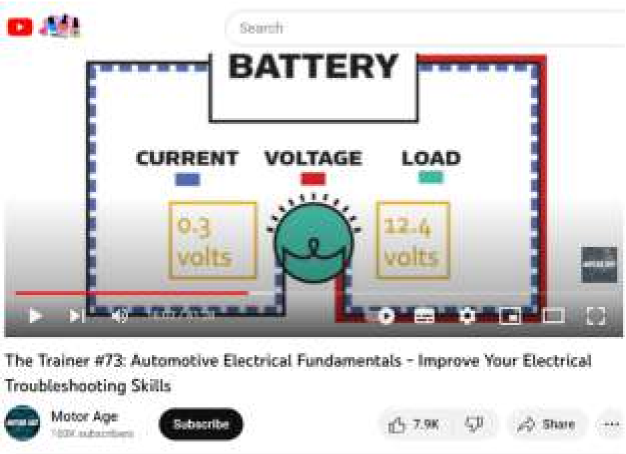
Math and Science, 2016

Fig. 7.12 – Voltage, Current, Resistance (Engineering Circuit Analysis) – lecture with whiteboard

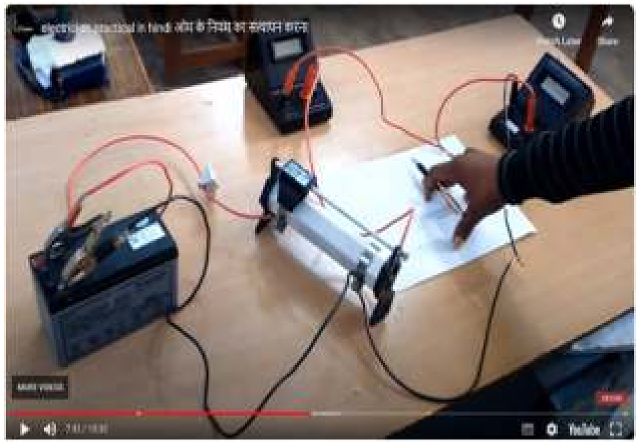
Table 7.2 gives the overview while the Sections below provide more details.

Table 7.2: Examples of ITI Electrician Course Online Possibilities

Method of Teaching / Learning	Performing Measurements & Tests	Assembling Circuits & Boards	Installing, Repairing & Maintaining Machines
Audio-Visual Experience			
Lectures	• 7.12 – Voltage, Current, Resistance (Engineering Circuit Analysis) – lecture with whiteboard • 7.13 – Improve Electrical troubleshooting skills – lecture	• 7.21 – How to read electrical & wiring drawings – lecture with illustrations • 7.22 – Understanding plate earthing – lecture with Q&A	• 7.33 – Working of AC generator – Lecture using digital whiteboard features effectively • 7.34 – Working of Auto Transformer – lecture with illustration
Demos / Illustrations	• 7.14 – Ohms Law / Rheostat – lecture with practical demo • 7.15 – How to use a digital Multi-meter – demo • 7.16 – How to repair a Multi-meter – demo	• 7.23 – Electric current & circuit – illustrative video • 7.24 – Fire Detection Alarm – demo video • 7.25– Electrical Grid & Electricity Supply – simple illustrative video • 7.26 – House Wiring with inverter connection – demo video	• 7.35 – Construction and Working of a DC Motor – with 3D animation. • 7.36 – Working principles of a DC Motor – with animation • 7.37 – How does a DC motor work – another animation
Interactive Experience			
	• 7.17 – Electricity & Magnetism – e-book with diverse features • 7.18 – Interactive Quiz on Electric Meter • 7.19– Measuring resistance – interactive assignment	• 7.27 – Electric Installation – Interact. Quiz • 7.28 – Interactive Circuit construction (kit) through V-labs • 7.29 – Learning circuits through challenging & fun gamification • 7.30 – Online circuit simulator – for assignments, tutorials, assignments	• 7.38 – Build a simple Electric motor – interactive project • 7.39 – Adjusting variables of a DC Motor – Interactive tutorial • 7.40 – 3-phase motors – interactive quiz • 7.41 – Speed control of DC Motor – interactive simulation
Immersive Experience			
	• 7.20 – Procedure for testing connections in low voltage electricity network using Virtual Reality training	• 7.31 – Learn electric current & circuits using augmented reality (AR) • 7.32 – Possible simulations of electrical systems (walkthrough)	• 7.42 – Building a simple motor using digital twin technology. • 7.43 – Machine dismantling & servicing illustrated using VR/AI assisted robotics



Motor Age, 2018
Fig.7.13 – Improve Electrical troubleshooting skills – lecture with PowerPoint illustrations



ITIguru, 2016
Fig.7.14 – Ohm's Law/Rheostat theory – lecture with practical demo (Hindi)

Tech StudyCell, 2020
Fig.7.15 – How to use a digital multi-meter – demo video; may appear crude, but very practical

SkillTrain, 2016
Fig.7.16 – How to repair a Multi-meter – demo video; good Indian content curated at the ITI level

b. Interactive experience

Kyle Forinash and Wolfgang Christian, 2023
Fig.7.17 – Electricity and Magnetism – e-book with diverse features; clicking upon the links will open further contents, videos, simulations, etc.

edumedia-sciences.com, 2023

Fig.7.18 – Interactive Quiz on Electric Meter; basic but very effective

DCAClab, 2022

Fig.7.19 – Measuring resistance – interactive assignment; educative, but can be more creative

c. *Immersive experience*

Digital Engineering and Magic, 2022

Fig.7.20 – Procedure for testing connections on a low voltage electricity network using Virtual Reality. Very useful, but can become costly. Embark on priority basis.

7.3.2 Assembling/Constructing Circuits and Boards

a. *Audio-visual experience*

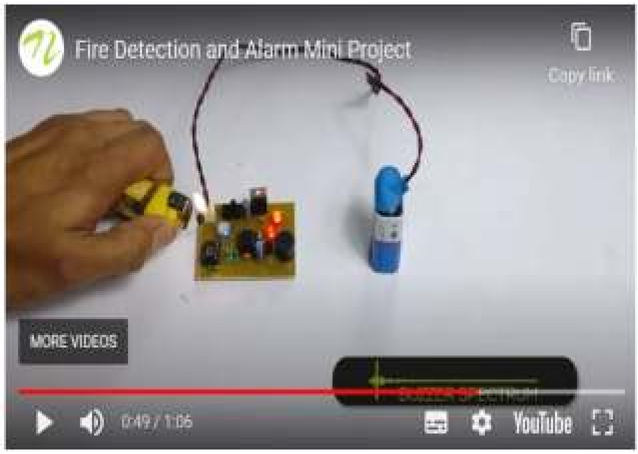
PLC Program, 2022

Fig.7.21 – How to read electrical and wiring drawings – lecture with illustrations

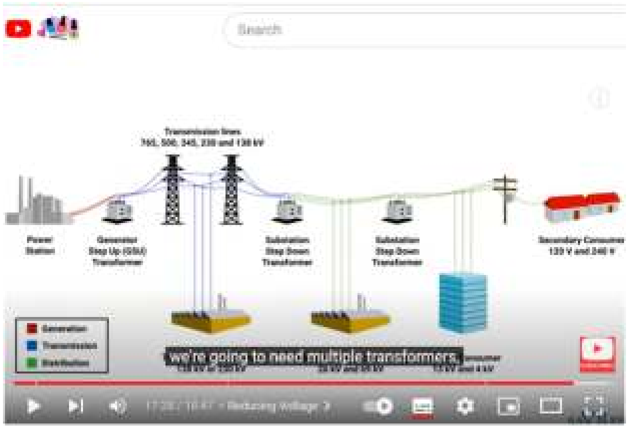
SkillTrain, 2017

Fig.7.22 – Understanding plate earthing – lecture with illustrations

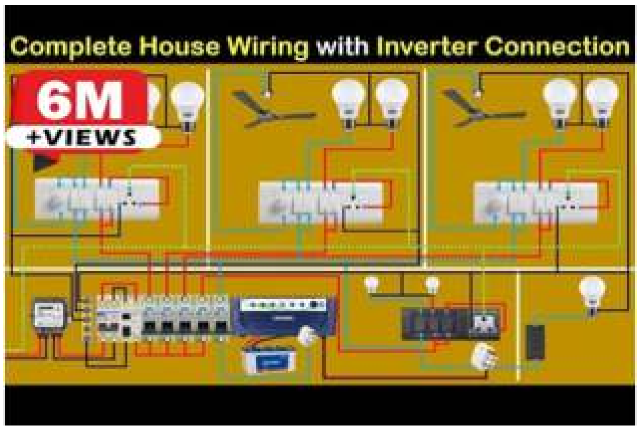
edumedia-sciences.com, 2023
Fig.7.23 – Electric current and circuit – illustrative video; simple and explained well



nevonprojects.com, 2023
Fig.7.24 – Fire Detection and Alarm mini project – demo video; good projects for students to create something and understand concepts better



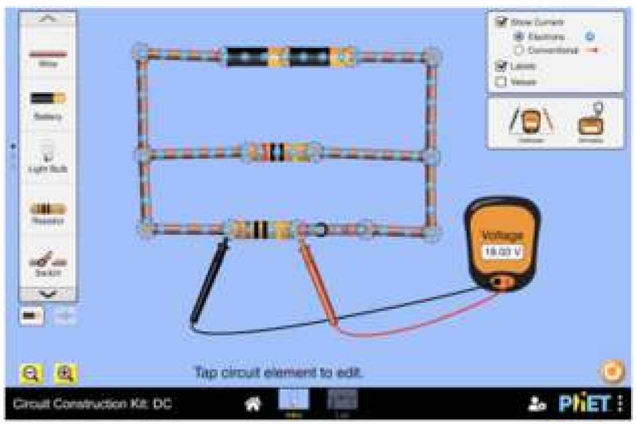
saVRee, 2020
Fig.7.25 – Electrical Grid and Electricity Supply – simple illustrative video



Electrical Technician, 2021
Fig.7.26 – House Wiring with inverter connection – demo video in Hindi; curated at the ITI level, explained and demonstrated very clearly

b. *Interactive experience*

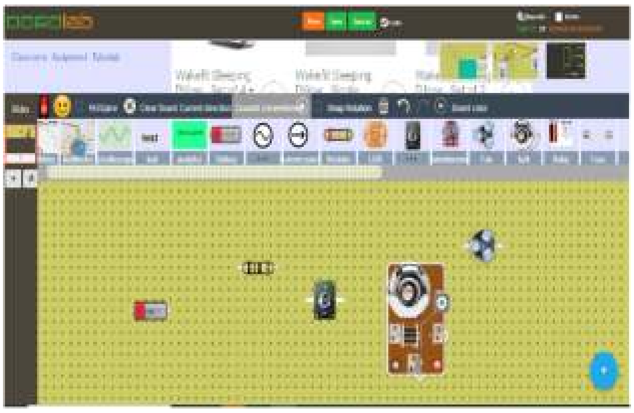
edumedia-sciences.com
Fig.7.27 – Interactive Quiz on Electrical Installation; quizzes details while reinforcing the big picture



phet.colorado.edu, 2023
Fig.7.28 – Interactive Circuit construction (kit) through (virtual) V-labs; simple and effective both for learning and assessments

[circuitjam, 2019](#)

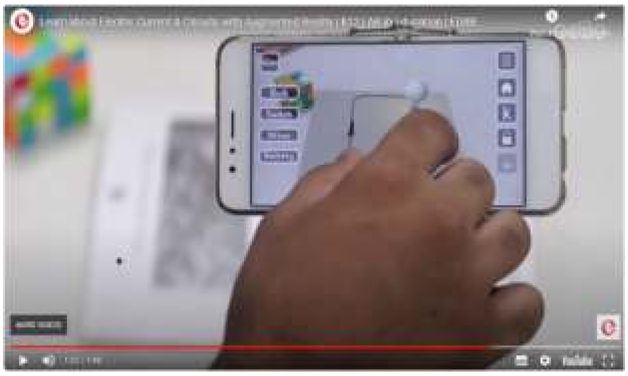
Fig.7.29 – Learning circuits through challenging and fun gamification having sophisticated graphics and simulation



[DCAClab, 2023](#)

Fig.7.30 – Online interactive circuit simulator – for assignments, tutorials, and assessments

c. *Immersive experience*



[EDIIIE, 2020](#)

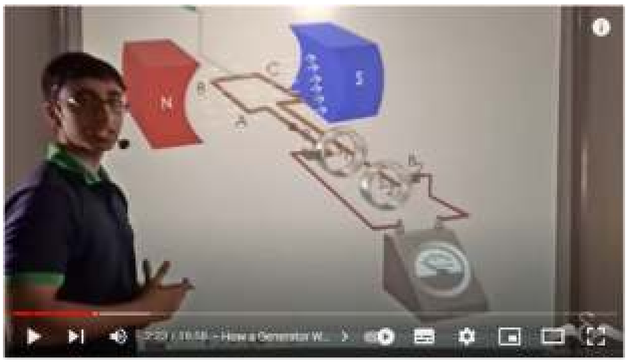
Fig.7.31 – Learn electric current and circuits using augmented reality (AR)

[Simulations Walkthrough, 2023](#)

Fig.7.32 – Possible simulations of electrical systems. The simulated walkthrough provides training on how to identify faults and repair them.

7.3.3 Installing, Repairing and Maintaining Machines

a. *Audio-visual experience*

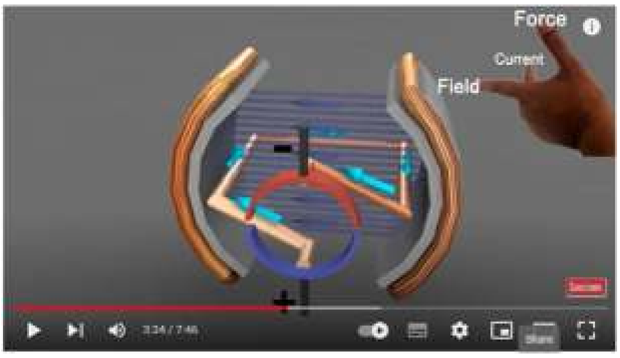


[DeltaStep, 2016](#)

Fig.7.33 – Working of AC generator – Lecture using digital whiteboard features effectively

[electrician funda, 2022](#)

Fig.7.34 – Working of Auto Transformer – lecture in Hindi with demonstration

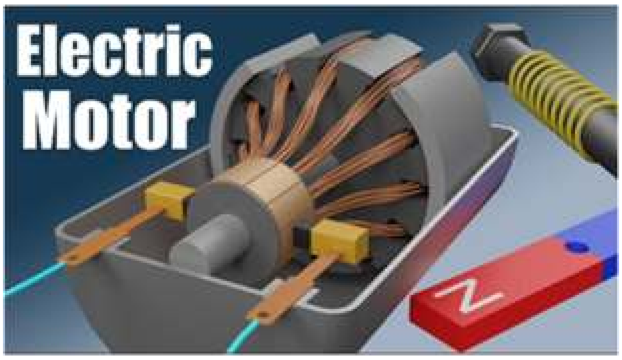


[sourabh sharma, 2019](#)

Fig.7.35 – Construction and Working of a DC Motor – illustration with 3D animation

Learning Vibes, 2022

Fig.7.36 – Working principles of a DC Motor – illustration with animation



[Jared Owen, 2021](#)

Fig.7.37 – How does a DC motor work – another illustration with 3D animation

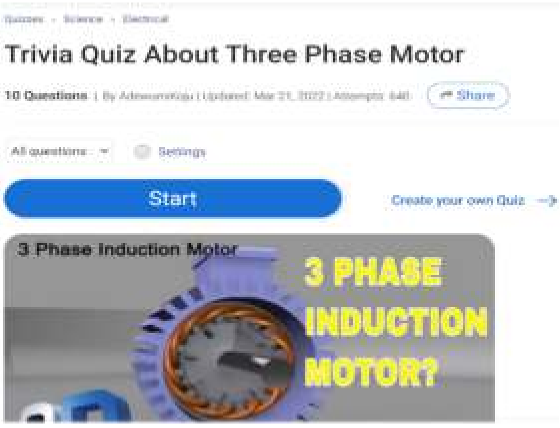
b. *Interactive experience*

[Science Buddies, 2019](#)

Fig.7.38 – Build a simple Electric motor – Interactive project to explain the principle

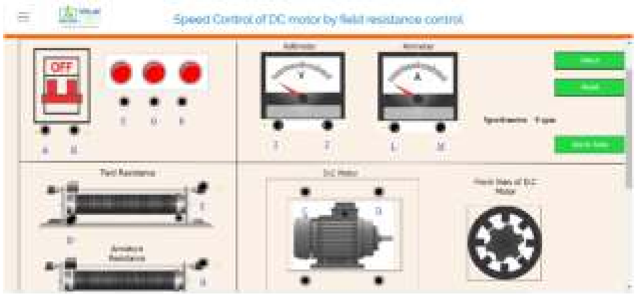
[National MagLab, 2023](#)

Fig.7.39 – Interactive tutorial where students can learn the impact of adjusting variables in a DC Motor.



ProProfs Quizzes, 2023

Fig.7.40 – 3-phase motors – interactive quizzes; also new quizzes can be created



iitr.vlabs.ac.in, 2023

Fig.7.41 – Speed control of DC Motor – interactive simulation created by the V-lab project of IIT Roorkee

c. Immersive experience

Rajvir Singh using Simumatic, 2022

Fig.7.42 – Building a simple motor using digital twin technology; interesting application of digital twinning technology

Immative Technologies, 2022

Fig.7.43 – Machine dismantling and servicing illustrated using virtual reality (VR) and artificial intelligence (AI) assisted robotics. Technology already being used in India by companies like ITC for their industrial training.

8.0

ITI Learning Management System

The learning management system (LMS) is one of the most important aspects of transitioning to a blended learning approach that has not received the requisite attention it deserves especially in the public education space. Most public institutions have rightly tended to focus initially on 'Content Management,' and in this basic access to textbook pdf and lecture videos. For example, NCERT/CIET currently the most advanced in the online public education space has

- DIKSHA – a content management system
- NVSK – public education program management and information system

In the recent past, it has started focusing on a more comprehensive LMS.

Private EdTech on the other hand, with the advantage of being much smaller and less complex, have given much more attention to more integrated learning management systems, especially since their operations have to be very closely integrated with the e-commerce applications.

The goal of the proposed ITI learning management system (LMS) is to create a seamless system, that stimulates engagement and results in a fulfilling learning/teaching experience for the student and instructor.

The primary users of the LMS include – students, instructors (including laboratory/workshop assistants, external project or on-the-job training guides). The secondary users visualised include – the ITI administration, central and state regulatory agencies – harvesting the data and analytics for planning and system improvement.

It needs to be stated here that the LMS is not visualised as a CRM or REP system for the ITI. It will focus on learning/teaching. It will be linked to other components of the ITI ERP like HR, Management of equipment, Stocks and Supplies, Accounts and Financial Management, etc. Not included at present but important elements include – Relationship Management with alumni, partner companies, etc. – providing equipment, specialist instructors, project or training guides, etc.

ITI Learning Management System – *Functions/Features*

The proposed LMS for the ITI courses in India (to be initiated with the Electrician Course) will facilitate three core functions. These encompass:

- Course and Content Management
- Support for Flexible Learning
- Analytics, Assessment and Certification

Specific features relevant to each of these functions are described below. Further Critical Technological Features to support the three core functions are also elaborated.

It may be noted that a considerable part of this section has been adapted from:

https://www.selecthub.com/learning-management/lms-features/

8.1 Course and Content Management

The Course and Content Management System is the most basic building block where most public educational systems have concentrated on. The ITI Electrician course already has several basic elements like the online curriculum and textbook PDF documents, lecture videos, question bank, etc. incorporated in the Bharat Skills portal and NIMI Online portals. Key features of the proposed centralised online content include:

- *Enabling multimedia integration* to store eLearning material, like documents, images, audio files, videos, PDFs, progress reports and presentations. It enables a more engaging experience by mixing various media elements.
- *Organising* the pre-built or custom online courses content in four quadrants as recommended by the UGC Guidelines. These include:
  - Quadrant-I – e-Tutorial

    - Video and Audio Contents, animation, simulations, virtual labs.
  - Quadrant-II – e-Content

    - Portable Document Format (PDF) or e-Books or Illustration, video demonstrations, documents, and interactive simulations, wherever required.
  - Quadrant-III – Web Resources
  - - Related Links, Open Content on Internet, Case Studies, Historical development of the subject, Articles.
  - Quadrant-IV – Self-Assessment

    - MCQ, Problems, Quizzes, Assignments and solutions, Discussion forum topics and setting up the FAQ, Clarifications on general misconceptions.
- Providing *access* to centralized eLearning content, without time and location constraints
- *Enabling creation of new material*, like copy and reuse classes and content, customise material to meet requirements and manage the participants through inbuilt course-authoring software. Users will be able to upload courseware, stream live training and edit existing data. This gives administrators full flexibility over the information in each module. Like Docebo, for example, the software will support external embedding to insert assignments, quizzes and more from web pages.

8.2 Enabling/Support for Flexible Learning

An important function that public education systems have not given adequate attention to are the user-friendly tools for flexible learning. Some of the key features include:

- *Providing options for learning paths* that are available to the student. Guiding the student, with or without the assistance of the instructor, to chalk out his/her learning paths depending on circumstances, prior learning (RPL), current progress, etc.
- *Support both instructor-led and self-guided learning modules*
  - *Instructor-led training (ILT)* – more synchronous learning.

    Providing instructors the tools to facilitate either face-to-face learning or via a virtual classroom (known as VILT). Features include:

    * Promoting the event
    * Sending reminders

    * Managing schedules to prevent double-booking for rooms, instructors or web conference accounts
    * Providing virtual training exercises to students
    * Managing registrations, participation and reports for online and offline events
    * Setting a max number of attendees
    * Providing an online setting where students can interact, ask questions, and engage in conversation. It works well for lessons, lectures, workshops, and seminars.
  - *Self-paced training* – more asynchronous learning
    * Providing students the option to pursue classes at their own pace. They can log in and complete assignments without participating in a group. While some may do well in a classroom setting, others prefer the flexibility and independence to tackle modules at their own pace, time and setting.

      The option for blended learning will provide each student the opportunity to attain the best skills, no matter their circumstances, style of learning or schedule.

- *Incorporating game-based elements* that reward students for completing specific tasks and meeting set goals. Some of these features that help inspire and motivate students include:
  - A point system, which rewards students for accomplishing various activities.
  - Badges and awards based on certain achievements.
  - A 'Leader Board' that shows the rewards and achievements of students.
  - Incentives like gift cards, bonuses, discounts on learning or vocational tools and materials, scholarships, etc.
- *Integrating collaborative elements*, like discussion forums, team-building activities, and informal check-ins to encourage students to work together. These elements facilitate social learning through chat groups and forums and allow course users to communicate and collaborate as they work through their modules. They can engage in peer-to-peer discussions, ask questions, and get answers. Knowledge sharing takes place via blogs, wikis, and FAQ sections which many are already doing through WhatsApp groups. Going to others for advice and help comes with advantages, such as:
  - Immediate responses, which are helpful if someone needs to solve a time-sensitive problem.
  - A sense of camaraderie, where each student invests in the success of their peers.
  - More participation from students who shy away from speaking up when in-person or in a group.
  - Less demand on trainers, freeing them to focus on where they are more critically required

8.3 Analytics, Assessment and Certification

An integral part of the proposed Learning Management System is analytics and assessment to generate reports for learning outcomes, completion rates, special initiatives by the ITI, eCommerce analysis, assessments of exams and a range of customisable reports and data fields. This is another function that deserves much more attention than it has received up to now. Some of the key features include:

- *Tracking learner progress with real-time analytics*, evaluating how well learners progress and measuring their levels of engagement and knowledge retention. Tests, quizzes, projects, assignments and other interactive formats through the LMS gives each learner the chance to demonstrate their knowledge, identify their strengths and weaknesses, and strategise how to improve. The system

- Analyses each student's progress as they work through their modules. It offers a clear outlook of who's performing well and who needs retraining. It also enables the instructors to clearly communicate areas for improvement and reward students for areas where their competence has increased.
- Offers insights into team performance and helps in designing effective improvement strategies especially, in the case of group projects. It monitors participation and indicates who's really invested in the conversation and who needs a gentle nudge. It also shows what students get the most excited about.
- Provides the option to proctor exams based on the needs and progress of the students
- Streamlines and automates the certification process.
- Facilitates career guidance and placement support based on student aptitude and performance

- *Enabling automated grading* that uses pre-defined criteria or allows the instructor or learner to configure the criteria to cater to specific needs. Learners know their scores immediately, and can retake a test if needed. Real-time feedback to learners enables them to better understand their performance and address areas of improvement.
- *Incorporating offline learning trackers* that track and report learner engagement offline by collecting data from multiple sources and creating an electronic record. Learners can document their activity time using time logs and upload images and documents to register their progress updates. Instructors use this information to evaluate assessments, approve submitted time, measure learners' progress along learning paths each day and more. This is particularly important for the proposed seamless system of blended learning at ITIs.
- *Assessing the performance of instructors and departments* with similar data-driven analytics and reports.

The analytics and assessment component of the proposed ITI LMS will streamline efforts, save time, reduce subjectivity in assessments and examinations, and most importantly give the learner a much higher sense of ownership and responsibility.

8.4 Critical Technological Features

Besides the features for the three core functions, there are some critical technological features that will be ingrained in the proposed ITI Learning Management System. These include:

- Compliance with standards, so that courses are delivered consistently across systems and devices. It will also ensure data migration from one system to another.
- Enabling integrations and interoperability with other software including enterprise resource planning (ERP) tools, legacy software, etc.
- Integration with eCommerce tools
  - Payment gateway for convenient payments of fees, etc.
  - Rewards and Scholarships based on performance of the students
  - Online store/subscriptions/coupons for student materials or vocational tools and equipment at student discount rates
- Having a responsive design that adapts to the small screen of a cell phone or a 30-inch monitor. The Single Sign-On (SSO) feature will allow users to log in to multiple applications using a single user ID

and password. It will provide a streamlined user experience, allowing learners to access all the materials they need without switching platforms or having to remember multiple login credentials.

- Incorporating alerts and notifications that keep learners aware and on track of any updates; including automated alerts and reminders about important deadlines, upcoming events, test schedules, course updates and additions, timetable changes and other training-related developments in real time, to both mobile and desktop devices.
- Ingrained security components to protect data against malware and unauthorised third-party access. Some key features include data encryption, multi-factor authentication, user roles and permissions, automated data backups, IP blockers and audit reports.
- Support for localisation in multiple languages, especially the Indian languages and also foreign languages, such that the Indian ITI programme can be used across the country as well as students in other geographies.
- Ability to cater to the learning needs of students with different types of disabilities.
- Adaptable to all file formats and media integration Video Conferencing: The ability to speak face-to-face with trainees is crucial. Consider the live video capabilities or examine any third-party apps users might need access to this feature. If this is an add-on, factor in the added cost before deciding.
- Automating administrative tasks like enrolments, managing learning paths, sending notifications for upcoming due dates and events, and automatically adding or removing users and, in the process, saving time and other resources.

The Learning Management System for the ITI Blended Programme to be initiated with the Electrician Course is visualised as follows:

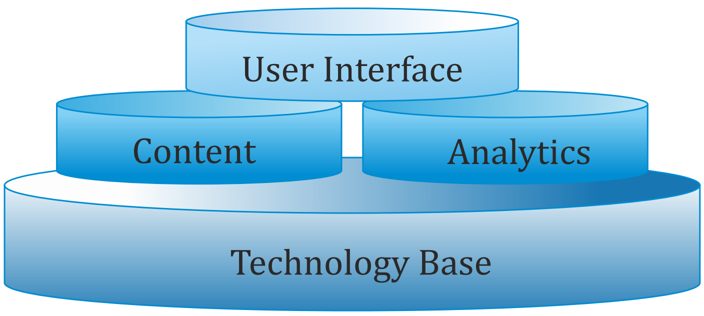


Fig. 8.1: Proposed ITI Learning Management System

The foundational underpinnings will include all the technological features described above. Embedded in the technological base will be the content in the four quadrants, together with the assessment and analytical tools. On top of this will sit the user-friendly and flexible interface which enables the student, instructor, and other stakeholders a much richer learning, teaching, and management experience.

It is worth re-emphasising that the proposed ITI learning management system is not visualised as an enterprise resource planning (ERP) or customer relationship management (CRM) package for the ITIs. It focusses on enabling the learning and teaching experience with easier access to content, a flexible blended learning opportunity, supported by the latest of analytics and information technology tools.

9.0

Key Operational Issues to be Addressed

As a course imparting vocational skills, the proposed ITI Electrician Blended Programme is clearly visualised as an online cum face-to-face programme rather than a purely online initiative. The imperative of practical exposure and skilling practise is recognised; both in the laboratories and workshops, and on-the-job training. Further human interaction in classrooms and workshops is seen an integral part of the student acquiring social and employability skills.

The overall aim of the proposed ITI Electrician Blended Programme is to enhance its efficacy and efficiency. The operational design and implementation will attempt to:

- *Provide a significantly better learning and teaching experience* – which is educative and empowering; lively, engaging and rewarding
- *Reduce time and provide flexibility to the student* – to learn at their pace and time depending on their circumstances in a synchronous or asynchronous manner. Depending on the interest and capability of student, it should possible to complete the course as follows:
  - Highly motivated student : 1.0 year
  - Normal student : 1.5 years
  - Average student : 2.0 years
  - Learning while working : > 2.0 years
- *Enable and empower instructors as Course Facilitators* – rather than attempting to have 'good' instructors across the country, especially in the rural ITIs. Students anywhere in the country will have access to the best instructors and industry experts with the support of technology.
- *Provide more effective training with available infrastructure and equipment.* – The online preparatory exercises with simulation, virtual reality (VR), digital twinning, and gamification tools and experiences will significantly reduce the time required on the expensive machines. It is envisaged that the equipment available currently will be able to serve the needs of double the number of students; making the overall programme much more cost effective.

It is not worthwhile to implement the proposed blended programme in a piece-meal manner. Operationalising the bended course requires an integrated systems approach to provide the fulfilling experience envisaged. The Learning Management System described in Section 8 will play a critical role in providing this seamless experience.

Some of the key operational issues to be addressed at this stage include:

- Talent Mobilisation and Capacity Building
- Infrastructure and Technological Challenges
- Budgeting and Financial Resources
- Phasing of Activities

These are discussed in the sections below.

a. *Talent Mobilisation and Capacity Building*

The transition to a blended system of learning and teaching will imply talent mobilisation and capacity building, in two distinct yet parallel phases.

- Design and Development
- Deployment and Implementation

During the *design and development phase*, the first challenge will be to mobilise and crowd source the best talent available in the country. As visible from the examples cited above, the expertise and skill sets that are required to build up the digital assets and make the transition to a blended programme are available but scattered across the country. They are broadly in two categories

- The Content Experts – with thematic expertise
- The Convertors – with digital skills to convert the content

There are also a few with skills and expertise across the spectrum.

Most of the content experts required for the Electrician programme are available within the ITI system. Those with the aptitude and interest can be selected through incentivised competitions. As indicated in Section 2.2, the NSDC system has aggregated several individuals and smaller institutions that generate content and provide other skill development services. They include both content experts and convertors. The examples in Section 7 also highlight a whole range of individual enthusiasts who provide content and other services on YouTube and other internet channels.

Most of these individuals and smaller players lack access to proper workshop and laboratory equipment, and standard digital recording equipment. About 700 ITIs (approximately one per district) can be selected from amongst government and private institutions, based on the available infrastructure and interest to participate in the design and development process.

The system can be organised such that broad norms and frames are outlined for the different types of illustrative, interactive, and immersive content and experiences described in Section 6&7 above. Based on these norms and frames, challenge awards and hackathons can be organised to mobilise and select potential design and development partners. These activities will also generate iterations of sample products and services.

The capacity building for the *deployment and implementation phase* will essentially involve the ITI staff associated support and administrative personnel.

COVID provided a first-hand experience of what happens when different categories of persons are pushed into unfamiliar and sometimes difficult situations. On the one hand students were able to embrace the online courses more intuitively and faster; even though there were cases of associated social and mental health issues. On the other hand, teachers required much more hand-holding to familiarise themselves and use the technology effectively. There were even instances of some teachers giving up their jobs.

Through a phased process of training of trainers, the instructors and other staff will be exposed to the digital skill sets required to efficiently perform their responsibilities in a blended environment. More importantly, they will be counselled on how to effective play the role of a learning facilitator promoting logical thinking and problem solving in a collaborative manner, rather than a just being a know-all teacher imparting knowledge and skills.

b. *Infrastructure and Technological Challenges*

While transitioning the ITI Electrician course into a blended programme, it needs to be recognised that there is still only 50% internet penetration in rural India. Most ITI students will continue to come from rural India and any system being designed will have to be inclusive and ensure that it caters to their needs. Then only will the country be able to benefit from the demographic dividend though vocational educational and skilling.

The typical rural ITI student can at best afford a Rs.4000 smartphone. In many locations the bandwidth is limited, and costs not affordable. Hence all content and services need to be designed keeping these realities and limitations in mind. Many of the technological imperatives and hence the features required have already been highlighted in Section 8.4 on Learning Management Systems.

It is visualised that the ITI student will have three levels of access to the proposed Blended Learning Programme.

- The first will be though their own device – smartphone, tablet, or laptop. In this context the student can be incentivised to participate actively and perform in the course through some of the reward programmes outline in Section 8.4 on Learning Management Systems. They can own these and other professional equipment by earning rewards while undertaking the course.
- The second level of access can be through the local internet café. The student can have access closer home and at a convenient time. Static digital content can be downloaded, and interactive tutorials, tests and assignments completed taking care of bandwidth limitations.
- The third level of access will be through the ITI laboratories and workshops, including computers, virtual reality (VR) headsets, simulators, (virtual) v-lab equipment, etc. The system will have to be re-organised such that students will be able to pre-book time slots over an extended period of the day and evening. In this way the students can learn at their pace and time, and the available infrastructure and equipment is utilised much more cost-effectively.

An important investment that will be required early in the transition process will be the (artificial intelligence) AI enabled cameras in the laboratories to record activities and provide feedback for improvement and continuous formative assessment.

c. *Budgeting and Financial Resources*

At this stage, it is a little premature to budget the transition process. While the costs are not going to be insignificant, the costs of inaction are much higher. The current purely face-to-face method of ITI training cannot effectively produce employable skilled personnel at the pace required. The demographic dividend, if not carefully harnessed at the pace required can turn into a social disaster.

Two parallel action strands are visualised to arrive at a realistic budget.

- *Mobilise and collate cost related information from available public and private initiatives.*

  There is already enough evidence within the public education system at different levels to provide a reasonable idea of costs. The NCERT/CIET, NIOS, and State Boards have attempted various initiatives at the school level as described in Section 3. Similarly, the UGC, IGNOU and AICTE, etc. have online experiments at the higher education level. NIMI Online and Bharat Skills have experience in the vocational education and training space. The collation of these experiences can provide a wealth of information to craft specifications and arrive at costs.

  At the same time, private EdTechs, though significantly smaller in scale, have a range of user-friendly online products and services. The learning management systems can help in seamlessly integrating these features and services, and enhancing the online experience of learners and trainers/educators. It will be useful to have interactions with selected private players to scope out the features required and estimate the costs. Some of these players may be engaged as partners to develop and manage the system.

- *Generate specifications and cost related information from the sample products and services.*

  The challenge awards and hackathons described above to mobilise and select potential design and development partners will also generate a range of sample products and services. The first-hand experience from these will be very critical in finalising specifications for different categories of products and services, at different levels of sophistication, and also provide an estimate of the effort, infrastructure, time, and costs involved.

  Based on the feedback from initiatives by other institutions, and also the structured efforts to develop sample products and services, a detailed Plan of Action with estimates can be prepared after one year.

d. *Phasing of Activities*

The structured and systematic transformation of the ITI Electrician Course into a Blended Programme is expected to take time; but with tangible intermittent building blocks delivered at each stage. The system visualised is not a make-shift 'jugaad' arrangement to address an emergency like COVID. It is envisaged as a carefully crafted system to re-engineer vocational education and training in ITIs and harvest the demographic dividend.

Summarising from the earlier sections, the proposed Blended ITI Electrician Programme will have the following components:

- Audio-visual experiences – including
  - Static content and lectures with supporting tools like interactive white-boards
  - Illustrative and process demonstration content
- Interactive Tools and Experiences – including
  - Chatbots and other group discussion tools to foster participation and peer learning
  - Interactive e-books, v-lab activities, quizzes, group projects, etc. to reinforce learning creatively through tutorials, assignments, etc.
  - Quizzes, tests, simulations, gamifications, etc. for more objective and transparent assessments, providing timely feedback and building into the continuous formative assessments
- Immersive Tools and Experiences – including
  - Virtual Reality walk-throughs, AI assisted robotics, Digital twinning, with simulation and gaming to provide a realistic feel and experience of processes

In attempting to phase activities, it is important to note that all elements of audio-visual and interactive tools and experiences are essential and need to be initiated in the first year itself. Fortunately, as seen from the examples in Section 7, there is adequate experience already available that can be built upon. It is also relatively much less expensive to develop and deploy. Leaving out any of these will make the overall system appear patchy, and frustrate the seamless learning cum teaching experience visualised. The only component that can be delayed to be initiated in the second year are the immersive tools and experiences. Given that these are more complex and expensive, they need to be carefully identified, designed, developed, and deployed based on need and priority.

Broadly the activities are visualised in four phases with some overlaps. Some of the key activities identified in each phase are as follows:

- *Phase 1/Year 1 – Design and Develop*
  - Design content transition
  - Mobilise talent and expertise
  - Develop about 5-10 percent sample products and services (excluding immersive)

    (Cover all the types of products in the samples to finally test seamless integration)
  - Prepare detailed Plan of Action and Estimates
- *Phase 2/Year 2 – Field Test and Develop*
  - Field test sample products and services with selected students and teachers
  - Obtain feedback, revise the design parameters
  - Develop 100 percent products and services
  - Initiate work on immersive products and experiences
- *Phase 3/Year 3 – Deploy and Revise*
  - Deploy the content developed with 10 percent ITIs

    (About two per district to test out at scale in different contexts)
  - Obtain feedback, revise the design parameters and products
  - Design Standard Operating Procedures
- *Phase 4/Year 4 – Implement at Scale*
  - Implement the full array of products and services in all the ITIs
  - Finalise the Standard Operating Procedures

As the ITI establishment embarks on the journey to transform its Electrician course into an online cum face-to-face blended programme, many more challenges are expected to crop up. These hurdles and milestones will be crossed based on the internal experience gained at each stage, and the information available from other initiatives.

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Annex 1 – Bharat Skills – CTS Electrician Course – Video Links

1st Year

Sr. No.	Week No.	Topics	Video Link
1	1	SCOPE OF ELECTRICIAN TRADE ¼fo|r 0;olk; e volj½	https://youtu.be/8JgnVrgxO4g
2	1	SAFETY SIGN ¼lqj{kk fpUg½	https://youtu.be/3B8ANCEe5Wc
3	1	TYPE OF FIRE, TYPE OF FIRE EXTINGUISHER ¼vkx rFkk vkx c>kus oky ;=k d idkj½	https://youtu.be/mt5G9lVseto
4	2	FIRST AID SAFETY ¼ikFkfed fpfdRlk mik;½	https://youtu.be/0n2IJjDIzAA
5	2	FIRST AID SAFETY ¼ikFkfed fpfdRlk mik;½	https://youtu.be/Ln7Onoxjp2Y
6	3	CONCEPT AND ADVANTAGES OF BIS/ISI ¼BIS/ISI dh ldYiuk rFkk ykHk½	
7	4-5	INTRODUCTION OF TOOLS	https://youtu.be/iUqi3qkDnsc
8	4-5	WOODEN JOINTS ¼ydMh d tkM½	
9	6-7	MARKING TOOLS ¼vdu vkStkj½	https://youtu.be/juJ6-buElzo
10	8	ELECTRICITY ¼fctyh½	https://youtu.be/3fyidfEggnk
11	8	ELECTRICITY ¼fctyh½	https://youtu.be/vR5B0HW9EPk
12	8	CONDUCTOR AND INSULATOR ¼pkyd rFkk dpkyd½	https://youtu.be/DVlNlVJfipM
13	9-10	JOINT OF ELECTRICAL CONDUCTOR ¼fctyh d rkjk d tkM½	https://youtu.be/sITt7uSJIQw
14	9-10	TECHNIQUE FOR SOLDERING ¼Vkdju dh rduhd½	https://youtu.be/AcTGkvjjL0c
15	11-12	UNDERGROUND CABLES ¼Hkfexr dcy½	https://youtu.be/g3qW112dfKw
16	13-14	OHMS LAW ¼vkge dk fu;e½	https://youtu.be/4PC1YEJHdbQ
17	13-14	KIRCHHOFFS LAW ¼fdjpkQ d fu;e½	
18	13-14	KCL	https://youtu.be/Jd-RLPy95zc
19	13-14	KVL	https://youtu.be/8yGV6xsd4hk
20	15	WHEATSTONE BRIDGE ¼0ghVLVku lr½	https://youtu.be/yjfKts8tCDU
21	15	LAW OF RESISTOR ¼ifrjk/kd d fu;e½	https://youtu.be/qpE4tSigkDg
22	15	SERIES PARALLEL COMBINATION OF RESISTANCE ¼ifrjk/k dk J[kyk rFkk lekukrj Øe½	https://youtu.be/kCdukr9ibuA
23	16-17	MAGNETIC MATERIAL ¼pcdh; inkFk½	https://youtu.be/Kf5E4A0ASks
24	16-17	ELECTRO MAGNETISM ¼byDVk eXufVTe½	https://youtu.be/YBo3FLNVGJM
25	16-17	CAPACITOR AND ITS TYPES ¼l/kfj= ,o mld idkj½	https://youtu.be/R4oejVfW4ps

Sr. No.	Week No.	Topics	Video Link
26	16-17	CAPACITOR AND ITS TYPES ¼l/kkfj= ,o mld idkj½	https://youtu.be/hiG9bfbTFIE
27	18-19	AC DC SYSTEM	https://youtu.be/AMTCJbTm-NU
28	18-19	POWER ¼”kfDr½	https://youtu.be/-hpVjvOoXEU
29	18-19	SINGLE AND THREE-PHASE SYSTEM	https://youtu.be/26aDiacwH4A
30	20-21	ADVANTAGES OF AC POLY PHASE SYSTEM ¼cgQt i.kkyh d ykHk½	https://youtu.be/V-HHG3n1TKY
31	20-21	THREE PHASE STAR AND DELTA CONNECTION ¼rhu Ql Lvkj ,o MYVk l;ktu½	https://youtu.be/f5v1j-jpAeI
32	20-21	PHASE SEQUENCE METER ¼pj.k vuØe ehVj½	https://youtu.be/9BiuVH2swR8
33	22-23	PROJECT WORK	
34	24-26	REVISION	
35	27-28	LAW OF ELECTROLYSIS ¼fo|r vi?kVu fu;e½	https://youtu.be/E-Qj5Dbp3uM
36	27-28	CELLS ¼ly½	https://youtu.be/Y8QHW81jRkc
37	27-28	CELLS ¼ly½	https://youtu.be/2VS-C9ruMIw
38	27-28	CONNECTION OF CELLS ¼lyk dk l;ktu½	https://youtu.be/TK0cDYkC4TA
39	27-28	CONNECTION OF CELLS ¼lyk dk l;ktu½	https://youtu.be/jqXfrSZS2xQ
40	27-28	SOLAR CELL ¼lkyj ly½	https://youtu.be/XPKK55PlyIw
41	29-30	DOMESTIC AND INDUSTRIAL WIRING ¼?kjy o vk|kfxd ok;fjx½	https://youtu.be/uFtnjs-3hRs
42	29-30	DOMESTIC WIRING ACCESSORIES AND TYPES OF SWITCHES ¼?kjy ok;fjx dk lkeku rFkk fLopk d idkj½	https://youtu.be/uFtnjs-3hRs
43	29-30	MCB	https://youtu.be/D3UOUT8r8No
44	29-30	RCCB	https://youtu.be/4Wzob50E8Yk
45	29-30	MCCB	https://youtu.be/APkLjcensVU
46	29-30	ELCB	https://youtu.be/NxH5RESnB9w
47	31-32	DIFFERENT TYPES OF WIRING ¼ok;fjx d idkj½	https://youtu.be/f0y1YTqyUI0
48	33-35	LOAD CALCULATION ¼ykM x.kuk½	https://youtu.be/5pafXBes0Yc
49	33-35	SPECIAL WIRING CKT.	
50	33-35	GODOWN WIRING ¼xknke ok;fjx½	https://youtu.be/xW-507n3DkI
51	33-35	TUNNEL WIRING ¼ljx ok;fjx½	https://youtu.be/v3y6cM3Qbkk
52	36	EARTHING ¼vfFkx½	https://youtu.be/gSaxl-17SWI
53	36	TYPE OF EARTHING ¼vfFkx d idkj½	https://youtu.be/MjAjNkWR5d4
54	37-38	ILLUMINATION ¼inhiu½	https://youtu.be/Ph14-qAS190
55	37-38	ILLUMINATION ¼inhiu½	https://youtu.be/dKvmNyocSPw

Sr. No.	Week No.	Topics	Video Link
56	37-38	ILLUMINATION ¼inhiu½	https://youtu.be/ReF7oiST60c
57	39-40	CLASSIFICATION OF ELECTRICAL MEASURING INSTRUMENTS ¼fo|rh;ekiu ;= d idkj½	https://youtu.be/pCxTtJfkjAA
58	39-40	CLASSIFICATION OF ELECTRICAL MEASURING INSTRUMENTS ¼fo|rh;ekiu ;= d idkj½	https://youtu.be/tygE8zSD3mI
59	39-40	CLASSIFICATION OF ELECTRICAL MEASURING INSTRUMENTS ¼fo|rh;ekiu ;= d idkj½	https://youtu.be/fng04VpuLWs
60	39-40	CLASSIFICATION OF ELECTRICAL MEASURING INSTRUMENTS ¼fo|rh;ekiu ;= d idkj½	https://youtu.be/kKPqeoEZgoo
61	41	ERROR IN MEASUREMENTS ¼ekiu e =fV;k½	https://youtu.be/tsnuFOfdEVU
62	42-44	VARIOUS ELECTRICAL EQUIPMENT	
63	42-44	ELECTRIC IRON	https://youtu.be/d8pYnhZs-kE
64	42-44	WORKING OF THERMOSTAT	https://youtu.be/0gLVNvisLsg
65	42-44	WASHING MACHINE	https://youtu.be/1I26M4uuI1s
66	42-44	CONCEPT OF NEUTRAL AND EARTHING	https://youtu.be/Rydi3AqMgcw
67	45-46	TRANSFORMERS	
68	45-46	INTRODUCTION AND WORKING	https://youtu.be/b5PpFRCA1Ks
69	45-46	CORE	https://youtu.be/p-Rz69K9vOA
70	45-46	ADVANTAGES AND EMF EQUATION	https://youtu.be/5mLcCM4UTDQ
71	45-46	IMPORTANT DEFINITIONS	https://youtu.be/-a3U-TmCjNU
72	45-46	LOSSES	https://youtu.be/TiwW0OGBqZA
73	45-46	LOSSES	https://youtu.be/mfXBaibVHNY
74	45-46	TEST ON TRANSFORMER	https://youtu.be/WFARNhxi7VA
75	45-46	INSTRUMENT TRANSFORMER	https://youtu.be/OdXvQQd9RRs
76	45-46	INSTRUMENT TRANSFORMER	https://youtu.be/jSe-aHy19N4
77	45-46	TYPES OF TRANSFORMERS	https://youtu.be/ML-CQhaASNY
78	47	TYPE OF COOLING	https://youtu.be/bfRH21GwVhc

2nd Year

Sr. No.	Week No.	Topics	Video Link
80	53-54	ROTATING ELECTRIC MACHINE	https://youtu.be/5kzWC84-DOg
81	53-54	DC GENERATOR	https://youtu.be/Nxdj36XLMSk
82	53-54	DC GENERATOR	https://youtu.be/F5CtT52Ueuw
83	53-54	EMF EQUATION	https://youtu.be/gZMDTvD-NWo
84	53-54	TYPES	https://youtu.be/EcRlkEuLCqI
85	53-54	TYPES	https://youtu.be/U88sCYFEu-I
86	55-56	ARMATURE REACTION	https://youtu.be/jpeaVqgKAhk
87	55-56	LOSES	https://youtu.be/B0ltlw-QY1M
88	57-58	DC MOTOR	https://youtu.be/G5kOCpch-UA
89	57-58	BACK EMF	https://youtu.be/7D-Ed-K-O94
90	57-58	DC MOTOR STARTER	https://youtu.be/gBY9TvTtj0g
91	57-58	DC MOTOR STARTER	https://youtu.be/PEXFIW7K8GY
92	57-58	LOSES	https://youtu.be/xMUbvn23Eqo
93	57-58	TYPES	https://youtu.be/KbyVZQc94Wo
94	57-58	CHANGE OF DIRECTION OF ROTATION	https://youtu.be/a4eAsKlocE0
95	59-60	SPEED CONTROL OF DC MOTOR	https://youtu.be/PleUaHavBTI
96	59-60	LAP WINDING	https://youtu.be/KOxp1zNM9ic
97	59-60	WAVE WINDING	https://youtu.be/j9J6ghPZsac
98	59-60	DEFINITION ABOUT WINDINGS	https://youtu.be/1KXFtFG15bg
99	61-62	THREE-PHASE INDUCTION MOTOR	https://youtu.be/gVKH-wL4H58
100	61-62	THREE-PHASE INDUCTION MOTOR	https://youtu.be/v6Sc7a2Zzus
101	61-62	TYPES	
102	61-62	SQUIRREL CAGE	https://youtu.be/KkeJ-ijqp7U
103	61-62	SLIP RING	https://youtu.be/mT-qJNVs0ME
104	61-62	STARTERS	
105	61-62	DOL STARTER	https://youtu.be/WZB6-4KKyxo
106	61-62	STAR-DELTA STARTER	https://youtu.be/kDDbHg5H3dg
107	61-62	AUTO TRANSFORMER STARTER	https://youtu.be/ct4B-4JOkPM
108	63-64	LOSES	https://youtu.be/7Ex5y3AkWOw
109	63-64	SPEED CONTROL METHOD	https://youtu.be/GnN-ghRctNA
110	63-64	BRAKING SYSTEM OF MOTOR	https://youtu.be/ZP-nZue7Ito
111	65	WINDING	https://youtu.be/qYwklqEHlUk

Sr. No.	Week No.	Topics	Video Link
112	65	WINDING	https://youtu.be/4qVzo4ieefg
113	65	WINDING	https://youtu.be/aPucheok17E
114	65	WINDING	https://youtu.be/Mo7gyMAsluY
115	65	WINDING TESTING	https://youtu.be/O3-NckIY9GU
116	66-67	SINGLE PHASE MOTOR	https://youtu.be/eufMi-FxyTo
117	66-67	APPLICATION	https://youtu.be/U8jlkHAR2YA
118	66-67	TYPES	https://youtu.be/oO9VAGk5pwE
119	66-67	TYPES	https://youtu.be/KgaDkk8WYY4
120	66-67	TYPES	https://youtu.be/b-95gpi3g2I
121	68-69	UNIVERSAL MOTOR	https://youtu.be/X-huaypkByk
122	68-69	SPEED CONTROL OF UNIVERSAL MOTOR	https://youtu.be/get2BslVjpM
123	70-71	ALTERNATOR	https://youtu.be/TOYibX7Sk8E
124	70-71	ALTERNATOR	https://youtu.be/Aj1-soYN7-w
125	72	SYNCHRONOUS MOTOR	https://youtu.be/RtRe-drrmOc
126	72	STARTING OF SYNCHRONOUS MOTOR	https://youtu.be/Az-9X6SFtsQ
127	73	MG SET	https://youtu.be/STmpMQrN-o0
128	74-75	PROJECT WORK	
129	76-78	REVISION	
130	79	RESISTOR ¼ifrj{k/kd½	https://youtu.be/K9ZDArXh7yk
131	79	RESISTOR ¼ifrj{k/kd½	https://youtu.be/q7QqtrOova8
132	79	ATOMIC STRUCTURE ¼ukfHkdh; lajpuk½	https://youtu.be/6A8BDrt6hRs
133	79	SEMICONDUCTOR ¼v/kpkyd½	https://youtu.be/NKYBc7u6hO4
134	79	SEMICONDUCTOR ¼v/kpkyd½	https://youtu.be/DvYfs6rXKuE
135	80-81	P-N JUNCTION, BIASING ¼P-N tD"ku½	https://youtu.be/hKGJoW-u6wo
136	80-81	CHARACTERISTICS OF DIODE ¼Mk;kM dh fo"ks'krk,½	https://youtu.be/xPm161-eLtc
137	80-81	ZENER DIODE ¼thuj Mk;kM½	https://youtu.be/Kj6Vpm6m9lU
138	80-81	LIGHT EMITTING DIODE (LED)	https://youtu.be/tPFI2-PdCYA
139	80-81	PHOTO DIODE	https://youtu.be/idyOIr-m18A
140	80-81	RECTIFIER ¼fn'Vdkjh½	https://youtu.be/yaUMBKjkOjg
141	80-81	RECTIFIER ¼fn'Vdkjh½	https://youtu.be/JG3asbRqHDs
142	80-81	FILTERS ¼fQYVj½	https://youtu.be/0XtBatAPmQ8
143	80-81	TRANSISTOR ¼VkftLVj½	https://youtu.be/dTx9VKV0hjo
144	80-81	TRANSISTOR ¼VkftLVj½	https://youtu.be/d2lmY-AMs24

Sr. No.	Week No.	Topics	Video Link
145	80-81	AMPLIFIER ¼,EiyhQk;j½	https://youtu.be/sGv1kdO1Lkc
146	80-81	AMPLIFIER ¼,EiyhQk;j½	https://youtu.be/G6Uee9VAI6k
147	82-83	INTRODUCTION OF POWER ELECTRONICS ¼ikoj byDVkfuDl dk ifjp;½	
148	82-83	POWER SUPPLY	https://youtu.be/gL2SAbB-MKU
149	82-83	DIGITAL ELECTRONICS	
150	82-83	NUMBER SYSTEM ¼ucj flLVe½	https://youtu.be/kAnBaQoJkpo
151	82-83	LOGIC GATES ¼ykftd xV½	https://youtu.be/AT-GjUjNFpo
152	82-83	LOGIC GATES ¼ykftd xV½	https://youtu.be/EBk8c-OOdpQ
153	84-85	OSCILLOSCOPE ¼nkyun"kh½	https://youtu.be/-aLN-Z5B9vU
154	84-85	SCR	https://youtu.be/mTo-46GbUIs
155	84-85	DIAC	https://youtu.be/mZJSm4--wSU
156	84-85	TRIAC	https://youtu.be/FquC5eY0mGk
157	84-85	IGBT	https://youtu.be/ZT6TfaooNEk
158	84-85	MULTIVIBRATORS ¼cgdfi=½	https://youtu.be/uJ-c6ElmJiA
159	84-85	MULTIVIBRATORS ¼cgdfi=½	https://youtu.be/t72T5p56aGs
160	86-87	ISOLATOR	https://youtu.be/TOlSRaC6miU
161	86-87	FUSES	https://youtu.be/V0bcdeu0dR0
162	86-87	RELAYES	https://youtu.be/flknwz1lyuI
163	86-87	TIMER	https://youtu.be/tYVQ0JoAArw
164	88-89	DISTRIBUTION AND TRANSMISSION	https://youtu.be/Y7-zKCnGgsI
165	88-89	THIMBLES AND OTHER CONNECTING MATERIAL	https://youtu.be/0P-3vcvykYY
166	90-91	AC DRIVE	https://youtu.be/fNEEa4-dvoY
167	90-91	DC DRIVE	https://youtu.be/945RHBUckQA
168	90-91	VVVF/VFD	https://youtu.be/L-I0G-JfbDY
169	92-93-94	STABILIZER	https://youtu.be/MutjK0-v0I4
170	92-93-94	BATTERY CHARGER	https://youtu.be/nsf2n1c05Ws
171	92-93-94	UPS	https://youtu.be/eSeKwoAotlE
172	92-93-94	INVERTER	https://youtu.be/IBdQucgcJ40
173	92-93-94	EMERGENCY LIGHT	https://youtu.be/9f20R1lLtic
174	92-93-94	PREVENTIVE AND BREAKDOWN MAINTENANCE	https://youtu.be/NR4JW8hhMCM
175	95	CONVENTIONAL AND NON-CONVENTIONAL ENERGY SOURCES ¼ijijkxr rFkk xj&ijijkxr Åtk d lkr½	https://youtu.be/dnA0nshoxgQ

Sr. No.	Week No.	Topics	Video Link
176	95	CONVENTIONAL AND NON-CONVENTIONAL ENERGY SOURCES ¼ijijkxr rFkk xj&ijijkxr Åtk d lkr½	https://youtu.be/hr2sNfqFBsM
177	95	HYDRO POWER STATION ¼iu fctyh ?kj½	https://youtu.be/f7kJ0z11lws
178	95	THERMAL POWER STATION	https://youtu.be/q0G1fz9kx04
179	96	SOLAR ENERGY	https://youtu.be/0oK-VQnPDuY
180	96	WIND POWER GENERATION	https://youtu.be/grppmyKXY-Q
181	97	TRANSMISSION AND DISTRIBUTION NETWORK	https://youtu.be/Y7-zKCnGgsI
182	97	LINE INSULATOR	https://youtu.be/k78GHf-aT7M
183	98	SAFETY PRECAUTIONS IE RULES ¼IE lj{kk fu;e½	https://youtu.be/DQcYtWmoZEg
184	98	MAXIMUM DEMAND ¼vf/kdre ekx½	https://youtu.be/Gs9r1HpbDpo
185	98	DIVERSITY FACTOR ¼fofo/krk dkjd½	https://youtu.be/1d5SyDBNFZs
186	99	RELAYS	https://youtu.be/fIknwz1IyuI
187	99	CIRCUIT BREAKERS	https://youtu.be/eit5LhDAZ5A
188	99	CIRCUIT BREAKERS	https://youtu.be/hjrw98GoHJk

Annex 2 – NIMI Online – Power Sector – Electrician Course – Weekly Lesson Plan

S. No.	Week No.	Lessons
1	1	Occupational safety (07 hrs.)
2	2	Safety practice and hand tools (07 Hrs.)
3	3	Trade hand tools (07 Hrs.)
4	4	Fitting tools and marking tools (07 Hrs.)
5	5	5 marking tools
6	6	Marking tools 2
7	7	Fundamental of Electricity
8	8	Conductors – Insulators
9	9	Wire Joints – types – soldering methods
10	10	Alternating current circuits and electromagnetic waves
11	11	Alternating current terms
12	12	Alternating current terms
13	13	Alternating current terms
14	14	Chemical effect of electric current
15	15	Electrical wiring practices and diagrams
16	16	Electrical wiring practices and diagrams
17	17	Alternating current terms
18	18	Fuses and circuit breakers
19	19	Electrical earthing
20	20	Importance for earthing
21	21	Electrode
22	22	Illumination and shading
23	23	Diffuse light contribution
24	24	Lighting in OpenGL and global light properties
25	25	Measuring instruments
26	26	Introduction to three-phase power
27	27	Inspection and testing of wiring installations
28	28	Basic wiring practice
29	29	Wiring Installation and Earthing

S. No.	Week No.	Lessons
30	30	Illumination
31	31	Illumination terms – Laws
32	32	Reading instrument scales
33	33	Measuring instruments
34	34	Measuring instruments 1
35	35	Geyser
36	36	Domestic appliances
37	37	Domestic appliances
38	38	Transformer
39	39	Series and parallel operation of transformer
40	40	Three-phase transformer – connections
41	41	Screws
42	42	DC generator
43	43	Characteristics of DC generator
44	44	Hysteresis loss
45	45	Relation between torque, flux and armature current in a DC motor
46	46	Speed – torque characteristics
47	47	Speed control methods of a DC motor and their applications
48	48	Materials used for winding – field coil winding
49	49	AC three-phase motor
50	50	Starter for 3 – phase induction motor – power control circuits – D.O.L starter
51	51	Efficiency – characteristics of induction motor – no load,blocked rotor test
52	52	Standby/Off-line
53	53	Stabiliser, battery charger, emergency light, inverter and UPS
54	54	General precautions for preventive maintenance
55	55	Atomic number and mass number
56	56	Electrical power generation by non-conventional methods
57	57	Electrical supply system – transmission - line insulators
58	58	Bus – bar system – power tariff terms and definitions
59	59	Bus-bar system – power tariff terms and definitions
60	60	Line protective relays – types – operation
61	61	Resistors – colour code, types and characteristics
62	62	Atomic structure and semiconductor theory

S. No.	Week No.	Lessons
63	63	P-N junction, classification, specifications, biasing
64	64	Rectifier circuit – half wave, full wave, bridge rectifiers and filters
65	65	Basic concept of power electronics devices
66	66	Function generator and cathode ray oscilloscope (CRO)
67	67	Study and understand layout drawing of control cabinet
68	68	Study and understand power and control circuits
69	69	Isolators, pushbuttons, switches, indicators, MCB
70	70	Installation of instruments and sensors in the control panel
71	71	Instruments in panel board
72	72	Testing of various control elements and circuits.
73	73	Speed control of 3-phase induction motor by using VVVF/AC drive
74	74	The basic concept, block diagram and working of voltage stabiliser
75	75	Stabiliser, battery charger, emergency light, inverter and UPS
76	76	Sources of energy – Thermal power generation
77	77	Electrical power generation by non-conventional methods
78	78	Transmission and distribution
79	79	Domestic service line - IE rules
80	80	Line protective relays – types – operation

C·O·L
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