National Curriculum of Pakistan
2022-23

TECHNICAL EDUCATION

GENERAL AND INDUSTRIAL ELECTRICIAN

Grades 11 -12

NATIONAL CURRICULUM COUNCIL SECRETARIAT
MINISTRY OF FEDERAL EDUCATION AND
PROFESSIONAL TRAINING, ISLAMABAD
GOVERNMENT OF PAKISTAN

بسم الله الرحمن الرحيم

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It is with great pride that we, at the National Curriculum Council Secretariat, present the first core curriculum in Pakistan's 75-year history. Consistent with the right to education guaranteed by Article 25-A of our Constitution, the National Curriculum of Pakistan (2022-23) aspires to equip every child with the necessary tools required to thrive in and adapt to an ever-evolving globalized world.

The National Curriculum is in line with international benchmarks, yet sensitive to the economic, religious, and social needs of young scholars across Pakistan. As such, the National Curriculum aims to shift classroom instruction from rote learning to concept-based learning.

Concept-based learning permeates all aspects of the National Curriculum, aligning textbooks, teaching, classroom practice, and assessments to ensure compliance with contemplated student learning outcomes. Drawing on a rich tapestry of critical thinking exercises, students will acquire the confidence to embark on a journey of lifelong learning. They will further be able to acknowledge their weaknesses and develop an eagerness to build upon their strengths.

The National Curriculum was developed through a nationwide consultative process involving a wide range of stakeholders, including curriculum experts from the public, private, and non-governmental sectors. Representatives from provincial education departments, textbook boards, assessment departments, teacher training departments, *deeni madaris*, public and private publishers, private schools, and private school associations all contributed their expertise to ensure that the National Curriculum could meet the needs of all Pakistani students.

The experiences and collective wisdom of these diverse stakeholders enrich the National Curriculum, fostering the core, nation-building values of inclusion, harmony, and peace, making the National Curriculum truly representative of our nation's educational aspirations and diversity.

I take this opportunity to thank all stakeholders, including students, teachers, and parents who contributed to developing the National Curriculum of Pakistan (2022-23)

Dr. Mariam Chughtai
Director
National Curriculum Council Secretariat
Ministry of Federal Education and Professional Training

General and Industrial electrician

Grade 9 and 10

Progression Grid

Domain A: Maintain Occupational Health and Safety

Standard: Students will demonstrate proficiency in occupational health and safety through effective PPE management and first aid skills and adhering to International and National Safety Standards, recognizing and mitigating hazards in accordance with established norms from organizations such as IEC, EPA, IEE, ESFI, ILO and local legislations, ensuring a safe and environmentally compliant workplace.

Grade 9	**Grade 10**
Benchmark I: Students will be able to develop the skill and competence required to maintain Occupational Health and Safety and take remedial measures to deal with emergencies professionally, thus minimizing the losses and providing a safe and healthy working environment.	Students will be able to develop the skill and competence required to maintain Occupational Safety, Health and Environment at the workplace according to the National and International Protection Agencies Standards and take remedial measures for Personal, Occupational and Environmental Protection.
Student Learning Outcomes	
Ensure use of personal protective equipment (PPE) Students will be able to:	**Implement International Safety Standards in your work environment** Students will be able to:

[SLO:GE-09-A-01]: • arrange the required personal protective equipment [SLO:GE-09-A-02]: • demonstrate checking functional condition of PPE's [SLO:GE-09-A-03]: • wear personal protective equipment [SLO:GE-09-A-04]: • demonstrate skills to store PPE at the appropriate place after use.	[SLO:GE-10-A-01]: recognize Electrical Safety hazards as per International Electro- Technical Commission (IEC) Standards [SLO:GE-10-A-02]: determine Environmental Pollution risk factors as per Protection Agency (EPA) standards [SLO:GE-10-A-03]: identify Electrical Safety Hazards as per Institute of Electrical and Electronics Engineers (IEE) standards [SLO:GE-10-A-04]: categorize the Electrical Safety Hazards as per Electrical Safety Foundation International(ESFI) standards [SLO:GE-10-A-05]: identify Labor Protection Laws as per International Labor Organization(ILO) rules [SLO:GE-10-A-06]: identify the steps to minimize the Electrical hazards and Environmental Pollution. [SLO:GE-10-A-07]: prepare a report for all the above activity.

Maintain First-aid Box Students will be able to: [SLO:GE-09-A-05]: ensure availability of first aid box [SLO:GE-09-A-06]: check first aid box for requisite emergency [SLO:GE-09-A-07]: check expiry of medicines [SLO:GE-09-A-08]: perform first aid treatment against electric shocks [SLO:GE-09-A-09]: perform first aid treatment/bandages against minor injuries.	**Implement National Safety Standards in your work environment** Students will be able to:

	[SLO:GE-10-A-08]: identify Factory associated hazard as per Chapter 3 of Factories Act, 1934 [SLO:GE-10-A-09]: determine Environmental Pollution factors as per Pakistan Environmental Protection Act, 1997 [SLO:GE-10-A-10]: recognize the Labor protection laws as per Labor Protection Policy 2006 [SLO:GE-10-A-11]: identify the workplace hazards as per Occupational health and safety (OHS) standards [SLO:GE-10-A-12]: identify the steps to minimize the Electrical hazards, Environmental Pollution and Labor Safety [SLO:GE-10-A-13]:

	prepare a report for all the above activity.
Maintain Fire Extinguisher Students will be able to: [SLO:GE-09-A-10]: check expiry of fire extinguisher [SLO:GE-09-A-11]: operate fire extinguisher [SLO:GE-09-A-12]: replace fire extinguisher [SLO:GE-09-A-13]: ensure that the fire brigade is at stand by(for major emergency)	**Implement International and National Labor Protection Laws** Students will be able to:

	[SLO:GE-10-A-14]: identify labor protection laws as per international labor organization(ilo) rules [SLO:GE-10-A-15]: recognize the labor protection laws as per labor protection policy 2006 [SLO:GE-10-A-16]: identify the bonded labor and child labor policy. [SLO:GE-10-A-17]: determine the leaves policy and compensation policy for the labor. [SLO:GE-10-A-18]: recognize the minimum wage for the labor [SLO:GE-10-A-19]: identify the remedial steps for protection and prosperity of labor.

	[SLO:GE-10-A-20]: prepare a report for all the above activities.
Ensure Safeguard of Machines Students will be able to: [SLO:GE-09-A-14]: maintain radiator shield [SLO:GE-09-A-15]: maintain alternator fan shield [SLO:GE-09-A-16]: maintain heat resister material on silencer [SLO:GE-09-A-17]: cover main circuit breaker [SLO:GE-09-A-18]: lock canopy doors	**Implement national and international environmental protection laws** Students will be able to:

	[SLO:GE-10-A-21]: determine environmental pollution risk factors as per protection agency (epa) standards [SLO:GE-10-A-22]: identify the steps to minimize the electrical hazards and environmental pollution. [SLO:GE-10-A-23]: determine environmental pollution factors as per pakistan environmental protection act, 1997 [SLO:GE-10-A-24]: identify the requirements for initial environmental examination (iee) [SLO:GE-10-A-25]: identify the requirements for Environmental Impact Assessment (EIA) [SLO:GE-10-A-26]:

	prepare a report for all the above activity.
Adopt company policies and procedures Students will be able to: [SLO:GE-09-A-19]: ensure company's safety policy [SLO:GE-09-A-20]: adopt company safety procedure [SLO:GE-09-A-21]: advocate worker with company safety policy [SLO:GE-09-A-22]: implement safety sign board as per standard	**Prepare for emergencies** Students will be able to: [SLO:GE-10-A-27]: take emergency response training [SLO:GE-10-A-28]: ensure practice of emergency exercises [SLO:GE-10-A-29]: ensure the availability of first aid box and fire extinguisher [SLO:GE-10-A-30]: check the expiry of medicines and fire extinguishers [SLO:GE-10-A-31]: check the emergency alarms

	[SLO:GE-10-A-32]: ensure regular practice of gathering the workers in assembly area during the emergency. **Respond to emergencies** [SLO:GE-10-A-33]: follow emergency plan [SLO:GE-10-A-34]: communicate instructions to co-workers [SLO:GE-10-A-35]: assess risk and determine course of action [SLO:GE-10-A-36]: operate emergency equipment and supplies [SLO:GE-10-A-37]: ensure that the ambulance and fire brigade are on stand-by (for major emergency)

Attain health & safety training Students will be able to: [SLO:GE-09-A-23]: take required health and safety training [SLO:GE-09-A-24]: implement work hazardous material information system (WHMIS) [SLO:GE-09-A-25]: adopt first aid cardio respiratory, resuscitation and cpr	**Adopt company policies and procedures** Students will be able to: [SLO:GE-10-A-38]: ensure company's safety policy [SLO:GE-10-A-39]: adopt company safety procedure [SLO:GE-10-A-40]: advocate worker with company safety policy [SLO:GE-10-A-41]: implement safety sign board as per standard
Prepare for emergencies Students will be able to: [SLO:GE-09-A-26]: take emergency response training [SLO:GE-09-A-27]:	

ensure practice of emergency exercises [SLO:GE-09-A-28]: check the emergency alarms [SLO:GE-09-A-29]: ensure regular practice of gathering the workers in the assembly area during the emergency. **Respond to emergencies** Students will be able to: [SLO:GE-09-A-30]: follow emergency plan [SLO:GE-09-A-31]: communicate instructions to co-workers [SLO:GE-09-A-32]: assess risk and determine course of action	

[SLO:GE-09-A-33]: operate emergency equipment and supplies [SLO:GE-09-A-34]: ensure that the ambulance is on stand-by (for emergency)	

Domain B: Fundamentals of Electricity

Standard I: The students will be able to develop the skill and competence required to describe the fundamentals of Electricity.

Grade 9	**Grade 10**
Benchmark I: Students will be able to demonstrate proficiency in describing the fundamentals of electricity, encompassing matter and its states, as well as understanding key electrical concepts, symbols, components, measuring instruments, Ohm's Law and the principles governing the heating effect and resistance in conductors.	
Student Learning Outcomes	

Fundamental of electricity Students will be able to: [SLO:GE-09-B-01]: describe matter and its states [SLO:GE-09-B-02]: describe current, voltage and resistance [SLO:GE-09-B-03]: describe electrical quantities and their units	N/A

Basic Electrical symbols Students will be able to: [SLO:GE-09-B-04]: describe conductor, insulator, semi-conductors [SLO:GE-09-B-05]: enlist measuring instruments [SLO:GE-09-B-06]: describe ohm's law [SLO:GE-09-B-07]: define heating effect of conductor [SLO:GE-09-B-08]: explain law of resistance	N/A

Domain C: Electric Wiring and Maintenance of Tools & Equipments

Maintain Tools & Equipment for Single Phase Wiring

Standard I: Students will demonstrate proficiency in arranging, maintaining, insulating, calibrating measuring tools and managing inventory according to established standards, ensuring adherence to proper procedures and maintaining accurate records throughout the tools/equipment lifecycle.

Grade 9	**Grade 10**
Benchmark I: Students will be able to demonstrate skills and knowledge required to arrange tools/equipment, maintain tool box, insulate tools/equipment, calibrate measuring tools and manage proper inventory of used/unused tools/equipment. Students will be expected to follow the procedures to maintain the tools/equipments	
Student Learning Outcomes **students will be able to:**	

Arrange Tools and Equipment Students will be able to: [SLO:GE-09-C-01]: identify tools and equipment [SLO:GE-09-C-02]: interpret job card [SLO:GE-09-C-03]: prepare list of tools and equipment as per requirement [SLO:GE-09-C-04]: collect tools and equipment from store	

Maintain Tool Box Students will be able to: [SLO:GE-09-C-05]: check physical conditions of tools and equipment before use [SLO:GE-09-C-06]: perform preventive main perform corrective maintenance of tools as per requirements [SLO:GE-09-C-08]: clean tools and equipment after use [SLO:GE-09-C-09]: place tools and equipment at appropriate place	

Insulate Tools and Equipment Students will be able to: [SLO:GE-09-C-10]: select insulated tools and Equipment [SLO:GE-09-C-11]: adopt insulated tools and equipment as per standards	
Calibrate measuring tools Students will be able to: [SLO:GE-09-C-12]: check calibration status of the measuring tools [SLO:GE-09-C-13]: perform calibration of measuring tools as per standards [SLO:GE-09-C-14]: record calibration test results	

Manage Inventory of tools and equipment Students will be able to: [SLO:GE-09-C-15]: check tools and equipment as per record [SLO:GE-09-C-16]: report for faulty tools and equipment to supervisor [SLO:GE-09-C-17]: generate demand for deficit tools and equipment [SLO:GE-09-C-18]: maintain all records of tools and equipment	

Standard II: Electrical Wiring Accessories

This domain covers the skills and knowledge required to arrange tools/equipment, maintain toolbox, insulate tools/equipment, calibrate measuring tools and manage proper inventory of used/unused tools/equipment. Students will be expected to follow the procedures to maintain the tools/equipments.

Grade 9	Grade 10
Benchmark I: Students will be able to arrange tools/equipment, maintain toolbox, insulate tools/equipment, calibrate measuring tools, manage proper inventory of used/unused tools/equipment, and follow procedures to maintain the tools/equipments.	
Student Learning Outcomes	
Important wiring accessories and their purpose Students will be able to: [SLO:GE-09-C-19]: identify types of switches with respect to shape ratings, class and use (Piano, tumbler, ceiling, bed, toggle, rotary switch, bell push switch, ceiling switch bed switch, Main Switch etc.)	

[SLO:GE-09-C-20]: identify types of socket with respect to shape and use (Flush type piano, surface type, two pin sockets). [SLO:GE-09-C-21]: identify types of Socket outlets with respect to ratings, class and uses of pins [SLO:GE-09-C-22]: identify types of Plugs with respect to shape ratings, class and use and use [SLO:GE-09-C-23]: identify types of lamp Holders with respect to shape ratings, class and use and use. [SLO:GE-09-C-24]: identify types of fuse and Breakers with respect to shape, ratings, class and use	
Important wiring accessories and their purpose Students will be able to:	

[SLO:GE-09-C-25]: identify types of Ceiling Rose with respect to shape [SLO:GE-09-C-26]: identify types of Distribution Box with respect to shape [SLO:GE-09-C-27]: identify types of Breakers with respect to shape, Ratings, class and use(MCCB,MCB,RCB,ELCB)	

Wire/Cable and their Joints for Single Phase Wiring

Standard III: Students will demonstrate proficiency in understanding and categorizing important wiring accessories, including switches, sockets, socket outlets, plugs, lamp holders, fuses, breakers, ceiling roses and distribution boxes, with respect to their shapes, ratings, classes and specific uses.

Grade 9	**Grade 10**
Benchmark I: Students will identify and describe the purpose of various wiring accessories such as switches (e.g., piano, tumbler, ceiling), sockets, socket outlets, plugs, lamp holders, fuses and breakers, demonstrating knowledge of their shapes, ratings, classes and specific applications in electrical systems.	

Student Learning Outcomes

Wire and cables Students will be able to: [SLO:GE-09-C-28]: identify types of electrical cables with respect to applications [SLO:GE-09-C-29]: identify types of cables with respect to insulation [SLO:GE-09-C-30]: identify types of wiring cables with respect to cores [SLO:GE-09-C-31]: identify types of wiring cables with respect to voltage grade [SLO:GE-09-C-32]: identify types of cables with respect to conductor [SLO:GE-09-C-33]: identify types of cables with respect to shapes and flexibility [SLO:GE-09-C-34]:	

identify types of cables with respect to mechanical protection [SLO:GE-09-C-35]: draw flow charts of Current carrying capacity of wiring cables [SLO:GE-09-C-36]: identify types of Flexible Cables and Cords; types of LT and HT power cables [SLO:GE-09-C-37]: identify type of Special Purpose Cables	
Make Cross/Twist joint Students will be able to:	

[SLO:GE-09-C-38]: select the cable [SLO:GE-09-C-39]: strip the wire according to 50mm [SLO:GE-09-C-40]: twist the conductors [SLO:GE-09-C-41]: solder the conductor [SLO:GE-09-C-42]: insulate the joint	
Make Straight/Married joint Students will be able to:	

[SLO:GE-09-C-43]: select the cable [SLO:GE-09-C-44]: strip wire to 75mm according to joint requirement [SLO:GE-09-C-45]: intermingle the conductors to 60mm into each other [SLO:GE-09-C-46]: twist 60mm conductors leaving behind 15mm of each cable [SLO:GE-09-C-47]: solder the conductor [SLO:GE-09-C-48]: insulate the joint	

Make T- Joint Students will be able to: [SLO:GE-09-C-49]: select the cable [SLO:GE-09-C-50]: remove the insulation of cable 1 to 50mm from where a connection is required [SLO:GE-09-C-51]: separate conductors of cable 1 equally [SLO:GE-09-C-52]: select and take another 12 mm stripped wire 2 [SLO:GE-09-C-53]: insert between two equally half conductors of cable 1 and twist. half conductors clockwise and half anti-clock wise of cable 2 [SLO:GE-09-C-54]: solder the joint	

Make Rat tail joint Students will be able to: [SLO:GE-09-C-55]: select the single conductor wires [SLO:GE-09-C-56]: strip both the wires to 5mm [SLO:GE-09-C-57]: twist the conductor [SLO:GE-09-C-58]: insulate the joint [SLO:GE-09-C-59]: solder the joint	
Make Britannia joint Select the cable. Students will be able to:	

[SLO:GE-09-C-60]: strip both cables to 75mm [SLO:GE-09-C-61]: demonstrate to bend the tips of both cable right angle about to 6mm [SLO:GE-09-C-62]: hold the two cables overlap 50mm with tips in opposite direction [SLO:GE-09-C-63]: demonstrate to take another bare conductor of 1mm and wrap around in both directions to 6mm [SLO:GE-09-C-64]: solder the joint [SLO:GE-09-C-65]: insulate the joint	

Electrical Wiring system

Standard IV: Students will demonstrate proficiency in the installation of electrical wiring systems for both domestic and industrial/commercial applications, adhering to safety and electrical regulations while considering architectural aesthetics.

Grade 9	**Grade 10**
Benchmark I: Students will apply knowledge and skills in installing domestic wiring systems, progressing from cleat wiring and wood casing to modern methods like PVC duct, batten wiring, lead sheathed and PVC conduit, ensuring compliance with safety standards and architectural considerations.	
Student Learning Outcomes **students will be able to:**	
Domestic (or residential) wiring systems Students will be able to:	

[SLO:GE-09-C-66]: demonstrate to cleat wiring system [SLO:GE-09-C-67]: demonstrate wood casing and capping wiring system (now obsolete) [SLO:GE-09-C-68]: demonstrate pvc duct or pvc casing - capping wiring system [SLO:GE-09-C-69]: Demonstrate batten wiring (cts or trs) wiring system (now obsolete) [SLO:GE-09-C-70]: demonstrate lead sheathed wiring system [SLO:GE-09-C-71]: demonstrate pvc conduit wiring system.(open or concealed)	

Industrial or commercial wiring Students will be able to: [SLO:GE-09-C-72]: demonstrate steel conduit wiring system [SLO:GE-09-C-73]: demonstrate metal trunking wiring system [SLO:GE-09-C-74]: demonstrate ducting wiring system [SLO:GE-09-C-75]: catenary wiring system [SLO:GE-09-C-76]: demonstrate tough sheathed wiring system [SLO:GE-09-C-77]: demonstrate overhead bus bar wiring system or metal clad bus bar system	

Carryout Basic Electrical Installation for Single phase

Standard V: Students will demonstrate competence in cable laying, single-phase and three-phase connections, basic electrical wiring and wiring tests for basic electrical Air Condition (AC) installation, following company guidelines and established procedures.

Grade 9	**Grade 10**
Benchmark I: Students will develop skills to lay cables, beginning with interpreting electrical drawings, identifying cables, laying them and performing earthing. Advanced stages include executing single-phase and three-phase connections, selecting appropriate cable gauges and colors, connecting cables, insulating joints, performing basic electrical wiring and conducting wiring tests, including voltage, current, continuity, polarity, earthing and insulation tests, with accurate record-keeping.	
Student Learning Outcomes **Students will be able to:**	

Lay cables Students will be able to: [SLO:GE-09-C-78]: interpret electrical drawing/document [SLO:GE-09-C-79]: identify cables [SLO:GE-09-C-80]: demonstrate laying of cables [SLO:GE-09-C-81]: perform earthling	

Perform single-phase Connection Students will be able to: [SLO:GE-09-C-82]: select cable gauge [SLO:GE-09-C-83]: select cables colors [SLO:GE-09-C-84]: connect cables [SLO:GE-09-C-85]: insulate joints	
Perform three phase Connection	

Students will be able to: [SLO:GE-09-C-86]: select cable gauge [SLO:GE-09-C-87]: select cables colors [SLO:GE-09-C-88]: connect cables [SLO:GE-09-C-89]: insulate joints	

Perform Basic Electrical wiring Students will be able to: [SLO:GE-09-C-90]: measure cables as per requirement [SLO:GE-09-C-91]: connect cables [SLO:GE-09-C-92]: perform joints [SLO:GE-09-C-93]: insulate joints	
Conduct wiring Test	

Students will be able to: [SLO:GE-09-C-94]: operate multi-meter for voltage and current [SLO:GE-09-C-95]: perform continuity test [SLO:GE-09-C-96]: perform polarity test [SLO:GE-09-C-97]: perform earthling test [SLO:GE-09-C-98]: perform insulation test [SLO:GE-09-C-99]: record test results	

Install Simple Single Phase Electrical Wiring

Standard VI: Students will construct and test various electrical circuits (single pole switch, two-way switch, series/test lamp, intermediate switch, tunnel and impulse switch), demonstrating mastery in creating accurate diagrams, installing accessories, laying wires, making connections and ensuring circuit functionality while adhering to safety guidelines.

Grade 9	Grade 10
Benchmark I: Students will be able to draw precise wiring, current path and layout diagrams. They will successfully mark the working board, install accessories, demonstrate laying of wires in duct/pipe, make connections, perform pre-connection checks, connect to the main supply and verify circuit functionality, showcasing a comprehensive understanding of the circuit construction process.	
Student Learning Outcomes	

Make single pole switch circuit. Students will be able to: [SLO:GE-09-C-100]: draw wiring diagram of single pole switch circuit [SLO:GE-09-C-101]: draw current path diagram of single pole switch circuit [SLO:GE-09-C-102]: draw layout diagram of single pole switch circuit [SLO:GE-09-C-103]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-09-C-104]: install accessories according to layout diagram [SLO:GE-09-C-105]: demonstrate laying of wires in duct/pipe according to layout diagram	

[SLO:GE-09-C-106]: make connections according to wiring diagram [SLO:GE-09-C-107]: check the circuit before connect the main supply [SLO:GE-09-C-108]: make connection with main supply [SLO:GE-09-C-109]: check the function of circuit after connect the main supply	

Make two-way switch circuit. Students will be able to: [SLO:GE-09-C-110]: draw wiring diagram of two-way switch circuit. [SLO:GE-09-C-111]: draw current path diagram of two-way switch circuit. [SLO:GE-09-C-112]: draw layout diagram of two-way switch circuit. [SLO:GE-09-C-113]: demonstrate skills in marking on working board according to layout diagram. [SLO:GE-09-C-114]: install accessories according to layout diagram. [SLO:GE-09-C-115]: demonstrate laying of wires in duct/pipe according to layout diagram. [SLO:GE-09-C-116]:	

make connections according to wiring diagram. [SLO:GE-09-C-117]: check the circuit before connect the main supply. [SLO:GE-09-C-118]: make connection with main supply. [SLO:GE-09-C-119]: check the function of circuit after connect the main supply	

Series/test lamp circuit. Students will be able to: [SLO:GE-09-C-120]: draw wiring diagram of series circuit [SLO:GE-09-C-121]: draw current path diagram of series circuit [SLO:GE-09-C-122]: draw layout diagram of series circuit [SLO:GE-09-C-123]: apply marking on working board according to layout diagram [SLO:GE-09-C-124]: install accessories according to layout diagram [SLO:GE-09-C-125]: demonstrate laying of wires in duct/pipe according to layout diagram [SLO:GE-09-C-126]:	

make connections according to wiring diagram [SLO:GE-09-C-127]: check the circuit before connect the main supply [SLO:GE-09-C-128]: make connection with main supply [SLO:GE-09-C-129]: check the function of circuit after connect the main supply	

Make intermediate switch circuit. Students will be able to: [SLO:GE-09-C-130]: draw wiring diagram of intermediate switch circuit [SLO:GE-09-C-131]: draw current path diagram of intermediate switch circuit [SLO:GE-09-C-132]: draw layout diagram of intermediate switch circuit [SLO:GE-09-C-133]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-09-C-134]: install accessories according to layout diagram [SLO:GE-09-C-135]: demonstrate laying of wires in duct/pipe according to layout diagram	

[SLO:GE-09-C-136]: make connections according to wiring diagram [SLO:GE-09-C-137]: check the circuit before connect the main supply [SLO:GE-09-C-138]: make connection with main supply [SLO:GE-09-C-139]: check the function of circuit after connect the main supply	
Students will be able to:	

[SLO:GE-09-C-140]: demonstrate skills in making of tunnel circuit [SLO:GE-09-C-141]: draw wiring diagram of tunnel circuit [SLO:GE-09-C-142]: draw current path diagram of tunnel circuit [SLO:GE-09-C-143]: draw layout diagram of tunnel circuit [SLO:GE-09-C-144]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-09-C-145]: install accessories according to layout diagram [SLO:GE-09-C-146]: demonstrate laying of wires in duct/pipe according to layout diagram	

[SLO:GE-09-C-147]: make connections according to wiring diagram [SLO:GE-09-C-148]: check the circuit before connect the main supply [SLO:GE-09-C-149]: make connection with main supply [SLO:GE-09-C-150]: check the function of circuit after connect the main supply	

Make impulse switch circuit. Students will be able to: [SLO:GE-09-C-151]: draw wiring diagram of impulse switch circuit [SLO:GE-09-C-152]: draw current path diagram of impulse switch circuit [SLO:GE-09-C-153]: draw layout diagram of impulse switch circuit [SLO:GE-09-C-154]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-09-C-155]: install accessories according to layout diagram [SLO:GE-09-C-156]: Demonstrate laying of wires in duct/pipe according to layout diagram	

[SLO:GE-09-C-157]: make connections according to wiring diagram [SLO:GE-09-C-158]: check the circuit before connect the main supply [SLO:GE-09-C-159]: make connection with main supply [SLO:GE-09-C-160]: check the function of circuit after connect the main supply	

Install Single Phase Complex Electrical Wiring

Standard VII: Students will demonstrate proficiency in installing various residential electrical circuits, including the kitchen, drawing room, sleeping room, hall wiring and impulse switch circuits.

Grade 9	Grade 10

Benchmark I: Students will be able to draw wiring, current path and layout diagrams. They will mark the working board, install accessories, demonstrate laying of wires in duct/pipe, make connections, perform pre-connection checks, connect to the main supply and verify circuit functionality, showcasing comprehensive skills in residential circuit installation.
Student Learning Outcomes

[SLO 1]	**Install kitchen circuit** Students will be able to: [SLO:GE-10-C-01]: draw wiring diagram of single pole switch circuit [SLO:GE-10-C-02]: draw Current path diagram of single pole switch circuit [SLO:GE-10-C-03]: draw layout diagram of single pole switch circuit [SLO:GE-10-C-04]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-10-C-05]: install accessories according to layout diagram [SLO:GE-10-C-06]: demonstrate laying of wires in duct/pipe according to layout diagram

	[SLO:GE-10-C-07]: make connections according to wiring diagram [SLO:GE-10-C-08]: check the circuit before connect the main supply [SLO:GE-10-C-09]: make connection with main supply.Check the function of circuit after connect the main supply

[SLO 2…]	**Install Drawing room circuit** Students will be able to: [SLO:GE-10-C-10]: draw wiring diagram of single pole switch circuit. [SLO:GE-10-C-11]: draw current path diagram of single pole switch circuit [SLO:GE-10-C-12]: draw layout diagram of single pole switch circuit [SLO:GE-10-C-13]: demonstrate skill in marking on working board according to layout diagram [SLO:GE-10-C-14]: install accessories according to the layout diagram [SLO:GE-10-C-15]: demonstrate laying of wires in duct/pipe according to layout diagram

	[SLO:GE-10-C-16]: make connections according to wiring diagram [SLO:GE-10-C-17]: check the circuit before connect the main supply [SLO:GE-10-C-18]: make connection with main supply [SLO:GE-10-C-19]: check the function of circuit after connect the main supply

[SLO 3...]	**Install Sleeping room circuit** Students will be able to: [SLO:GE-10-C-20]: draw wiring diagram of single pole switch circuit [SLO:GE-10-C-21]: draw current path diagram of single pole switch circuit [SLO:GE-10-C-22]: draw layout diagram of single pole switch circuit [SLO:GE-10-C-23]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-10-C-24]: install accessories according to layout diagram [SLO:GE-10-C-25]: demonstrate laying of wires in duct/pipe according to layout diagram

	[SLO:GE-10-C-26]: make connections according to wiring diagram [SLO:GE-10-C-27]: check the circuit before connect the main supply [SLO:GE-10-C-28]: make connection with main supply [SLO:GE-10-C-29]: check the function of circuit after connect the main supply

[SLO 4...]	**Install Sleeping room circuit** Students will be able to: [SLO:GE-10-C-30]: draw wiring diagram of single pole switch circuit [SLO:GE-10-C-31]: draw current path diagram of single pole switch circuit [SLO:GE-10-C-32]: draw layout diagram of single pole switch circuit [SLO:GE-10-C-33]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-10-C-34]: install accessories according to layout diagram [SLO:GE-10-C-35]: demonstrate laying of wires in duct/pipe according to layout diagram [SLO:GE-10-C-36]:

	make connections according to wiring diagram [SLO:GE-10-C-37]: check the circuit before connect the main supply [SLO:GE-10-C-38]: make connection with main supply [SLO:GE-10-C-39]: check the function of circuit after connect the main supply

[SLO 05..]	**Install hall wiring.** Students will be able to: [SLO:GE-10-C-40]: draw wiring diagram of single pole switch circuit [SLO:GE-10-C-41]: draw current path diagram of single pole switch circuit [SLO:GE-10-C-42]: draw layout diagram of single pole switch circuit [SLO:GE-10-C-43]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-10-C-44]: install accessories according to layout diagram [SLO:GE-10-C-45]: demonstrate laying of wires in duct/pipe according to layout diagram

	[SLO:GE-10-C-46]: make connections according to wiring diagram [SLO:GE-10-C-47]: check the circuit before connect the main supply [SLO:GE-10-C-48]: make connection with main supply [SLO:GE-10-C-49]: check the function of circuit after connect the main supply

[SLO 06...]	**Install impulse switch.** Students will be able to: [SLO:GE-10-C-50]: draw wiring diagram of single pole switch circuit [SLO:GE-10-C-51]: draw current path diagram of single pole switch circuit [SLO:GE-10-C-52]: draw layout diagram of single pole switch circuit [SLO:GE-10-C-53]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-10-C-54]: install accessories according to layout diagram [SLO:GE-10-C-55]: demonstrate laying of wires in duct/pipe according to layout diagram

	[SLO:GE-10-C-56]: make connections according to wiring diagram [SLO:GE-10-C-57]: check the circuit before connect the main supply [SLO:GE-10-C-58]: make connection with main supply [SLO:GE-10-C-59]: check the circuit's function after connecting the main supply

[SLO 07...]	**Install Bell indicator circuit.** Students will be able to: [SLO:GE-10-C-60]: draw wiring diagram of single pole switch circuit [SLO:GE-10-C-61]: draw current path diagram of single pole switch circuit [SLO:GE-10-C-62]: draw layout diagram of single pole switch circuit [SLO:GE-10-C-63]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-10-C-64]: install accessories according to layout diagram [SLO:GE-10-C-65]: demonstrate laying of wires in duct/pipe according to layout diagram

	[SLO:GE-10-C-66]: make connections according to wiring diagram [SLO:GE-10-C-67]: check the circuit before connect the main supply [SLO:GE-10-C-68]: make connection with main supply [SLO:GE-10-C-69]: check the function of circuit after connect the main supply

[SLO 08...]	**Install timer/time switch circuit.** Students will be able to: [SLO:GE-10-C-70]: draw wiring diagram of single pole switch circuit [SLO:GE-10-C-71]: draw current path diagram of single pole switch circuit [SLO:GE-10-C-72]: draw layout diagram of single pole switch circuit [SLO:GE-10-C-73]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-10-C-74]: install accessories according to layout diagram [SLO:GE-10-C-75]: demonstrate laying of wires in duct/pipe according to layout diagram

	[SLO:GE-10-C-76]: make connections according to wiring diagram [SLO:GE-10-C-77]: check the circuit before connect the main supply [SLO:GE-10-C-78]: make connection with main supply [SLO:GE-10-C-79]: check the function of circuit after connect the main supply

[SLO 09..]	**Make fluorescent tube circuit and install** Students will be able to: [SLO:GE-10-C-80]: draw wiring diagram of single pole switch circuit [SLO:GE-10-C-81]: draw current path diagram of single pole switch circuit [SLO:GE-10-C-82]: draw layout diagram of single pole switch circuit [SLO:GE-10-C-83]: demonstrate skills in marking on working board according to layout diagram [SLO:GE-10-C-84]: install accessories according to layout diagram [SLO:GE-10-C-85]: demonstrate laying of wires in duct/pipe according to layout diagram

	[SLO:GE-10-C-86]: make connections according to wiring diagram [SLO:GE-10-C-87]: check the circuit before connect the main supply [SLO:GE-10-C-88]: make connection with main supply [SLO:GE-10-C-89]: check the function of circuit after connect the main supply

[SLO 10...]	**Perform Domestic Electrical Work** Students will be able to: [SLO:GE-10-C-90]: install wire for grounding [SLO:GE-10-C-91]: perform pre installation module based tests [SLO:GE-10-C-92]: install conduits or trunks in the building as per drawing [SLO:GE-10-C-93]: install electrical wiring, as per drawing and standard [SLO:GE-10-C-94]: install main box and distribution box [SLO:GE-10-C-95]: install electric breakers in main box, as per load for safety measures [SLO:GE-10-C-96]:

	install the appliances used in electric work as per drawing [SLO:GE-10-C-97]: install emergency light system in main box, as per standard color scheme [SLO:GE-10-C-98]: install main distribution board [SLO:GE-10-C-99]: test the installation and obtain test certificate

Domain D: Operate Measuring Instruments

Standard I: Students will demonstrate competence in operating measuring instruments, including the Ampere meter, Volt meter, Ohm meter and Digital Multimeter (DMM), identifying them among other instruments, adjusting ranges, making connections and accurately measuring current, voltage and resistance.

Grade 9	Grade 10
Benchmark I: Students will identify Ampere meter among other measuring instruments, create a parallel circuit with resistors on a breadboard, adjust the meter range, connect it in series to measure current across resistors, turn on the supply and record accurate current readings for each resistor, showcasing a comprehensive understanding of Ampere meter usage.	
Student Learning Outcomes **Students will be able to:**	
•	**Operate Ampere meter.** Students will be able to: [SLO:GE-10-D-01]: identify the ampere meter amongst other measuring instruments [SLO:GE-10-D-02]: make a parallel circuit with three different resistors on breadboard [SLO:GE-10-D-03]: adjust proper range of ampere meter as per load [SLO:GE-10-D-04]:

	connect ampere meter in series to each resistor to measure the current [SLO:GE-10-D-05]: turn on the supply and note the reading of current against each resistor

•	**Operate Volt meter.** Students will be able to: [SLO:GE-10-D-06]: identify the voltmeter amongst other measuring instruments [SLO:GE-10-D-07]: make a series circuit with three different resistors on bread board [SLO:GE-10-D-08]: adjust proper range of volt meter as per load [SLO:GE-10-D-09]: connect volt meter in circuit to take the reading

•	**Operate ohm meter.** Students will be able to: [SLO:GE-10-D-10]: identify the ohm meter amongst other measuring instruments [SLO:GE-10-D-11]: adjust proper range of ohm meter as per resistance value [SLO:GE-10-D-12]: connect ohm meter to a resistor in circuit to take the reading

•	**Operate DMM** Students will be able to: [SLO:GE-10-D-13]: identify the dmm amongst other measuring instruments [SLO:GE-10-D-14]: perform beep(continuity) test by pointing the knob towards alarm sign and connecting the probes together [SLO:GE-10-D-15]: adjust the selection knob for voltage, current and resistance [SLO:GE-10-D-16]: measure values with dmm for above three competency units. insulate joints

Domain E: Verify Ohm's Law & Kirchhoff's Law by Implementing Series/Parallel Circuits.

Standard I: Students will analyze electrical circuits, including constructing and verifying series and parallel circuits, applying Kirchhoff's Voltage and Current Laws, determining resistor values using color codes, applying Ohm's Law to complex circuits and measuring the resistance of Rheostat, Voltmeter and Incandescent lamp.

Grade 9	Grade 10
Benchmark I: Students will measure and note the voltage across each resistor accurately, sum up the voltage values and verify Kirchhoff's Voltage Law (KVL) by confirming if the sum equals the applied voltage, demonstrating a comprehensive understanding of series circuit analysis.	
Student Learning Outcomes **students will be able to:**	

•	**Make series circuit and measure voltage and verify KVL** Students will be able to: [SLO:GE-10-E-01]: construct series circuit with different resistors on bread board and give supply voltage [SLO:GE-10-E-02]: measure the voltage across each resistor [SLO:GE-10-E-03]: note the value of voltage against each resistor [SLO:GE-10-E-04]: sum up the voltage of each resistor and verify KVL(Kirchhoff's Voltage Law) is it equal to applied voltage

•	**Make parallel circuit and measure current and verify KCL** Students will be able to: [SLO:GE-10-E-05]: construct parallel circuit with different resistors on bread board [SLO:GE-10-E-06]: measure the current across each resistor as well as total current [SLO:GE-10-E-07]: take note of the value of current against each resistor [SLO:GE-10-E-08]: sum up the reading of ampere meters and verify, (kirchhoff's current law) is it equal to the total current of circuit

•	**Verify resistance of a resistor Select cable Gauge** Students will be able to: [SLO:GE-10-E-09]: select the resistor of different values [SLO:GE-10-E-10]: determine the value of resistor using color code [SLO:GE-10-E-11]: connect ohm meter across the resistor [SLO:GE-10-E-12]: take note of reading form ohm meter and compare both readings

•	**Find unknown value of ohms law** Students will be able to: [SLO:GE-10-E-13]: construct the complex circuit using different resistors [SLO:GE-10-E-14]: find i, v with proper meter and determine r using ohms law [SLO:GE-10-E-15]: find i, r with proper meter and determine v using ohm law [SLO:GE-10-E-16]: find r, v with proper meter and determine i using ohm law

•	**Measure resistance of Rheostat** Students will be able to: [SLO:GE-10-E-17]: take sliding rheostat of 17 ω and ohmmeter. (0 to 20 or more than 17 ω) which is available [SLO:GE-10-E-18]: check ohm's meter(analogue) for zero error [SLO:GE-10-E-19]: adjust zero with shortenings the ohmmeter leads [SLO:GE-10-E-20]: take reading of rheostat when slide is full placed at end,(whole resistance of rheostat) with the ohmmeter like diagram shown above and record the result [SLO:GE-10-E-21]: repeat these reading when sliding exact in half of rheostat and note this reading

•	**Measure resistance of voltmeter** Students will be able to: [SLO:GE-10-E-22]: take voltmeter of 15, 30 v (d.c) or any range [SLO:GE-10-E-23]: adjust zero error with shortening the ohmmeter leads and record the reading

	Measure resistance of incandescent lamp Students will be able to: [SLO:GE-10-E-24]: adjust zero error with shortening the ohmmeter leads [SLO:GE-10-E-25]: connect the ohmmeter with its terminal and note its resistance [SLO:GE-10-E-26]: measure the resistance of an incandescent lamp(40 w) [SLO:GE-10-E-27]: repeat this method for 60 & 100 w lamp

Domain F: Measure Electrical Power, Energy, Power Factor & Determine Phase Sequence and power Backup

Standard I: Students will adeptly measure single and three-phase power, determine power factors and analyze electrical systems using various instruments. They will also understand the principles of power backup systems.

Grade 9	Grade 10
Benchmark I: Students will demonstrate the measurement of single-phase power by skillfully selecting loads, utilizing Volt-Ampere and Watt meter methods, accurately measuring voltage and current and calculating power, showcasing expertise in electrical power analysis.	
Student Learning Outcomes	

	Measure single phase power using volt-ampere meter method Students will be able to: [SLO:GE-10-F-01]: select a proper load to calculate the power and give supply to it [SLO:GE-10-F-02]: measure the voltage and current by using voltmeter and ampere meter [SLO:GE-10-F-03]: find power using power formula

	Measure single power using watt meter Students will be able to: [SLO:GE-10-F-04]: select a proper load to calculate the power and connect watt meter with it. [SLO:GE-10-F-05]: give supply and measure the reading of power.

	Measure 3 phase power with watt meter Students will be able to: [SLO:GE-10-F-06]: connect current coil of watt meter in series to any phase and one terminal of balance load. [SLO:GE-10-F-07]: connect voltage coil of watt meter to that phase and neutral [SLO:GE-10-F-08]: give 3-phase supply to load and take reading. [SLO:GE-10-F-09]: multiply the reading of watt meter with 3 to get the total power of load.
	Measure power with two-watt meters Students will be able to: [SLO:GE-10-F-10]: connect current coil of 1st watt meter in series to 1st phase and load

	[SLO:GE-10-F-11]: connect voltage coil of 1st watt meter to 1st phase and 3rd phase [SLO:GE-10-F-12]: connect current coil of 2nd watt meter in series to 2nd phase and load [SLO:GE-10-F-13]: connect voltage coil of 2nd watt meter to 2nd phase and 3rd phase [SLO:GE-10-F-14]: give supply and take the readings of both watt meter [SLO:GE-10-F-15]: calculate the total power of load by adding the reading of both watt meter

	Measure power with three-watt meters [SLO:GE-10-F-16]: connect current coil of 1st watt meter in series to 1st phase and load [SLO:GE-10-F-17]: connect voltage coil of 1st watt meter to 1st phase and neutral [SLO:GE-10-F-18]: connect current coil of 2nd watt meter in series to 2nd phase and load [SLO:GE-10-F-19]: connect voltage coil of 2nd watt meter to 2nd phase and 3rd phase [SLO:GE-10-F-20]: give the supply and take the readings of both watt meter [SLO:GE-10-F-21]:

	calculate the total power of load by adding the reading of both watt meters

	Measure consumed energy with Energy meter Students will be able to: [SLO:GE-10-F-22]: connect phase line of ac supply to the left side terminal of energy meter [SLO:GE-10-F-23]: connect neutral line of ac supply to the next input terminal of energy meter [SLO:GE-10-F-24]: connect any ac load to the output terminals of energy meter [SLO:GE-10-F-25]: give supply and take reading of energy in terms of unit after few minutes form display

	Measure power factor with voltmeter, ampere meter and watt meter Students will be able to: [SLO:GE-10-F-26]: connect voltmeter & ampere meter with inductive load (motor) [SLO:GE-10-F-27]: connect watt meter with the load also [SLO:GE-10-F-28]: give ac supply and take the readings of volt, ampere and watt meter [SLO:GE-10-F-29]: utilize the above readings and calculate power factor using power formula p=vi $\cos\phi$

	Measure power factor with power factor meter Students will be able to: [SLO:GE-10-F-30]: connect current coil of power factor meter in series to the load [SLO:GE-10-F-31]: voltage coil of power factor meter in parallel to the load [SLO:GE-10-F-32]: give supply and note the value of power factor form power factor meter

	Improve power factor & measure it with power factor meter Students will be able to: [SLO:GE-10-F-33]: connect ampere meter as well as current coil of power factor meter in series with load [SLO:GE-10-F-34]: connect voltage coil of power factor meter in parallel to the load [SLO:GE-10-F-35]: connect a capacitor bank parallel to load [SLO:GE-10-F-36]: select the small value capacitor with the help of selector switch and give supply and note the value of power factor form power factor meter and current reading form ampere meter [SLO:GE-10-F-37]:

	select the higher value of capacitor from capacitor bank with the help of selector switch and note its effect on power factor and load current
	Determine phase sequence with phase sequence meter. Students will be able to: [SLO:GE-10-F-38]: connect three phase supply with safety switch. [SLO:GE-10-F-39]: connect all three leads of phase sequence meter with safety switch. [SLO:GE-10-F-40]: push the button and observe the direction of small induction motor, which is built-in in equipment. [SLO:GE-10-F-41]: check the rotation of motor disc for correct phase sequence. [SLO:GE-10-F-42]: check the rotation of motor disc for incorrect phase sequence.

	Power Backup Systems Students will be able to:

	[SLO:GE-10-F-43]: identify the importance of power backup systems [SLO:GE-10-F-44]: identify various types of power backup systems [SLO:GE-10-F-45]: select appropriate power backup system as per requirement [SLO:GE-10-F-46]: load calculation for the desired power backup systems [SLO:GE-10-F-47]: identify importance of load calculation for power backup systems [SLO:GE-10-F-48]: identify nature of load (single / three phase) [SLO:GE-10-F-49]: identify sources of power backup system

	[SLO:GE-10-F-50]: explain function of various components of power backup system [SLO:GE-10-F-51]: identify and select tools / materials for installation of power backup system [SLO:GE-10-F-52]: demonstrate installation techniques of the desired power backup system [SLO:GE-10-F-53]: apply procedure for maintaining pv solar system

Domain G: Prepare and Install Distribution Boards for Single Phase.

Standard Y: Students will estimate wiring materials, create basic drawings, perform material estimations and calculate labor costs for electrical installations.

Grade 9	Grade 10
Benchmark I: Students will be able to prepare and install distribution boards to provide protection and load division to wiring and prepare estimates for wiring material.	
Student Learning Outcomes **students will be able to:**	
	Prepare estimate for wiring material Students will be able to: [SLO:GE-10-G-01]: develop basic drawing [SLO:GE-10-G-02]: perform estimation of materials [SLO:GE-10-G-03]: calculate labor cost

	Prepare Distribution Board Students will be able to: [SLO:GE-10-G-04]: select distribution board w.r.t. size, current rating, voltage, no. of c.bs and phases [SLO:GE-10-G-05]: select main incoming residual current circuit breaker (rccb) having minimum sensitivity [SLO:GE-10-G-06]: select outgoing miniature circuit breaker (mcb) according to load [SLO:GE-10-G-07]: provide space for future mcb

	[SLO:GE-10-G-08]: select voltmeter, ampere meter and indicator according to load and phases [SLO:GE-10-G-09]: select wire according to load and for wiring in db [SLO:GE-10-G-10]: make neutral common for all load [SLO:GE-10-G-11]: connect accessories according to the circuit diagram

	Install Distribution Board and wiring Students will be able to: [SLO:GE-10-G-12]: fix the distribution board [SLO:GE-10-G-13]: take wire from db to load without joint [SLO:GE-10-G-14]: distribute load equally on all phases

Domain H: Perform Testing of Electrical Wiring

Standard I: Students will demonstrate proficiency in conducting various electrical tests, including earth leakage, open circuit, short circuit, continuity/loop, visual, insulation, polarity, earth resistance, Murray loop and BLAVIER & Earth Loop tests.

Grade 9	Grade 10

Benchmark I: Students will be able to perform: earth leakage test, open circuit test, short circuit test, continuity/loop test, visual test, insulation test, polarity test, earth resistance test, murray loop test and blavier & earth loop test.
Student Learning Outcomes **Students will be able to:**

	Perform Earth leakage Test. Students will be able to: [SLO:GE-10-H-01]: ensure the socket must be at least 13a for rcd plug in [SLO:GE-10-H-02]: adjust the sensitivity of rcd [SLO:GE-10-H-03]: ensure tripping time must not exceed than 200msec [SLO:GE-10-H-04]: plug the rcd in socket and switch on socket outlet [SLO:GE-10-H-05]: ensure p-n and p-e light up

	[SLO:GE-10-H-06]: press the test button [SLO:GE-10-H-07]: ensure that rcd will trip and reading must be shown less than 200msec [SLO:GE-10-H-08]: move the selection switch to 180o [SLO:GE-10-H-09]: press the test button [SLO:GE-10-H-10]: ensure that rcd will trip and reading must be shown less than 200msec

	[SLO:GE-10-H-11]: move selection switch to 00 [SLO:GE-10-H-01]: press the test button [SLO:GE-10-H-12]: ensure that rcd will trip and reading must be shown less than 200msec

	Perform Open Circuit Test Students will be able to: [SLO:GE-10-H-13]: disconnect the supply source, neutral conductor and earth conductor from distribution fuse box [SLO:GE-10-H-14]: connect ohmmeter between starting and ending terminals of live conductor [SLO:GE-10-H-15]: ensure the reading must be near to 0 ohm [SLO:GE-10-H-16]: repeat p2 to p3 for neutral and earth conductor

	Perform Short Circuit Test Students will be able to: [SLO:GE-10-H-17]: disconnect the supply source, neutral conductor and earth conductor from distribution fuse box [SLO:GE-10-H-18]: connect one terminal of ohmmeter with live conductor [SLO:GE-10-H-19]: connect the other terminals of ohmmeter with neutral conductor [SLO:GE-10-H-20]: ensure the reading must be infinity (no reading) [SLO:GE-10-H-21]: connect ohmmeter between live conductor and earth conductor

	[SLO:GE-10-H-22]: ensure the reading must be infinity (no reading)
	Perform Continuity/Loop Test Students will be able to: [SLO:GE-10-H-23]: connect all metal clad switches, metal parts, conduits with earth [SLO:GE-10-H-24]: open the main switch [SLO:GE-10-H-25]: turn on all the switches [SLO:GE-10-H-26]: connect earth continuity tester with conduit and independent earth [SLO:GE-10-H-27]: measure the resistance value with tester which must not be more than 1 ohm

	Perform Visual Test Students will be able to: [SLO:GE-10-H-28]: check the wires joints [SLO:GE-10-H-29]: check if there is any spark [SLO:GE-10-H-30]: check over heating of wires [SLO:GE-10-H-31]: check all the appliances are on or fluctuating [SLO:GE-10-H-32]: check all indications of meters

	[SLO:GE-10-H-33]: check voltages on all phases [SLO:GE-10-H-34]: check the db and breakers [SLO:GE-10-H-35]: check the main supply is coming properly

	Perform Insulation Test Students will be able to: [SLO:GE-10-H-36]: switch off the main breaker [SLO:GE-10-H-37]: demonstrate skills to short circuit all lighting connections [SLO:GE-10-H-38]: connect merger between line and earth [SLO:GE-10-H-39]: rotate the merger to generate the voltage [SLO:GE-10-H-40]: read the merger dial and ensure that the insulation resistance should not be less than 50m ohm of any single circuit.

	Perform Polarity Test Students will be able to: [SLO:GE-10-H-41]: switch off the main switch [SLO:GE-10-H-42]: disconnect all loads [SLO:GE-10-H-43]: switch on all circuit control switches [SLO:GE-10-H-44]: connect ohm meter between main line and all the terminal of sockets and load points one by one [SLO:GE-10-H-45]: ensure meter reading value must be less than 1 ohm

	Perform earth resistance test Students will be able to: [SLO:GE-10-H-46]: place 3 electrodes in earth at distance of 10m apart between every electrode [SLO:GE-10-H-47]: connect terminal e of earth resistance tester to first electrode [SLO:GE-10-H-48]: connect terminal p of earth resistance tester to the second electrode [SLO:GE-10-H-49]: connect terminal c of the earth resistance tester with third electrode

	[SLO:GE-10-H-50]: measure the resistances after applying specific voltage [SLO:GE-10-H-51]: repeat p1 to p5 by interacting earthling regions [SLO:GE-10-H-52]: ensure 3 readings must be equal

	Perform murray loop test Students will be able to: [SLO:GE-10-H-53]: connect galvanometer with wheatstone bridge [SLO:GE-10-H-54]: connect positive terminal of dc source with wheatstone bridge [SLO:GE-10-H-55]: connect negative terminal of dc source with ground. [SLO:GE-10-H-56]: connect remaining two terminal of wheatstone bridge with two cores of the cable [SLO:GE-10-H-57]:

	short the other end of these two cores of cable [SLO:GE-10-H-58]: note the reading of galvanometer [SLO:GE-10-H-59]: calculate rx [SLO:GE-10-H-60]: repeat the p1 to p7 for other cores of the cable

	Perform BLAVIER & Earth Loop Test Students will be able to: [SLO:GE-10-H-61]: connect galvanometer with Wheatstone bridge [SLO:GE-10-H-62]: connect positive terminal of DC source with Wheatstone bridge [SLO:GE-10-H-63]: connect negative terminal of DC source with ground [SLO:GE-10-H-64]: connect remaining two terminal of Wheatstone bridge with two cores of the cable

	[SLO:GE-10-H-65]: demonstrate skills to short the other end of these two cores of cable [SLO:GE-10-H-66]: note the reading of galvanometer [SLO:GE-10-H-67]: calculate Rx [SLO:GE-10-H-68]: repeat the P1 to P7 for other cores of the cable

Domain I: Repair/ Maintenance of Electrical Installations in Single Phase

Standard I: Students will demonstrate the skills necessary for fault analysis, troubleshooting electrical equipment and conducting preventive maintenance on electrical installations.

Grade 9	Grade 10
Benchmark I Students will be able to visually inspect wiring, fixtures and equipment, draw layouts before disassembly, utilize meters and scopes for fault detection and conduct tests as per manufacturer's specifications. This showcases their ability to identify and rectify electrical faults systematically and efficiently.	
Student Learning Outcomes **students will be able to:**	
	Analyze Fault in Electrical Installations Students will be able to: [SLO:GE-10-I-01]: inspect visually the electrical wiring, fixtures, equipment, soldering, connection, appliances and machinery for discovering the faults and defects [SLO:GE-10-I-02]: check the installation for consistency with the electrical drawing [SLO:GE-10-I-03]:

	draw the layout of equipment's before disassembling of electrical components [SLO:GE-10-I-04]: check the faulty components with scope or meter [SLO:GE-10-I-05]: re assembled the components as per drawing and the installation [SLO:GE-10-I-06]: check the fault indication at relay for HT installation [SLO:GE-10-I-07]: test electrical equipment as specified in the manufacturer's manual and record the results
	Troubleshooting of electrical equipments

	Students will be able to: [SLO:GE-10-I-08]: prepare a list of items/material(s) required for repair /replacement as per specifications [SLO:GE-10-I-09]: draw circuit diagram of electrical equipment be disassembling [SLO:GE-10-I-10]: make necessary adjustments in the control and protective switchgear [SLO:GE-10-I-11]: replace defective control & protective switch gear, cables and accessories with standard items [SLO:GE-10-I-12]:

	replace defective earth electrode & faulty/damaged earthling conductors [SLO:GE-10-I-13]: test installed electrical equipment for safe and optimum performance according to standards & regulations [SLO:GE-10-I-14]: record the results of the test performed on a standard format

	Carry out preventive maintenance Students will be able to: [SLO:GE-10-I-15]: perform preventive maintenance as specified by the manufacturers or sop [SLO:GE-10-I-16]: check out the equipment logging sheet and updates logging [SLO:GE-10-I-17]: update maintenance records as per requirement

Domain J: Repair/ Maintenance and Service of Home Appliance

Standard I: Students will demonstrate the skills to diagnose and repair a variety of home appliances, including electric irons, fans, juicers/grinders and refrigerators/air conditioners, adhering to manufacturer's instructions.

Grade 9	Grade 10
Benchmark I: Students will be able to carry out repair and maintenance of home appliances in accordance with the manufacturer's instructions. Students will diagnose fault and repair electric iron, repair/ maintenance of pedestal fan and ceiling fan, repair/ maintenance of juicer and kitchen and repair/ maintenance refrigerator /air conditioner.	
Student Learning Outcomes **students will be able to:**	

	Diagnose fault and repair electric iron Students will be able to: [SLO:GE-10-J-01]: dismantle the electric iron for internal tests/servicing/repairs according to manufacturer's instructions [SLO:GE-10-J-02]: check the continuity of wire/switch/protective device by using specified test [SLO:GE-10-J-03]: inspect visual mechanical defect such as, loose connection, short circuit, insulation and temperatures [SLO:GE-10-J-04]:\ check the thermostats by using specified test instruments to detect defects

	[SLO:GE-10-J-05]: diagnose the faulty area [SLO:GE-10-J-06]: clean the parts of the iron with specified cleaning material [SLO:GE-10-J-07]: repair/replace the faulty parts of iron as per diagnosed fault [SLO:GE-10-J-08]: reassembled the iron and check iron in test bench as per standard

	Repair/ maintenance of Pedestal Fan and Ceiling Fan Students will be able to: [SLO:GE-10-J-09]: dismantle the fan for internal tests/servicing/repairs according to manufacturer's instructions [SLO:GE-10-J-10]: check the continuity of wire/switch/protective device by using specified test [SLO:GE-10-J-11]: inspect visual mechanical defect such as, loose connection, short circuit, insulation and temperatures [SLO:GE-10-J-12]: check the speed and capacitor [SLO:GE-10-J-13]: check the winding by using specified test instruments to detect defects

	[SLO:GE-10-J-14]: diagnose the faulty parts in pedestal and ceiling fan [SLO:GE-10-J-15]: clean the parts of the fan with specified cleaning material [SLO:GE-10-J-16]: repair/replace the faulty parts of fan as per diagnosed fault [SLO:GE-10-J-17]: demonstrate skills to rewind the winding [SLO:GE-10-J-18]: assembled and test fan as per standard

	Repair/ maintenance of juicer and kitchen Students will be able to: [SLO:GE-10-J-19]: dismantle the juicer/grinder for internal tests/servicing/repairs according to manufacturer's instructions [SLO:GE-10-J-20]: check the continuity of wire/switch/protective device by using specified test [SLO:GE-10-J-21]: inspect visual mechanical defect such as, loose connection, short circuit, insulation and temperatures [SLO:GE-10-J-22]:

	check the winding by using specified test instruments to detect defects [SLO:GE-10-J-23]: diagnose the faulty components [SLO:GE-10-J-24]: clean the parts of the fan with specified cleaning material [SLO:GE-10-J-25]: repair/replace the faulty parts as per diagnosed fault [SLO:GE-10-J-26]: rewind the winding if wind is burnt [SLO:GE-10-J-27]:

	re assembled the juicer/grinder and check juicer in test bench as per standard

	Repair/ maintenance refrigerator /air conditioner Students will be able to: [SLO:GE-10-J-28]: turn off the refrigerator /air conditioner [SLO:GE-10-J-29]: dismantle the refrigerator /air conditioner for internal tests/servicing/repairs according to manufacturer's instructions [SLO:GE-10-J-30]: inspect visual mechanical defect such as, loose connection, short circuit, insulation and check the cooling system of air conditioner [SLO:GE-10-J-31]: check the thermostat glitches

	[SLO:GE-10-J-32]: check the temperature/heat or condenser coil and identify the problems [SLO:GE-10-J-33]: check the helium gas pressure with pressure gauge [SLO:GE-10-J-34]: check the leaking or dirty ducts [SLO:GE-10-J-35]: check the drainage of water [SLO:GE-10-J-36]: replace dirty filters [SLO:GE-10-J-37]:

	check ducts and thermostat with specified test equipment [SLO:GE-10-J-38]: diagnose the faulty components [SLO:GE-10-J-39]: clean the parts of the fan with specified cleaning material [SLO:GE-10-J-40]: repair/replace the faulty parts as per diagnosed fault. [SLO:GE-10-J-41]: demonstrate skills to refill the gas up to required standard (10 to 20 psi) [SLO:GE-10-J-42]:

	before refilling gas create vacuum in compressor or zero gas pressure [SLO:GE-10-J-43]: assembled refrigerator /air conditioner and performed test bench as per standard

General and Industrial electrician
11-12

Progression Grid

Domain A: Operate Oscilloscope

Standard I: Students will demonstrate skills to measure AC voltage, current, frequency, time period, RMS value and average value using an oscilloscope, demonstrating skills such as selecting appropriate settings, calculating actual values and applying relevant formulas.

Grade 11	Grade 12
Benchmark I: Students will be able to demonstrate the skills and knowledge required to Measure AC voltage, current, frequency, time period with oscilloscope, RMS value and average value of AC signal with oscilloscope	
Measure AC voltage with oscilloscope Students will be able to: [SLO:GIE-11-A-01]: • select a proper volt/division and give AC voltage to oscilloscope [SLO:GIE-11-A-02]: • demonstrate skills to read number of divisions between the +ve and -ve peaks of the signal [SLO:GIE-11-A-03]:	

• apply the formula to calculate the actual amplitude of AC voltage.	
Measure current with oscilloscope Students will be able to: [SLO:GIE-11-A-04]: • select the proper load to measure the current [SLO:GIE-11-A-05]: • connect the low value of resistance in series with the load [SLO:GIE-11-A-06]: • connect the oscilloscope across low value of resistor and measure the voltage [SLO:GIE-11-A-07]: • apply ohms law by using value of low value of resistor and voltage across it and find out current	…
Measure frequency of AC signal with oscilloscope Students will be able to: [SLO:GIE-11-A-08]: • select a proper time/division and give AC voltage to oscilloscope	

[SLO:GIE-11-A-09]: • calculate number of divisions between the one AC cycles of the AC signal [SLO:GIE-11-A-10]: • apply the formula to calculate the actual frequency of AC voltage	
Measure time period of AC signal with oscilloscope Students will be able to: [SLO:GIE-11-A-11]: • select a proper time/division and give AC voltage to oscilloscope [SLO:GIE-11-A-12]: • calculate number of divisions between the one AC cycles of the signal [SLO:GIE-11-A-13]: • apply the formula to calculate the actual frequency of AC voltage	
Measure RMS value of AC signal with oscilloscope Students will be able to:	

[SLO:GIE-11-A-14]: • select a proper volt/division and give AC voltage to oscilloscope. [SLO:GIE-11-A-15]: • record number of divisions between the +ve and -ve peaks of the signal. [SLO:GIE-11-A-16]: • apply the formula to calculate Vp-p of AC voltage. [SLO:GIE-11-A-17]: • calculate peak value form Vp-p [SLO:GIE-11-A-18]: • calculate rams value form peak voltage of AC	
Measure average value of AC signal with oscilloscope Students will be able to: [SLO:GIE-11-A-19]: • select a proper volt/division and give AC voltage to oscilloscope. [SLO:GIE-11-A-20]:	

• demonstrate skills to record number of divisions between the +ve and -ve peaks of the signal. [SLO:GIE-11-A-21]: • apply the formula to calculate Vp-p of AC voltage. [SLO:GIE-11-A-22]: • calculate peak value form Vp-p [SLO:GIE-11-A-23]: • calculate average value form peak voltage of AC.	

Standard II: Demonstrate skills to measure voltage, frequency, capacitance and inductance using a CRO, including calibration, waveform interpretation and accurate recording of results.

Grade 11	**Grade 12**
Benchmark I: Students will be able to demonstrate the skills and knowledge required to measure voltage using CRO, measure frequency using CRO, measure capacitance using CRO and measure inductance using CRO. measure voltage, frequency, capacitance & inductance using CRO (Cathode Ray Oscilloscope).	
	[…]

Measure voltage using CRO Students will be able to: [SLO:GIE-11-A-24]: • demonstrate skills to shut off the internal horizontal sweep generator [SLO:GIE-11-A-25]: • calibrate the CRO against known voltage and adjust the vertical gain. [SLO:GIE-11-A-26]: • demonstrate skills to Keep the vertical gain unchanged, apply the unknown voltage to be measured, to the vertical input terminals of the oscilloscope [SLO:GIE-11-A-27]: • measure the length of the vertical line obtained [SLO:GIE-11-A-28]: • calculate the voltage and record the result. [SLO:GIE-11-A-29]: • demonstrate skills to set the trigger button to auto. [SLO:GIE-11-A-30]:	

• adjust the Vertical and horizontal controls to get sine wave clear and stable image. [SLO:GIE-11-A-31]: • take measurements along the center vertical line which has the smallest divisions. [SLO:GIE-11-A-32]: • take Reading of the voltage signal by vertical control]SLO:GIE-11-A-33]: • record the reading.	
Measure frequency using CRO Students will be able to: [SLO:GIE-11-A-34]: • identify the inputs of CRO for frequency (vertical /horizontal) [SLO:GIE-11-A-35]: • adjust various controls as per input frequency [SLO:GIE-11-A-36]: • apply frequency input and read the pattern obtained [SLO:GIE-11-A-37]:	…

• interpret the pattern obtained to calculate frequency [SLO:GIE-11-A-38]: • record the result.	
Measure capacitance using CRO Students will be able to: [SLO:GIE-11-A-39]: • connect 1kohm resistor in series with standard capacitor [SLO:GIE-11-A-40]: • set the function generator to output a 1.9 V amplitude, 100 Hz sine wave. [SLO:GIE-11-A-41]: • set the voltage and frequency. P4. Adjust the vertical scale setting of the oscilloscope to use as much of the display as possible to improve the accuracy of voltage measurements. [SLO:GIE-11-A-42]: • connect probes of oscilloscope across capacitor. [SLO:GIE-11-A-43]:	

• set the oscilloscope to measure the channel 1 frequency, phase between channel 2 and channel 1, channel 1 amplitude and channel 2 amplitude. [SLO:GIE-11-A-44]: • calculate the impedance and capacitance from available data. [SLO:GIE-11-A-45]: • record the result.	
Measure inductance using CRO Students will be able to: [SLO:GIE-11-A-46]: • connect 1kohm resistor in series with standard capacitor [SLO:GIE-11-A-47]: • set the function generator to output a 1.9 V amplitude, 10kHz sine wave. [SLO:GIE-11-A-48]: • set the voltage and frequency. [SLO:GIE-11-A-49]:	

• adjust the vertical scale setting of the oscilloscope to use as much of the display as possible to improve the accuracy of voltage measurements. [SLO:GIE-11-A-50]: • connect probes of oscilloscope across inductor. [SLO:GIE-11-A-51]: • set the oscilloscope to measure the channel 1 frequency, phase between channel 2 and channel 1, channel 1 amplitude and channel 2 amplitude. [SLO:GIE-11-A-52]: • calculate the impedance and inductance from available data. [SLO:GIE-11-A-53]: • record the result.	

Domain B: Identify the Parts and Connection of Energy Meter (Single/3-Phase), Factor(PF) Meter, MDI Meter, Meagre.

Standard I: Identify and connect Energy meters, Power Factor meters, MDI meters and measure insulation resistance using a Meager, demonstrating knowledge of components, connections and accurate recording of measurements.

Grade 11	Grade 12

Benchmark I: Students will be able to demonstrate the skills and knowledge required to identify parts of Energy meter, identify different types of PF meter, its parts and connect it in circuit ,identify and implement MDI meter and measure insulation resistance.	
Identify parts and connection of Energy meter(Single/3-phase) Students will be able to: [SLO:GIE-11-b-01]: • identify the Energy meter(Single/3-phase) [SLO:GIE-11-b-02]: • differentiate between driving, moving, braking and recording system [SLO:GIE-11-b-03]: • identify aluminum disc, series and shunt electromagnet, copper shading ring, magnetic brake, pressure and current coil, permanent magnet and cyclometer [SLO:GIE-11-b-04]: • connect Single Phase Energy meter in a load circuit [SLO:GIE-11-b-05]: • connect 3phase Energy meter in a load circuit [SLO:GIE-11-b-06]: • take the measurements and record.	[…]

Identify different types of PF meter, its parts and connect it in circuit. Students will be able to: [SLO:GIE-11-b-07]: • identify the PF meters (Electrodynamometer type/ Moving Iron type) [SLO:GIE-11-b-08]: • differentiate between pressure coil and current coil [SLO:GIE-11-b-09]: • identify inductive and resistive part of pressure coil in electrodynamometer type PF meter [SLO:GIE-11-b-10]: • connect Single phase PF meter in a load circuit [SLO:GIE-11-b-11]: • connect 3 phase PF meter in a load circuit [SLO:GIE-11-b-12]: • take the measurements and record.	
Identify MDI meter parts and use it on line Students will be able to: [SLO:GIE-11-b-13]:	

• identify the parts of MDI meter [SLO:GIE-11-b-14]: • select the MDI meter according to load. [SLO:GIE-11-b-15]: • identify the connections and insert it on line as per procedure [SLO:GIE-11-b-16]: • demonstrate skills to note down the reading and interpret it.	
Measure insulation resistance by Meager Students will be able to: [SLO:GIE-11-b-17]: • demonstrate skills to isolate the unit under test [SLO:GIE-11-b-18]: • connect the meager with cable of unknown insulation resistance as per standard [SLO:GIE-11-b-19]: • demonstrate skills to Hand crank the meager to generate voltage [SLO:GIE-11-b-20]: • analyze the reading and note it down. [SLO:GIE-11-b-21]:	

• interpret the measurements	

Domain C: Digital Electronics and Microcontrollers

Standard I: Demonstrate skills in verifying Faraday's Law through practical experiments, including moving a permanent magnet inside a coil, moving a coil near a magnetic field, using relative motion of coil and magnet, employing a simple loop generator, confirming torque induction in a current-carrying loop and validating mutual induction.

Grade 11	Grade 12
Benchmark I: Students will be able to demonstrate the skills and knowledge required to verify Faraday's law by moving permanent magnet inside the coil, verify Faraday's law by moving coil near the magnet field, verify Faraday's law using relative motion of coil and magnet, verify Faraday's Law using simple loop generator, verify EMF through induction, verify Torque induce in a current carrying loop and verify Mutual induction.	

Verify Faraday's law by moving permanent magnet inside the coil. Students will be able to: [SLO:GIE-11-C-01]: • construct a coil. [SLO:GIE-11-C-02]: • connect Galvanometer with coil. [SLO:GIE-11-C-03]: • demonstrate skills to move permanent magnet inside the coil fast and slow. [SLO:GIE-11-C-04]: • record the effect of movement of magnet on reading of Galvanometer. [SLO:GIE-11-C-05]: • demonstrate skills to hold the magnet inside the coil and do not move. [SLO:GIE-11-C-06]: • record the effect on reading of Galvanometer again.	

Verify Faraday's law by moving the coil near the magnet field. Students will be able to: [SLO:GIE-11-C-07]: • construct a coil. [SLO:GIE-11-C-08]: • connect Galvanometer with coil. [SLO:GIE-11-C-09]: • fix permanent magnet and move the coil fast and slow on it. [SLO:GIE-11-C-10]: • record the effect of movement of coil on reading of Galvanometer. [SLO:GIE-11-C-11]: • demonstrate skills to Hold the coil near the magnetic field and do not move. [SLO:GIE-11-C-12]: • record the effect on reading of Galvanometer.	

Verify Faraday's law using relative motion of coil and magnet. Students will be able to: [SLO:GIE-11-C-13]: • construct a coil. [SLO:GIE-11-C-14]: • connect Galvanometer with coil. [SLO:GIE-11-C-15]: • make relative motion of coil and magnet. [SLO:GIE-11-C-16]: • record the effect of movement on reading of Galvanometer.	

Verify Faraday's Law using simple loop generator. Students will be able to: [SLO:GIE-11-C-17]: • identify single loop generator and its parts. [SLO:GIE-11-C-18]: • select field winding. [SLO:GIE-11-C-19]: • connect Galvanometer with single loop coil. [SLO:GIE-11-C-20]: • rotate the single loop coil of generator in the field [SLO:GIE-11-C-21]: • measure the voltage induce in loop generator. [SLO:GIE-11-C-22]: • record the effect of movement on reading of Galvanometer.	

Verify Torque induce in a current carrying loop Students will be able to: [SLO:GIE-11-C-23]: • construct a coil. [SLO:GIE-11-C-24]: • apply DC voltage to this coil. [SLO:GIE-11-C-25]: • demonstrate skills to place a current carrying loop in this coil. [SLO:GIE-11-C-26]: • check the direction of force to verify the torque produce.	
Verify Mutual induction Students will be able to: [SLO:GIE-11-C-27]: • construct 2 coils on two different legs of single core. [SLO:GIE-11-C-28]: • apply AC voltage to the any one coil. [SLO:GIE-11-C-29]: • check the volts induce in other coil by voltmeter.	

Standard II: Demonstrate skills in armature winding of DC machines by calculating key terms, developing Single Layer Lap and Double Layer Wave Windings, measuring winding resistances and accurately identifying DC shunt, series and compound generators.

Grade 11	Grade 12
Benchmark I: Students will be able to demonstrate skills to calculate different terms used in armature winding of DC machines, develop Single Layer Lap Winding, develop Double Layer Wave Winding, measure the resistance of field winding, armature winding and terminal polarity, identify DC shunt generator, identify DC series generator and identify DC compound generator	
Calculate different terms used in armature winding of DC machines Students will be able to: [SLO:GIE-11-C-30]: • count the number of slots (S) of armature. [SLO:GIE-11-C-31]: • calculate pole pitch (Y). [SLO:GIE-11-C-32]: • calculate Coil span/pitch. [SLO:GIE-11-C-33]: • calculate Back pitch (Yb) [SLO:GIE-11-C-34]: • calculate Front pitch (Yf) [SLO:GIE-11-C-35]:	[…]

• calculate Resultant Pitch (YR) [SLO:GIE-11-C-36]: • calculate commentator pitch (Yc)	

Develop Single Layer Lap Winding Students will be able to: [SLO:GIE-11-C-37]: • count the number of slot in armature core and numbering on it. [SLO:GIE-11-C-38]: • calculate total number of conductors (Z) [SLO:GIE-11-C-39]: • calculate average pitch, back pitch and commentator pitch. [SLO:GIE-11-C-40]: • demonstrate skills to start winding from slot no 1. [SLO:GIE-11-C-41]: • add the value of back pitch in conductor. [SLO:GIE-11-C-42]: • connect conductor 1 from back side to the added value. [SLO:GIE-11-C-43]: • demonstrate skills to subtract the value of back pitch from the added value. [SLO:GIE-11-C-44]: • connect added value from front side to subtracted value. [SLO:GIE-11-C-45]:	

• continue this process till completion of all conductors. [SLO:GIE-11-C-46]: • insert brushes in proper position.	
Develop Double Layer Wave Winding Students will be able to: [SLO:GIE-11-C-47]: • count the number of slot in armature core and numbering on it. [SLO:GIE-11-C-48]: • calculate total number of conductors (Z) [SLO:GIE-11-C-49]: • calculate average pitch, back pitch and commentator pitch. [SLO:GIE-11-C-50]: • demonstrate skills to start winding from slot no 1. [SLO:GIE-11-C-51]: • add the value of back pitch in conductor. [SLO:GIE-11-C-52]: • connect conductor 1 from back side to the added value. [SLO:GIE-11-C-53]: • add the value of front pitch in previous added value.	

[SLO:GIE-11-C-54]: • continue this process till completion of all conductors. [SLO:GIE-11-C-55]: • connect armature segment with armature conductor. [SLO:GIE-11-C-56]: • insert brushes in proper position.	
Measure the resistance of field winding, armature winding and terminal polarity Students will be able to demonstrate skills to [SLO:GIE-11-C-57]: • open the terminal box. [SLO:GIE-11-C-58]: • connect the ohm meter with the terminal of both winding. [SLO:GIE-11-C-59]: • read down ohm meter reading. [SLO:GIE-11-C-60]: • connect the probe of galvanometer with any terminal and touch other probe to other terminals one by one. [SLO:GIE-11-C-61]:	

• rotate the generator slowly by hand. [SLO:GIE-11-C-62]: • touch the probe of galvanometer with each winding. [SLO:GIE-11-C-63]: • dentify armature with the deflection of galvanometer pointer. [SLO:GIE-11-C-64]: • mark the polarity of terminals with the deflection of galvanometer.	
Identify DC shunt generator Students will be able to demonstrate skills to: [SLO:GIE-11-C-65]: • measure the terminal resistance of generator with ohm meter. [SLO:GIE-11-C-66]: • identify DC shunt generator from measured value of resistance. [SLO:GIE-11-C-67]: • disconnect both windings. [SLO:GIE-11-C-68]:	

• identify the shunt field winding of shunt generator. [SLO:GIE-11-C-69]: • identify armature of shunt generator. [SLO:GIE-11-C-70]: • measure the resistance of both winding separately. [SLO:GIE-11-C-71]: • record the resistance of armature winding and field winding. [SLO:GIE-11-C-72]: • compare the resistance of armature winding and field winding to identify the difference between them.	
Identify DC series generator Students will be able to demonstrate skills to: [SLO:GIE-11-C-73]: • measure the terminal resistance of generator with ohm meter. [SLO:GIE-11-C-74]: • identify DC series generator from measured value of resistance. [SLO:GIE-11-C-75]:	

• disconnect both windings. [SLO:GIE-11-C-76]: • identify the series field winding of series generator. [SLO:GIE-11-C-77]: • identify armature of series generator. • measure the resistance of both winding separately. [SLO:GIE-11-C-78]: • record the resistance of armature winding and field winding. [SLO:GIE-11-C-79]: • compare the resistance of armature winding and field winding to identify the difference between them.	
Identify DC compound generator Students will be able to demonstrate skills to: [SLO:GIE-11-C-80]: • measure the terminal resistance of generator with ohm meter. [SLO:GIE-11-C-81]:	

• identify DC Compound generator from measured value of resistance. [SLO:GIE-11-C-82]: • disconnect both windings. [SLO:GIE-11-C-83]: • identify the series field winding of generator. [SLO:GIE-11-C-84]: • identify the shunt field winding of generator. [SLO:GIE-11-C-85]: • identify armature of shunt generator. [SLO:GIE-11-C-86]: • measure and record the resistance of both winding separately. [SLO:GIE-11-C-87]: • measure and record the resistance of armature winding [SLO:GIE-11-C-88]: • compare the resistance of armature winding, series field winding and shunt field winding to identify the difference between them.	

Domain D: Analog Electronics and Communication

Standard I: Demonstrate skills to plot Open Circuit and Load Characteristics of Separately Excited, Shunt and Series DC Generators, including Compound Generators with under, flat and over compounding. Additionally, perform parallel operation of two DC shunt generators and determine copper, iron and friction losses of a shunt generator under actual loading conditions.

Grade 11	Grade 12
Benchmark I: Students will be able to demonstrate skills to Plot the Open circuit characteristics of a separately excited D.C generator, plot the Open circuit characteristics of a D.C shunt generator, plot the load characteristics of D.C shunt generator, plot the load characteristics of D.C series generator, plot the load characteristics of D.C compound generator for under, flat and over compounding, perform parallel operation of two DC shunt generators and determine copper, iron & friction losses of shunt generator by actual loading.	

Plot the Open circuit characteristics of a Separately excited D.C generator [SLO:GIE-11-D-01]: Students will be able to demonstrate skills to • connect DC supply to field coil through rheostat and ampere meter. [SLO:GIE-11-D-02]: • rotate armature at constant speed. [SLO:GIE-11-D-03]: • connect voltmeter across armature terminal. [SLO:GIE-11-D-04]: • decrease the resistance of rheostat in steps and measure and record the relevant output voltage of armature and field current. [SLO:GIE-11-D-05]: • repeat the P2 to P4 till voltage of armature reach at its saturation point. [SLO:GIE-11-D-06]: • plot the graph between field current and armature voltage from the recorded values.	
Plot the Open circuit characteristics of a D.C shunt generator	

[SLO:GIE-11-D-07]: Students will be able to demonstrate skills to • connect DC supply to field coil through rheostat and ampere meter. [SLO:GIE-11-D-08]: • rotate armature at constant speed. [SLO:GIE-11-D-09]: • connect voltmeter across armature terminal. [SLO:GIE-11-D-10]: • decrease the resistance of rheostat in steps and measure and record the relevant output voltage of armature and field current. [SLO:GIE-11-D-11]: • repeat the P2 to P4 till voltage of armature reach at its saturation point. [SLO:GIE-11-D-12]: • plot the graph between field current and armature voltage from the recorded values.	

plot the load characteristics of d.c shunt generator. students will be able to demonstrate skills to [SLO:GIE-11-D-13]: • select dc shunt generator and connect variable load. [SLO:GIE-11-D-14]: • connect ampere meter and voltmeter across the load. [SLO:GIE-11-D-15]: • rotate armature at constant speed and note the readings of ampere meter and voltmeter. [SLO:GIE-11-D-16]: • increase the load in steps till specific reduce in terminal voltage observed. [SLO:GIE-11-D-17]: • plot the graph between load current and terminal voltage from the recorded values.	

Plot the load characteristics of d.c series generator. Students will be able to demonstrate skills to [SLO:GIE-11-D-18]: • select DC series generator and connect variable load. [SLO:GIE-11-D-19]: • connect ampere meter and voltmeter across the load. [SLO:GIE-11-D-20]: • rotate armature at constant speed and note the readings of ampere meter and voltmeter. [SLO:GIE-11-D-21]: • increase the load in steps till specific reduce in terminal voltage observed. [SLO:GIE-11-D-22]: • plot the graph between load current and terminal voltage from the recorded values. [SLO:GIE-11-D-23]:	

• Plot the load characteristics of D.C compound generator for under, flat and over [SLO:GIE-11-D-24]: • Select DC compound generator and connect variable load. [SLO:GIE-11-D-25]: • Connect ampere meter and voltmeter across the load. [SLO:GIE-11-D-26]: • Rotate armature at constant speed and note the readings of ampere meter and voltmeter. [SLO:GIE-11-D-27]: • Adjust field diverter on zero ohm. [SLO:GIE-11-D-28]: • Increase the load in steps till specific reduce in terminal voltage observed. [SLO:GIE-11-D-29]: • Plot the graph between load current and terminal voltage from the recorded values. [SLO:GIE-11-D-30]: • Such off the load. [SLO:GIE-11-D-31]:	

• Adjust the field diverter at such position that the terminal voltages are equal to no load voltages. [SLO:GIE-11-D-32]: • Increase the load in steps till specific reduce in terminal voltage observed. [SLO:GIE-11-D-33]: • Plot the graph between load current and terminal voltage from the recorded values. [SLO:GIE-11-D-34]: • Such off the load. [SLO:GIE-11-D-35]: • Adjust the field diverter at such position that the terminal voltages are greater than no load voltages. [SLO:GIE-11-D-36]: • Increase the load in steps till specific reduce in terminal voltage observed. [SLO:GIE-11-D-37]: • Plot the graph between load current and terminal voltage from the recorded values.	

Perform parallel operation of two DC shunt generators. Students will be able to demonstrate skills to [SLO:GIE-11-D-38]: • connect the circuit according to the circuit diagram. [SLO:GIE-11-D-39]: • place all switches in off position. [SLO:GIE-11-D-40]: • run generator 1 at rated speed. [SLO:GIE-11-D-41]: • reduce field resistance of generator 1 [SLO:GIE-11-D-42]: • connect generator with bus bar after attaining rated voltage. [SLO:GIE-11-D-43]: • run generator 2 with prime mover. [SLO:GIE-11-D-44]: • reduce the field resistance of generator 2 to attain its rated voltage. [SLO:GIE-11-D-45]: • close th switches for parallel operation. [SLO:GIE-11-D-46]:	

• calculate and record the reading of voltage and current on different loads.	
Determine copper, iron & friction losses of shunt generator by actual loading. Students will be able to demonstrate skills to [SLO:GIE-11-D-47]: • connect ammeter in series with both winding. [SLO:GIE-11-D-48]: • connect voltmeter in parallel with both winding. [SLO:GIE-11-D-49]: • apply 10-20 DC volt. [SLO:GIE-11-D-50]: • record the readings of voltmeter and ammeter. [SLO:GIE-11-D-51]: • calculate Ra and Rsh. [SLO:GIE-11-D-52]: • run the generator at rated speed with prime mover. [SLO:GIE-11-D-53]: • turn on the load switch and record the meter reading. [SLO:GIE-11-D-54]:	

• calculate input power and output power [SLO:GIE-11-D-55]: • calculate total losses (Copper loss, Friction loss, Iron loss)	

Standard II: Identify DC shunt, series and compound motors by measuring terminal resistances, differentiating between armature and field windings and recording and comparing resistance values.

Grade 11	**Grade 12**
Benchmark I: Students will be able to identifies the competencies required to identify DC shunt motor, identify DC series motor and identify DC compound motor.	

Identify DC shunt motor Students will be able to demonstrate skills to: [SLO:GIE-11-D-56]: • measure the terminal resistance of motors with ohm meter. [SLO:GIE-11-D-57]: • identify DC shunt motor from measured value of resistance. [SLO:GIE-11-D-58]: • disconnect both windings. [SLO:GIE-11-D-59]: • identify field winding of shunt motor. [SLO:GIE-11-D-60]: • identify armature of shunt motor. [SLO:GIE-11-D-61]: • measure the resistance of both winding separately. [SLO:GIE-11-D-62]: • record the resistance of armature winding and field winding. [SLO:GIE-11-D-63]:	

• compare the resistance of armature winding and field winding to identify the difference between them.	
identify dc series motor students will be able to demonstrate skills to: [SLO:GIE-11-D-64]: • measure the terminal resistance of dc motors with ohm meter. [SLO:GIE-11-D-65]: • identify dc series motor from measured value of resistance. [SLO:GIE-11-D-66]: • disconnect both windings. [SLO:GIE-11-D-67]: • identify the series field winding of series motor. [SLO:GIE-11-D-68]: • identify armature of series motor. [SLO:GIE-11-D-69]: • measure the resistance of both winding separately. [SLO:GIE-11-D-70]: • record the resistance of armature winding and field winding. [SLO:GIE-11-D-71]:	

• compare the resistance of armature winding and field winding to identify the difference between them.	
identify dc compound motor [SLO:GIE-11-D-72]: • measure the terminal resistance of dc motor with ohm meter. [SLO:GIE-11-D-73]: • identify dc compound motor from measured value of resistance. [SLO:GIE-11-D-74]: • disconnect both windings. [SLO:GIE-11-D-75]: • identify the series field winding of motor. [SLO:GIE-11-D-76]: • identify the shunt field winding of motor. [SLO:GIE-11-D-77]: • identify armature of compound motor. [SLO:GIE-11-D-78]: • measure and record the resistance of both winding separately.	

[SLO:GIE-11-D-79]: • record the resistance of armature winding. [SLO:GIE-11-D-80]: • compare the resistance of armature winding, series field winding and shunt field winding to identify the difference between them	

Domain E: Transformer

Standard I: Identify transformer types, measure transformation ratios, create transformer windings, determine voltage regulation under various loads and perform parallel operation of single-phase transformers with precise understanding of connections and adjustments.

Grade 11	**Grade 12**
Benchmark I: Students will be able to identify types of transformer, measure transformer ratio of single phase transformer, make transformer winding, determine voltage regulation of single phase transformer with different load and perform parallel operation of single phase transformer.	
Identify types of transformer. Students will be able to demonstrate skills to: [SLO:GIE-11-E-01]:	[…]

• identify no of windings on primary and secondary side of transformer. [SLO:GIE-11-E-02]: • identify the types of transformer cores. [SLO:GIE-11-E-03]: • identify connection of the windings. [SLO:GIE-11-E-04]: • separate single phase, three phase and auto transformer.	
Measure transformation ratio of single phase transformer. Students will be able to demonstrate skills to: [SLO:GIE-11-E-05]: • connect volt meters on both side of the transformer. [SLO:GIE-11-E-06]: • apply rated voltage to the primary. [SLO:GIE-11-E-07]: • note the volt meter reading. [SLO:GIE-11-E-08]:	…

• calculate transformation ratio using ratio formula. [SLO:GIE-11-E-09]: • repeat P1 to P4 for different secondary tapping.	
Make transformer winding Students will be able to demonstrate skills to: [SLO:GIE-11-E-09]: • design the core of transformer according to the transformer rating. [SLO:GIE-11-E-10]: • select the wire for primary and secondary winding. [SLO:GIE-11-E-11]: • perform winding according to require turns with the help of winding machine. [SLO:GIE-11-E-12]: • cover the winding with insulating paper. [SLO:GIE-11-E-13]: • adjust the core pieces into the winding. [SLO:GIE-11-E-14]: • remove the insulation of enameled wire.	[SLO 3...]

[SLO:GIE-11-E-15]: • cover the ends of wire with sleeve. [SLO:GIE-11-E-16]: • perform continuity test with ohm meter.	
Determine voltage regulation of single phase transformer with different load Students will be able to demonstrate skills to [SLO:GIE-11-E-17]: • connect watt meter, ampere meter and volt meter to the primary side of transformer. [SLO:GIE-11-E-18]: • connect the voltmeter to secondary side of transformer. [SLO:GIE-11-E-19]: • connect resistive load to secondary side. [SLO:GIE-11-E-20]: • apply rated voltage to primary side of transformer. [SLO:GIE-11-E-21]: • calculate voltage drop and voltage regulations (%) from meter readings.	

[SLO:GIE-11-E-22]: • repeat from P1 to P5 for inductive load. [SLO:GIE-11-E-23]: • repeat from P1 to P5 for capacitive load	
Perform parallel operation of single phase transformer. Students will be able to demonstrate skills to [SLO:GIE-11-E-24]: • identify two transformer having same rated voltage, frequency and transformation ratio. [SLO:GIE-11-E-25]: • mark the terminals with the help of polarity test. [SLO:GIE-11-E-26]: • connect secondary sides of both transformers in parallel. [SLO:GIE-11-E-27]: • connect secondary sides of both transformers with load bus bar having ampere meters between them. [SLO:GIE-11-E-28]: • connect the primary side of both transformers in parallel.	

[SLO:GIE-11-E-29]: • connect primary side of transformer with generation bus bar. [SLO:GIE-11-E-30]: • adjust the ammeter readings to zero by adding inductor and resistor in series with secondary side of the transformer.	

Standard II: Demonstrate skills to perform polarity tests, open circuit tests, short circuit tests on transformers and calculate transformer efficiency using both direct method and back-to-back tests, demonstrating comprehensive knowledge of test setups and calculations.

Grade 11	**Grade 12**
Benchmark I: Students will be able to demonstrate skills to perform polarity test of single phase transformer,perform Open circuit test of transformer, perform Short Circuit Test of Transformer, calculate efficiency of transformer by direct method and calculate efficiency of transformer by Back to Back test	
Perform polarity test of single phase transformer Students will be able to demonstrate skills to: [SLO:GIE-11-E-31]:	[…]

• connect the circuit according to the diagram. [SLO:GIE-11-E-32]: • note the reading of both volt meter. [SLO:GIE-11-E-33]: • identify additive and subtractive polarity. [SLO:GIE-11-E-34]: • mark the terminal according to the additive and subtractive polarity.	
Perform Open circuit test of transformer. Students will be able to demonstrate skills to [SLO:GIE-11-E-35]: connect watt meter, ampere meter and volt meter to the lower voltage side of transformer. [SLO:GIE-11-E-36]: open the high voltage side of transformer. [SLO:GIE-11-E-37]: apply rated voltage to lower voltage side of transformer. [SLO:GIE-11-E-38]: read the instrument/meters reading.	…

[SLO:GIE-11-E-39]: calculate iron losses and excitation branch component (Ro, Xo).	
Perform Short circuit Test of Transformer Students will be able to demonstrate skills to [SLO:GIE-11-E-40]: connect watt meter, ampere meter and volt meter to the higher voltage side of transformer. [SLO:GIE-11-E-41]: connect lower voltage side terminal with each other (Short Circuit) [SLO:GIE-11-E-42]: apply 10 % to 15 % of rated voltage to higher voltage side of transformer. [SLO:GIE-11-E-43]: read the instrument/meters readings. [SLO:GIE-11-E-44]: calculate copper losses and winding component (Ro1, Xo1)	
Calculate efficiency of transformer by direct method Students will be able to demonstrate skills to [SLO:GIE-11-E-45]:	

perform open circuit test. [SLO:GIE-11-E-46]: perform short circuit test. [SLO:GIE-11-E-47]: calculate iron losses and copper losses from above tests. [SLO:GIE-11-E-48]: calculate input power and output power. [SLO:GIE-11-E-49]: calculate efficiency from calculated powers.	
Calculate efficiency of transformer by Back to Back test. Students will be able to demonstrate skills to [SLO:GIE-11-E-50]: identify two transformer of same rating. [SLO:GIE-11-E-51]: connect both transformer in parallel. [SLO:GIE-11-E-52]: connect another variable voltage transformer to secondary side of parallel transformers. [SLO:GIE-11-E-53]: connect a switch, watt meter and ammeter between variable voltage transformer and parallel transformer.	

[SLO:GIE-11-E-54]: connect voltmeter and watt meter to primary side of transformer parallel transformer. [SLO:GIE-11-E-55]: apply rated voltage to the primary side of the parallel transformers. [SLO:GIE-11-E-56]: open the switch. [SLO:GIE-11-E-57]: calculate iron losses. [SLO:GIE-11-E-58]: close the switch [SLO:GIE-11-E-59]: adjust the voltage of variable voltage transformer until the full load current passes from secondary side of parallel transformers. [SLO:GIE-11-E-60]: calculate copper losses. [SLO:GIE-11-E-61]: calculate efficiency from above calculated losses.	

Standard III: Demonstrate skills to identify the connection of an auto transformer and calculate its voltage and current ratios by connecting appropriate meters and applying rated voltage, demonstrating competence in understanding and manipulating auto transformer characteristics.

Grade 11	Grade 12
Benchmark I: Students will be able to demonstrate skills to identify the connection of auto transformer, calculate Voltage ratio of Auto Transformer and calculate Current ratio of Auto Transformer	
Identify the connection of auto transformer Students will be able to demonstrate skills to [SLO:GIE-11-E-62]: connect voltmeters to the both side of the transformer. [SLO:GIE-11-E-63]: apply rated voltage to the primary side. [SLO:GIE-11-E-64]: identify the lower voltage and higher voltage side with the help of volt meter reading. [SLO:GIE-11-E-65]: identify step up and step down transformer.	
Calculate Voltage ratio of Auto Transformer Students will be able to demonstrate skills to [SLO:GIE-11-E-66]: connect voltmeters to the both side of the transformer.	…

[SLO:GIE-11-E-67]: apply rated voltage to the primary side. [SLO:GIE-11-E-68]: read the voltmeters reading. [SLO:GIE-11-E-69]: calculate voltage ratio with the help of voltmeters reading.	
Calculate Current ratio of Auto Transformer Students will be able to demonstrate skills to [SLO:GIE-11-E-70]: connect ammeters to the both side of the transformer. [SLO:GIE-11-E-71]: connect a resistive load to secondary side of the transformer. [SLO:GIE-11-E-72]: apply rated voltage to the primary side. [SLO:GIE-11-E-73]: read the ammeters reading. [SLO:GIE-11-E-74]: calculate current ratio with the help of ammeters reading.	

Standard IV: Demonstrate skills to perform open circuit and short circuit tests on an auto transformer and calculate its efficiency using measured losses and powers, showcasing comprehensive understanding and application of testing methodologies.

Grade 11	Grade 12
Benchmark I: Students will be able to demonstrate skills to perform open circuit Test of auto transformer, perform short circuit test of auto transformer and calculate efficiency of auto transformer.	
Perform open circuit Test of auto transformer Students will be able to demonstrate skills to: [SLO:GIE-11-E-75]: connect watt meter, ampere meter and volt meter to the lower voltage side of transformer. [SLO:GIE-11-E-76]: open the high voltage side of transformer. [SLO:GIE-11-E-77]: apply rated voltage to lower voltage side of transformer. [SLO:GIE-11-E-78]: read the instrument/meters reading. [SLO:GIE-11-E-79]: calculate iron losses and excitation branch component (Ro, Xo).	
Perform short circuit test of auto transformer Students will be able to demonstrate skills to [SLO:GIE-11-E-80]:	…

connect watt meter, ampere meter and volt meter to the higher voltage side of transformer. [SLO:GIE-11-E-81]: connect lower voltage side terminal with each other (short circuit) [SLO:GIE-11-E-82]: apply 10 % to 15 % of rated voltage to higher voltage side of transformer. [SLO:GIE-11-E-83]: read the instrument/meters readings. [SLO:GIE-11-E-84]: calculate copper losses and winding component (Ro1, Xo1).	
Calculate efficiency of auto transformer. Students will be able to demonstrate skills to: [SLO:GIE-11-E-85]: perform open circuit test. [SLO:GIE-11-E-86]: perform short circuit test. [SLO:GIE-11-E-87]: calculate iron losses and copper losses from above tests. [SLO:GIE-11-E-88]: calculate input power and output power.	

[SLO:GIE-11-E-89]: calculate efficiency from calculated powers.	

Standard V: Demonstrate skills to make, connect and perform various configurations of three-phase transformers, including winding, star-delta connections, delta-star connections, delta-delta connections, delta-star connections, open delta connections and parallel operations, demonstrating comprehensive knowledge of design, connection and operation principles.

Grade 11	**Grade 12**
Benchmark I: Students will be able to demonstrate skills to make three phase transformer winding, perform star to star connection of three phase transformer, perform star to delta connection of three phase transformer, perform delta to delta connection of three phase transformer, perform delta to star connection of three phase transformer, connect two single phase transformers in open delta and perform parallel operation of 3 phase transformers.	
Student Learning Outcomes	
Make Three Phase Transformer Winding. Students will be able to demonstrate skills to: [SLO:GIE-11-E-90]: design the core of transformer according to the transformer rating. [SLO:GIE-11-E-91]: select the connection of primary and secondary. [SLO:GIE-11-E-92]:	

select the wire for primary and secondary winding. [SLO:GIE-11-E-93]: perform winding according to require turns with the help of winding machine. [SLO:GIE-11-E-94]: cover the winding with insulating paper. [SLO:GIE-11-E-95]: adjust the core pieces into the winding. [SLO:GIE-11-E-96]: remove the insulation of enameled wire. [SLO:GIE-11-E-97]: cover the ends of wire with sleeve. [SLO:GIE-11-E-98]: connect the winding terminals in star or delta. [SLO:GIE-11-E-99]: perform continuity test with ohm meter.	
Perform Star To Star Connection Of Three Phase Transformer. Students will be able to demonstrate skills to: [SLO:GIE-11-E-100]: select three same rated single phase transformers.	…

[SLO:GIE-11-E-101]: mark the polarity of the winding terminals. [SLO:GIE-11-E-102]: connect primary terminals and secondary terminals in star. [SLO:GIE-11-E-103]; connect voltmeters with primary and secondary. [SLO:GIE-11-E-104]: apply rated voltage to the primary. [SLO:GIE-11-E-105]: calculate and verify line voltage and phase voltage	
Perform Star To Delta Connection Of Three Phase Transformer Students will be able to demonstrate skills to: [SLO:GIE-11-E-106]: select three same rated single phase transformers. [SLO:GIE-11-E-107]: mark the polarity of the winding terminals. [SLO:GIE-11-E-108]: connect primary terminals in star and secondary terminals in delta. [SLO:GIE-11-E-109]:	

connect voltmeters with primary and secondary. [SLO:GIE-11-E-110]; apply rated voltage to the primary. [SLO:GIE-11-E-111]: calculate and verify line voltage and phase voltage	
Perform Delta To Delta Connection Of Three Phase Transformer Students will be able to demonstrate skills to: [SLO:GIE-11-E-112]: select three same rated single phase transformers. [SLO:GIE-11-E-113]: mark the polarity of the winding terminals. [SLO:GIE-11-E-114]: connect primary terminals and secondary terminals in delta. [SLO:GIE-11-E-115]: connect voltmeters with primary and secondary. [SLO:GIE-11-E-116]: apply rated voltage to the primary. [SLO:GIE-11-E-117]: calculate and verify line voltage and phase voltage	

Perform Delta To Star Connection Of Three Phase Transformer Students will be able to demonstrate skills to: [SLO:GIE-11-E-118]: select three same rated single phase transformers. [SLO:GIE-11-E-119]: mark the polarity of the winding terminals. [SLO:GIE-11-E-120]: connect primary terminals in delta and secondary terminals in star. [SLO:GIE-11-E-121]: connect voltmeters with primary and secondary. [SLO:GIE-11-E-122]: apply rated voltage to the primary. [SLO:GIE-11-E-123]: calculate and verify line voltage and phase voltage.	
Connect two single phase transformers in open delta. students will be able to demonstrate skills to: [SLO:GIE-11-E-124]: select two same rated single phase transformers. [SLO:GIE-11-E-125]:	

mark the polarity of the winding terminals. [SLO:GIE-11-E-126]: connect opposite terminals of primary winding of both transformers [SLO:GIE-11-E-127]: take out connected terminals and other two terminals. [SLO:GIE-11-E-128]: repeat p2 to p4 of cu6 for secondary side of transformer. [SLO:GIE-11-E-129]: connect voltmeters with primary and secondary sides of transformers. [SLO:GIE-11-E-130]: apply rated voltage to the primary. [SLO:GIE-11-E-131]: calculate and verify line voltage and phase voltage.	
Perform parallel operation of 3 phase transformers. Students will be able to demonstrate skills to: [SLO:GIE-11-E-132]: identify two three phase transformer having same rated voltage, frequency and transformation ratio.	

[SLO:GIE-11-E-133]: connect the primary of each transformer in star connection. [SLO:GIE-11-E-134]: connect the secondary of each transformer in delta connection. [SLO:GIE-11-E-135]: connect secondary sides of both transformers in parallel. [SLO:GIE-11-E-136]: connect secondary sides of both transformers with load bus bar having indicator between them. [SLO:GIE-11-E-137]: connect the primary side of both transformers in parallel. [SLO:GIE-11-E-138]: connect primary side of transformer with generation bus bar. [SLO:GIE-11-E-139]: adjust the series resistance and series inductance to off the indicator.	

Domain F: Electrical Wiring

Standard I: Demonstrate skills in various 3-phase motor connections, including Reverse/Forward, Star/Delta (Manual and Auto) and 2-speed configurations, with and without indicators, using magnetic contactors.

Grade 11	Grade 12
Benchmark I: Students will be able to demonstrate skills and knowledge required to Make and Install 3 phase motor connection Reverse/ forward by Magnetic contactor, Make and Install 3 phase motor connection Reverse/ forward by Magnetic contactor with indicator, Make and Install 3 phase motor connection Star/Delta (Manual) by Magnetic contactor, Make and Install 3 phase motor connection Star/Delta (Manual) by Magnetic contactor with indicator, Make and Install 3 phase motor connection Star/Delta (Auto) by Magnetic contactor, Make and Install 3 phase motor connection Star/Delta (Auto) by Magnetic contactor with indicator, Make and Install 3 phase motor connection 2 speed by Magnetic contactor, Make and Install 3 phase motor connection 2 speed by Magnetic contactor with indicator.	
Student Learning Outcomes	
	Make and Install 3 phase motor connection Reverse/ forward by Magnetic contactor. Students will be able to demonstrate skills to:

	[SLO:GIE-12-F-01]: draw power diagram of circuit. [SLO:GIE-12-F-02]: draw control diagram of circuit. [SLO:GIE-12-F-03]: draw installation diagram of circuit. [SLO:GIE-12-F-04]: mark on exercise board according to installation/layout diagram. [SLO:GIE-12-F-05]: install accessories according to layout diagram. [SLO:GIE-12-F-06]: lay wires in duct/pipe according to layout diagram. [SLO:GIE-12-F-07]: make connections according to wiring diagram. [SLO:GIE-12-F-08]: check the circuit before connect the main supply. [SLO:GIE-12-F-09]: make connection with main supply. [SLO:GIE-12-F-10]: check the function of circuit after connect the main supply

	make and install 3 phase motor connection reverse/ forward by magnetic contactor with indicator. Students will be able to demonstrate skills to: [SLO:GIE-12-F-11]: draw power diagram of circuit. [SLO:GIE-12-F-12]: draw control diagram of circuit. [SLO:GIE-12-F-13]: draw installation diagram of circuit. [SLO:GIE-12-F-14]: mark on exercise board according to installation/layout diagram. [SLO:GIE-12-F-15]: install accessories according to layout diagram. [SLO:GIE-12-F-16]: lay wires in duct/pipe according to layout diagram. [SLO:GIE-12-F-17]: make connections according to wiring diagram. [SLO:GIE-12-F-18]: check the circuit before connect the main supply. [SLO:GIE-12-F-19]: make connection with main supply. [SLO:GIE-12-F-20]: check the function of circuit after connect the main supply

	[SLO:GIE-12-F-21]: make and install 3 phase motor connection star/delta (manual) by magnetic contactor. [SLO:GIE-12-F-22]: draw power diagram of circuit. [SLO:GIE-12-F-23]: draw control diagram of circuit. [SLO:GIE-12-F-24]: draw installation diagram of circuit. [SLO:GIE-12-F-25]: mark on exercise board according to installation/layout diagram. [SLO:GIE-12-F-26]: install accessories according to layout diagram. [SLO:GIE-12-F-27]: lay wires in duct/pipe according to layout diagram. [SLO:GIE-12-F-28]: make connections according to wiring diagram. [SLO:GIE-12-F-29]: check the circuit before connect the main supply. [SLO:GIE-12-F-30]: make connection with main supply. [SLO:GIE-12-F-31]: check the function of circuit after connect the main supply

	Make and Install 3 phase motor connection Star/Delta (Manual) by Magnetic contactor with indicator. Students will be able to demonstrate skills to: [SLO:GIE-12-F-32]: draw power diagram of circuit. [SLO:GIE-12-F-33]: draw control diagram of circuit. [SLO:GIE-12-F-34]: draw installation diagram of circuit. [SLO:GIE-12-F-35]: mark on exercise board according to installation/layout diagram. [SLO:GIE-12-F-36]: install accessories according to layout diagram. [SLO:GIE-12-F-37]: lay wires in duct/pipe according to layout diagram. [SLO:GIE-12-F-38]: make connections according to wiring diagram. [SLO:GIE-12-F-39]: check the circuit before connect the main supply. [SLO:GIE-12-F-40]: make connection with main supply. [SLO:GIE-12-F-41]: check the function of circuit after connect the main supply

	make and install 3 phase motor connection star/delta (auto) by magnetic contactor. students will be able to demonstrate skills to: [SLO:GIE-12-F-42]: draw power diagram of circuit. [SLO:GIE-12-F-43]: draw control diagram of circuit. [SLO:GIE-12-F-44]: draw installation diagram of circuit. [SLO:GIE-12-F-45]: mark on exercise board according to installation/layout diagram. [SLO:GIE-12-F-46]: install accessories according to layout diagram. [SLO:GIE-12-F-47]: lay wires in duct/pipe according to layout diagram. [SLO:GIE-12-F-48]: make connections according to wiring diagram. [SLO:GIE-12-F-49]: check the circuit before connect the main supply. [SLO:GIE-12-F-50]: make connection with main supply. [SLO:GIE-12-F-51]: check the function of circuit after connect the main supply
	Make and install 3 phase motor connection star/delta (auto) by magnetic contactor with indicator

	Students will be able to demonstrate skills to: [SLO:GIE-12-F-52]: draw power diagram of circuit. [SLO:GIE-12-F-53]: draw control diagram of circuit. [SLO:GIE-12-F-54]: draw installation diagram of circuit. [SLO:GIE-12-F-55]: mark on exercise board according to installation/layout diagram. [SLO:GIE-12-F-56]: install accessories according to layout diagram. [SLO:GIE-12-F-57]: lay wires in duct/pipe according to layout diagram. [SLO:GIE-12-F-58]: make connections according to wiring diagram. [SLO:GIE-12-F-59]: check the circuit before connect the main supply. [SLO:GIE-12-F-60]: make connection with main supply. [SLO:GIE-12-F-61]: check the function of circuit after connect the main supply
	Make and install 3 phase motor connection 2 speed by magnetic contactor.

	students will be able to demonstrate skills to: [SLO:GIE-12-F-62]: draw power diagram of circuit. [SLO:GIE-12-F-63]: draw control diagram of circuit. [SLO:GIE-12-F-64]: draw installation diagram of circuit. [SLO:GIE-12-F-65]: mark on exercise board according to installation/layout diagram. [SLO:GIE-12-F-66]: install accessories according to layout diagram. [SLO:GIE-12-F-67]: lay wires in duct/pipe according to layout diagram. [SLO:GIE-12-F-68]: make connections according to wiring diagram. [SLO:GIE-12-F-69]: check the circuit before connect the main supply. [SLO:GIE-12-F-70]: make connection with main supply. [SLO:GIE-12-F-71]: check the function of circuit after connect the main supply
	Make and install 3 phase motor connection 2 speed by magnetic contactor with indicator Students will be able to demonstrate skills to:

	[SLO:GIE-12-F-72]: draw power diagram of circuit. [SLO:GIE-12-F-73]: draw control diagram of circuit. [SLO:GIE-12-F-74]: draw installation diagram of circuit. [SLO:GIE-12-F-75]: mark on exercise board according to installation/layout diagram. [SLO:GIE-12-F-76]: install accessories according to layout diagram. [SLO:GIE-12-F-77]: lay wires in duct/pipe according to layout diagram. [SLO:GIE-12-F-78]: make connections according to wiring diagram. [SLO:GIE-12-F-79]: check the circuit before connect the main supply [SLO:GIE-12-F-80]: make connection with main supply. [SLO:GIE-12-F-81]: check the function of circuit after connect the main supply.
	Perform electrical work in industrial area. Students will be able to demonstrate skills to: [SLO:GIE-12-F-82]: install wire for grounding

	[SLO:GIE-12-F-8]: perform pre installation module based tests [SLO:GIE-12-F-84]: perform integrated tests. [SLO:GIE-12-F-85]: install conduits or trunks in the building as per drawing [SLO:GIE-12-F-86]: install electrical wiring, as per drawing and standard. [SLO:GIE-12-F-87]: install centralize lighting, heating, cooling system and other appliances [SLO:GIE-12-F-88]: install main box and distribution box. [SLO:GIE-12-F-89]: install electric breakers and switch gears in main box, as per load for safety measures [SLO:GIE-12-F-90]: install fire alarm and smoke detector system [SLO:GIE-12-F-91]: install the appliances used in electric work as per drawing [SLO:GIE-12-F-92]: install emergency light system in main box, as per standard color scheme [SLO:GIE-12-F-93]: install main distribution board. [SLO:GIE-12-F-94]:

	test and certify the installed system.

Standard II: The long-term learning goals and understandings for a particular lesson, chapter or the whole course.

Grade 11	**Grade 12**
Benchmark I: Students will be able to demonstrate skills and knowledge required to perform earth leakage test, perform open circuit test, perform short circuit test, perform continuity/loop test, perform visual test, perform insulation test, perform polarity test, perform earth resistance test, perform Murray loop test and perform Blavier & earth loop test	
Student Learning Outcomes	

	Perform Earth leakage Test. Students will be able to demonstrate skills to:

	[SLO:GIE-12-F-95]: ensure the socket must be at least 13A for RCD plug in. [SLO:GIE-12-F-96]: adjust the sensitivity of RCD. [SLO:GIE-12-F-97]: ensure tripping time must not exceed than 200msec. [SLO:GIE-12-F-98]: plug the RCD in socket and switch on socket outlet. [SLO:GIE-12-F-99]: ensure P-N and P-E light up. [SLO:GIE-12-F-100]: press the test button. SLO:GIE-12-F-101]: nsure that RCD will trip and reading must be shown less than 200msec. SLO:GIE-12-F-102]: move the selection switch to 180o. SLO:GIE-12-F-103]: press the test button. SLO:GIE-12-F-104]: ensure that RCD will trip and reading must be shown less than 200msec. SLO:GIE-12-F-105]: move selection switch to 00. SLO:GIE-12-F-106]: press the test button.

	SLO:GIE-12-F-107]: ensure that RCD will trip and reading must be shown less than 200msec.
	Perform Open Circuit Test Students will be able to demonstrate skills to: [SLO:GIE-12-F-108]: disconnect the supply source, neutral conductor and earth conductor from distribution fuse box. [SLO:GIE-12-F-109]: connect ohmmeter between starting and ending terminals of live conductor. [SLO:GIE-12-F-110]: ensure the reading must be near to 0 ohm. [SLO:GIE-12-F-111]: repeat P2 to P3 for neutral and earth conductor.
	Perform short circuit test students will be able to demonstrate skills to:

	[SLO:GIE-12-F-112]: disconnect the supply source, neutral conductor and earth conductor from distribution fuse box. [SLO:GIE-12-F-113]: connect one terminal of ohmmeter with live conductor. [SLO:GIE-12-F-114]: connect the other terminals of ohmmeter with neutral conductor. [SLO:GIE-12-F-115]: ensure the reading must be infinity (no reading). [SLO:GIE-12-F-116]: connect ohmmeter between live conductor and earth conductor. [SLO:GIE-12-F-117]: ensure the reading must be infinity (no reading)
	Perform continuity/loop test Students will be able to demonstrate skills to: [SLO:GIE-12-F-118]: connect all metal clad switches, metal parts, conduits with earth. [SLO:GIE-12-F-119]: open the main switch. [SLO:GIE-12-F-120]: turn on all the switches. [SLO:GIE-12-F-121]: connect earth continuity tester with conduit and independent earth.

	[SLO:GIE-12-F-122]: measure the resistance value with tester which must not be more than 1 ohm.
	perform visual test students will be able to demonstrate skills to: [SLO:GIE-12-F-123]: check the wires joints. [SLO:GIE-12-F-124]: check if there is any spark. [SLO:GIE-12-F-125]: check over heating of wires. [SLO:GIE-12-F-126]: check all the appliances are on or fluctuating. [SLO:GIE-12-F-127]: check all indications of meters. [SLO:GIE-12-F-128]: check voltages on all phases. [SLO:GIE-12-F-129]: check the db and breakers. [SLO:GIE-12-F-130]: check the main supply is coming properly.
	Perform insulation test

	Students will be able to demonstrate skills to: [SLO:GIE-12-F-131]: switch off the main breaker. [SLO:GIE-12-F-132]: short circuit all lighting connections. [SLO:GIE-12-F-133]: connect merger between line and earth. [SLO:GIE-12-F-134]: rotate the merger to generate the voltage. [SLO:GIE-12-F-135]: read the merger dial and ensure that the insulation resistance should not be less than 50m ohm of any single circuit.
	Perform polarity test Students will be able to demonstrate skills to: [SLO:GIE-12-F-136]: switch off the main switch. [SLO:GIE-12-F-137]: disconnect all loads. [SLO:GIE-12-F-138]: switch on all circuit control switches. [SLO:GIE-12-F-139]: connect ohm meter between main line and all the terminal of sockets and load points one by one.

	[SLO:GIE-12-F-140]: ensure meter reading value must be less than 1 ohm.
	Perform Earth Resistance Test Students will be able to demonstrate skills to: [SLO:GIE-12-F-141]: place 3 electrodes in earth at distance of 10m apart between every electrode. [SLO:GIE-12-F-142]: connect terminal E of earth resistance tester to first electrode. [SLO:GIE-12-F-143]: connect terminal P of earth resistance tester to the second electrode. [SLO:GIE-12-F-144]: connect terminal C of the earth resistance tester with third electrode. [SLO:GIE-12-F-145]: measure the resistances after applying specific voltage. [SLO:GIE-12-F-146]: repeat P1 to P5 by interacting earthling regions. [SLO:GIE-12-F-147]: ensure 3 readings must be equal.

	Perform Murray Loop Test Students will be able to demonstrate skills to: [SLO:GIE-12-F-148]: connect galvanometer with wheatstone bridge. [SLO:GIE-12-F-149]: connect positive terminal of DC source with wheatstone bridge. [SLO:GIE-12-F-150]: connect negative terminal of DC source with ground. [SLO:GIE-12-F-151]: connect remaining two terminal of wheatstone bridge with two cores of the cable. [SLO:GIE-12-F-152]: short the other end of these two cores of cable. [SLO:GIE-12-F-153]: note the reading of galvanometer. [SLO:GIE-12-F-154]: calculate RX. [SLO:GIE-12-F-155]: repeat the P1 to P7 for other cores of the cable
	Perform BLAVIER & Earth Loop Test Students will be able to demonstrate skills to: [SLO:GIE-12-F-156]: connect galvanometer with Wheatstone bridge.

	[SLO:GIE-12-F-157]: connect positive terminal of DC source with Wheatstone bridge. [SLO:GIE-12-F-158]: connect negative terminal of DC source with ground. [SLO:GIE-12-F-159]: connect remaining two terminal of Wheatstone bridge with two cores of the cable. [SLO:GIE-12-F-160]: short the other end of these two cores of cable. [SLO:GIE-12-F-161]: note the reading of galvanometer. [SLO:GIE-12-F-162]: calculate Rx. [SLO:GIE-12-F-163]: repeat the P1 to P7 for other cores of the cable.

Standard III: Analyze and repair electrical faults in installations by visually inspecting, drawing layouts, checking components and conducting tests in accordance with manufacturer's instructions and organizational requirements.

Grade 11	**Grade 12**
Benchmark I: Students will be able to demonstrate the competencies required to analyze fault in electrical installations, troubleshooting of electrical equipment's and carry out preventive maintenance. They will also carry out repair and maintenance of electrical installations at workplace in accordance with the manufacturer's instructions and organizational requirements	
Student Learning Outcomes	

	Analyze Fault in Electrical Installations **Students will be able to demonstrate skills to:** [SLO:GIE-12-F-164]: inspect visually the electrical wiring, fixtures, equipment, soldering, connection, appliances and machinery for discovering the faults and defects [SLO:GIE-12-F-165]: check the installation for consistency with the electrical drawing [SLO:GIE-12-F-166]: draw the layout of equipment's before disassembling of electrical components [SLO:GIE-12-F-167]: check the faulty components with scope or meter [SLO:GIE-12-F-168]: re assembled the components as per drawing and the installation [SLO:GIE-12-F-169]: check the fault indication at relay for HT installation [SLO:GIE-12-F-170]: test electrical equipment as specified in the manufacturer’s manual and record the results
	Repair Fault in Electrical Installations Students will be able to demonstrate skills to:

	[SLO:GIE-12-F-171]: prepare a list of items/material(s) required for repair /replacement as per specifications [SLO:GIE-12-F-172]: draw circuit diagram of electrical equipment's be disassembling [SLO:GIE-12-F-173]: make necessary adjustments in the control and protective switchgear [SLO:GIE-12-F-174]: replace defective control & protective switch gear, cables and accessories with standard items

Domain G: Carry Out Manual Electrical Planning and Estimation

Standard I: Analyze customer requirements, plan and estimate electrical work for domestic, commercial and industrial settings, considering safety, energy efficiency and global trends.

Grade 11	**Grade 12**
Benchmark I: Students will be able to demonstrate competencies required to analyze customer requirement and specification, Plan and estimate domestic electric work, Plan and estimate commercial electric work and Plan and estimate industrial electric work	
Student Learning Outcomes	

	Analyze customer requirement and specification Students will be able to demonstrate skills to: [SLO:GIE-12-G-01]: draw the general value chain of the end user. [SLO:GIE-12-G-02]: highlight the various stages and set of activities in the value chain drawing [SLO:GIE-12-G-03]: enlist the electrical appliances/materials required in electrical development process [SLO:GIE-12-G-04]: identify critical stages in the development [SLO:GIE-12-G-05]: identify the safety aspect required in the critical stages of the development [SLO:GIE-12-G-06]: enlist the possible energy efficient appliance/devices and global trends in electrical works [SLO:GIE-12-G-07]: analyse the client requirement at broad level. [SLO:GIE-12-G-08: generate a report of various stages of electrical works.

	[SLO:GIE-12-G-09]: proposed appliance/materials as per global trends and clarify the technical specification.
[	**Plan and estimate domestic electric work** Students will be able to demonstrate skills to: [SLO:GIE-12-G-10]: plan the client requirement at broad level from the proposal.

	[SLO:GIE-12-G-11]: plan the electrical appliances/materials / used in different stages of the electrical development process [SLO:GIE-12-G-12]: plan and estimate electrical wiring [SLO:GIE-12-G-13]: estimate installation and material cost [SLO:GIE-12-G-14]: estimate power consumption for lighting and appliances [SLO:GIE-12-G-15]: plan a main and sub distribution board. [SLO:GIE-12-G-16]: ensure safety system.
	Plan and estimate commercial electric work. Students will be able to demonstrate skills to: [SLO:GIE-12-G-17]: analyze the client requirement at broad level from the proposal. [SLO:GIE-12-G-18]: plan the electrical equipment /appliances/materials / used in different stages of the commercial electrical work [SLO:GIE-12-G-19]: plan and estimate electrical wiring [SLO:GIE-12-G-20]: estimate installation and material cost

	[SLO:GIE-12-G-21]:]: estimate power consumption for centralize lighting, heating, cooling system and other appliances. [SLO:GIE-12-G-22]: plan a main and sub distribution board. SLO:GIE-12-G-23]: ensure safety measures in development process. [SLO:GIE-12-G-24]: enlist the material required.
	Plan and estimate industrial electric work. Students will be able to demonstrate skills to: [SLO:GIE-12-G-25]: analyze the client requirement at broad level from the proposal. [SLO:GIE-12-G-26]: plan the electrical equipment /appliances/materials / used in different stages of the commercial electrical work [SLO:GIE-12-G-27]: plan and estimate electrical wiring [SLO:GIE-12-G-28]: estimate installation and material cost

	[SLO:GIE-12-G-29]: estimate power consumption for centralize lighting, heating, cooling system and other appliances. [SLO:GIE-12-G-30]: plan 3-phase line for heavy loads [SLO:GIE-12-G-31]: plan a separate control panel box for heavy machinery. [SLO:GIE-12-G-32]: plan a main and sub distribution board. [SLO:GIE-12-G-33]: design a safety system for protection of machinery and labor. [SLO:GIE-12-G-34]: assign color scheme for safety measures

Domain H: Analyze Single Phase, three phase and special purpose Motors

Standard I: Demonstrate skills to operate and control single-phase AC motors, including split phase, capacitor start/run and shaded pole types; construct and operate stepper and servo motors; operate 3-phase squirrel cage motors with different starters; measure motor performance; draw torque-slip curves; assess efficiency; start and control synchronous motors, understanding the impact of field current on three-phase synchronous motors.

Grade 11	Grade 12

Benchmark I: Students will be able to demonstrate skills in operating and controlling various single-phase AC motors, including split phase, capacitor start/run and shaded pole motors, as well as miniature motors; construct and operate stepper and servo motors; operate 3-phase squirrel cage motors with different starters; measure motor performance parameters, draw torque-slip curves and assess efficiency; and start and control synchronous motors with an understanding of the impact of field current on three-phase synchronous motors.	
Student Learning Outcomes	
	Operate split phase single phase AC motor. Students will be able to demonstrate skills to: [SLO:GIE-12-H-01]: make connections according to circuit diagram. [SLO:GIE-12-H-02]: apply rated voltage to the stator. [SLO:GIE-12-H-03]: measure RPM and direction of rotation. [SLO:GIE-12-H-04]: disconnect the auxiliary winding from centrifugal switch. [SLO:GIE-12-H-05]: check the effect of this change.
	Operate capacitor start and Capacitor run single phase AC motor. Students will be able to demonstrate skills to: [SLO:GIE-12-H-06]: make connections according to circuit diagram.

	[SLO:GIE-12-H-07]: apply rated voltage to the stator. [SLO:GIE-12-H-08]: measure the RPM. [SLO:GIE-12-H-09]: remove the starting capacitor with centrifugal switch. [SLO:GIE-12-H-10]: measure the RPM again. [SLO:GIE-12-H-11]: check the effect of starting capacitor on motor torque.
	Operate shaded pole single phase motor. Students will be able to demonstrate skills to: [SLO:GIE-12-H-12]: make connections according to circuit diagram. [SLO:GIE-12-H-13]: apply rated voltage to the stator. [SLO:GIE-12-H-14]: change the applied voltage to measure the effect on motor speed.
	Operate and speed control of AC series motor. Students will be able to demonstrate skills to: [SLO:GIE-12-H-15]: connect the armature and field winding in series.

	[SLO:GIE-12-H-16]: apply rated voltage to the motor. [SLO:GIE-12-H-17]: measure the effect on motor speed by change in applied voltage.
	Operate miniature (reluctance and hysteresis) single phase AC motors. Students will be able to demonstrate skills to: [SLO:GIE-12-H-18]: connect the stator of motor with single phase supply. [SLO:GIE-12-H-19]: apply mechanical load by hand [SLO:GIE-12-H-20]: measure the effect of load change on motor speed. [SLO:GIE-12-H-21]: draw torque speed curves.
	Construct and operate stepper motor Students will be able to demonstrate skills to: [SLO:GIE-12-H-22]: connect the stator of the motor with control circuit. [SLO:GIE-12-H-23]: adjust the control voltage of control unit. [SLO:GIE-12-H-24]: measure the RPM.

	[SLO:GIE-12-H-25]: readjust the control voltage of control unit. [SLO:GIE-12-H-26]: measure the RPM again. [SLO:GIE-12-H-27]: make comparison between Control voltage and RPM.
	Construct, Operate and develop control circuit of servo motor. Students will be able to demonstrate skills to: [SLO:GIE-12-H-28]: pair the servo motor with some encoder to provide position and speed feedback. [SLO:GIE-12-H-29]: compare the measured position to external input to the controller. [SLO:GIE-12-H-30]: check the effect of feedback on motor position
	Identify and operate 3 phase Squirrel cage motor. Students will be able to demonstrate skills to: [SLO:GIE-12-H-31]: identify and select 3 phase squirrel cage motor. [SLO:GIE-12-H-32]: make connection as per diagram.

	[SLO:GIE-12-H-33]: connect the supply and interpret the result.
	Verify rotating magnetic field Students will be able to demonstrate skills to: [SLO:GIE-12-H-34]: connect the three terminals of stator winding with each other and with ground. [SLO:GIE-12-H-35]: apply three phase supply to the other terminals. [SLO:GIE-12-H-36]: place a compass between the stator and note the direction of rotating magnetic field. [SLO:GIE-12-H-37]: change the two phases with each other. [SLO:GIE-12-H-38]: note the direction of rotating magnetic field.
	Measure the starting and running current of three phase induction motor. Students will be able to demonstrate skills to: [SLO:GIE-12-H-39]: connect the stator winding in star.

	[SLO:GIE-12-H-40]: connect an ammeter in series with stator. [SLO:GIE-12-H-41]: note the ammeter reading at instant of just starting. [SLO:GIE-12-H-42]: note the reading of ammeter at running condition.
	Draw torque slip curve of three phase induction motor Students will be able to demonstrate skills to: [SLO:GIE-12-H-43]: connect three phase induction motor with electro dynamo meter with belt. [SLO:GIE-12-H-44]: start the motor and run at rated speed [SLO:GIE-12-H-45]: measure the RPM. [SLO:GIE-12-H-46]: change the torque with electro dynamo meter and note the speed [SLO:GIE-12-H-47]: calculate slip with given values of speed. [SLO:GIE-12-H-48]: draw graph between slip and torque.
	Determine the slip of 3 phase induction motor by stroboscope Students will be able to demonstrate skills to: [SLO:GIE-12-H-49]: connect the stator of three phase induction motor in star

	[SLO:GIE-12-H-50]: apply single phase AC supply to the stroboscope. [SLO:GIE-12-H-51]: mark dot on motor shaft with marker. [SLO:GIE-12-H-52]: apply three phase supply to the motor [SLO:GIE-12-H-53]: note the RPM of the motor with the help of stroboscope. [SLO:GIE-12-H-54]: calculate slip.
	Start 3 phase Induction motor with direct on line. Students will be able to demonstrate skills to: [SLO:GIE-12-H-55]: draw line diagram of direct-on 3-phase motor starter. [SLO:GIE-12-H-56]: identify and select 3 phase induction motor. [SLO:GIE-12-H-57]: make Connection of motor with DOL as per diagram. [SLO:GIE-12-H-58]: switch on the 3 phase breaker and interpret the result.
	Start 3 phase Induction motor with Auto transformer starter. Students will be able to demonstrate skills to: [SLO:GIE-12-H-59]: connect power circuit with the help of diagram.

	[SLO:GIE-12-H-60]: connect control circuit with the help of diagram. [SLO:GIE-12-H-61]: apply rated voltage to the motor. [SLO:GIE-12-H-62]: gradually reduce the taping of auto transformer with the help of control circuit.
	determine the efficiency of three phase induction motor students will be able to demonstrate skills to: [SLO:GIE-12-H-63]: connect wattmeter, ammeter with the stator of three phase induction motor. [SLO:GIE-12-H-64]: run the motor at rated speed. [SLO:GIE-12-H-65]: measure the reading of wattmeter and voltmeter. [SLO:GIE-12-H-66]: stop the motor [SLO:GIE-12-H-67]: couple three phase induction motor and electro dynamo meter with belt. [SLO:GIE-12-H-68]: run the motor. [SLO:GIE-12-H-69]: supply single phase supply to the dynamo meter.

	[SLO:GIE-12-H-70]: adjust the supply of electro dynamo meter so that the maximum current passes through the motor. [SLO:GIE-12-H-71]: read the meters reading. [SLO:GIE-12-H-72]: calculate the efficiency of the motor by using these reading.
	control the speed of three phase induction motor by changing primary voltage [SLO:GIE-12-H-73]: connect the stator of the motor in star connection. [SLO:GIE-12-H-74]: insert rheostat in series with stator of the motor. [SLO:GIE-12-H-75]: set the rheostat resistance to its max value. [SLO:GIE-12-H-76]: run the motor [SLO:GIE-12-H-77]: change rheostat resistance and note the effect of speed changes.
	Control the speed of three phase induction motor by rotor resistance control method Students will be able to demonstrate skills to:

	[SLO:GIE-12-H-78]: select wound rotor induction motor. [SLO:GIE-12-H-79]: connect the stator of motor in star connection. [SLO:GIE-12-H-80]: connect a star connected starter with motor rotor. [SLO:GIE-12-H-81]: set rotor resistance to its max value. [SLO:GIE-12-H-82]: run the motor. [SLO:GIE-12-H-83]: change the rotor resistance and note the effect of speed change.
	Start the synchronous motor using external prime mover. Students will be able to demonstrate skills to: [SLO:GIE-12-H-84]: couple the shaft of the synchronous motor with external prime mover (DC Shunt motor) [SLO:GIE-12-H-85]: connect the stator winding of synchronous motor in star connection. [SLO:GIE-12-H-86]: apply rated voltage to the stator.

	[SLO:GIE-12-H-87]: run the prime mover, which results in locking of rotor with stator magnetic field
	Identify the effect of field current on three phase synchronous motor. Students will be able to demonstrate skills to: [SLO:GIE-12-H-88]: apply rated voltage to stator. [SLO:GIE-12-H-89]: excite the field winding. [SLO:GIE-12-H-90]: change the field winding voltage and measure the effect on armature current. [SLO:GIE-12-H-91]: draw the V curve between Armature Current and Field current.

Domain I: Implement Single Phase and Three Phase Inverter

Standard I: Demonstrate skills to construct and observe the outputs of a single-phase half-bridge inverter, single-phase full-bridge inverter and three-phase bridge inverter.

Grade 11	**Grade 12**
Benchmark I: Students will be able to demonstrate skills and knowledge required to construct single phase half bridge inverter and observe its output, construct single phase full bridge inverter and observe its output and construct three phase bridge inverter and	

observe its output construct single phase half bridge inverter, single phase full bridge, three phase bridge inverter and observe their outputs.	
Student Learning Outcomes	
	Construct single phase half bridge inverter and observe its output Students will be able to demonstrate skills to: [SLO:GIE-12-I-01]: make connection as per diagram. [SLO:GIE-12-I-02]: apply triggering pulses to circuit with the help of signal generator. [SLO:GIE-12-I-03]: connect oscilloscope across the load resistor and record the output wave shape
	Construct single phase full bridge inverter and observe its output Students will be able to demonstrate skills to: [SLO:GIE-12-I-04]: draw circuit diagram of single-phase full bridge inverter. [SLO:GIE-12-I-05]: make connection as per diagram.

	[SLO:GIE-12-I-06]: apply triggering pulses to circuit with the help of signal generator. [SLO:GIE-12-I-07]: connect oscilloscope across the load resistor and record the output wave shape
	Construct three phase bridge inverter and observe its output Students will be able to demonstrate skills to: [SLO:GIE-12-I-08]: draw circuit diagram of three-phase bridge inverter. [SLO:GIE-12-I-09]: make connection as per diagram. [SLO:GIE-12-I-10]: apply output of controller IC to the gates of MOSFET's for triggering pulses. [SLO:GIE-12-I-11]: connect oscilloscope across the load resistor and record the output wave shape

Domain J: Control speed of DC/AC Motor

Standard I: Demonstrate skills to implement armature and field control methods for DC motor speed control using 3-phase control bridge rectifier and bridge rectifier; implement AC to AC converter for 3-phase AC motor speed control; and apply single-phase cycle-converter with SCR's, along with synchros for torque transmission.

Grade 11	Grade 12
Benchmark I: Students will demonstrate skills in implementing diverse control methods for DC and AC motors, including armature and field control with 3-phase bridge rectifiers, AC to AC converters, single-phase cycle-converters and synchros for torque transmission.	
Student Learning Outcomes	
	Implement armature control method to control the speed of DC motor with 3 phase control bridge rectifier and Bridge rectifier. Students will be able to demonstrate skills to: [SLO:GIE-12-J-01]: draw circuit diagram of armature control method to control the speed of DC motor. [SLO:GIE-12-J-02]: make connection as per diagram. [SLO:GIE-12-J-03]: apply output of controller IC to the gates of all SCR's [SLO:GIE-12-J-04]: now change the triggering of SCR's and record the effect on speed of DC motor.
	Implement Field control method to control the speed of DC motor with 3 phase bridge rectifier and control Bridge rectifier.

	Students will be able to demonstrate skills to: [SLO:GIE-12-J-05]: draw circuit diagram of field control method to control the speed of DC motor. [SLO:GIE-12-J-06]: make connection as per diagram. [SLO:GIE-12-J-07]: apply output of controller IC to the gates of all SCR's [SLO:GIE-12-J-08]: now change the triggering of SCR's and record the effect on speed of DC motor.
	Implement Field control method & armature control method to control the speed of DC motor with 3 phase bridge rectifier. Students will be able to demonstrate skills to: [SLO:GIE-12-J-09]: draw circuit diagram of field control & armature control method to control the speed of DC motor. [SLO:GIE-12-J-10]: make connection as per diagram. [SLO:GIE-12-J-11]: apply output of controller IC to the gates of all SCR's [SLO:GIE-12-J-12]: change the triggering of SCR's and record the effect on speed of DC motor.

	Implement AC to AC converter to control the speed of 3 phase AC motor. Students will be able to demonstrate skills to: [SLO:GIE-12-J-13]: draw circuit diagram of AC to AC converter to control the speed of AC motor. [SLO:GIE-12-J-14]: make connection as per diagram. [SLO:GIE-12-J-15]: apply output of controller IC to the gates of all SCR's [SLO:GIE-12-J-16]: change the triggering of SCR's and record the effect on speed of AC motor.
	Implement single phase cycle-converter with center tapped transformer and SCR's and change the frequency of output AC signal. Students will be able to demonstrate skills to: [SLO:GIE-12-J-17]: draw circuit diagram of single phase cycle-converter to produce variable frequency AC signal. [SLO:GIE-12-J-18]: make connection as per diagram.

	[SLO:GIE-12-J-19]: apply output of controller IC to the gates of all SCR's [SLO:GIE-12-J-20]: apply Triggering to SCR's 1 & 3 for 1st 25 cycles to get positive half cycle and apply triggering for remaining 25 half cycle to SCR's 2 & 4 to get the negative half cycle with controller IC. [SLO:GIE-12-J-21]: connect the oscilloscope across the load and record the output
	Implement synchro's to transmit torque Students will be able to demonstrate skills to: [SLO:GIE-12-J-22]: place synchrony transmitter and synchrony receiver at two different places. [SLO:GIE-12-J-23]: establish connection between corresponding terminal of TX& Rx i.e. S1 to S1, S2 to S2 and S3 to S3 respectively with help of cord [SLO:GIE-12-J-24]: give single phase AC supply to the rotor of both TX and Rx. [SLO:GIE-12-J-25]: rotate the rotor of TX in step to 30 degrees and observe the new position of rotor of Rx. [SLO:GIE-12-J-26]: enter the input angular position & output angular position in the table.

Domain K: PLC

Standard I: Demonstrate skills to install PLC software, select a suitable simulator and demonstrate programming proficiency in ladder logic, including creating programs for basic control functions like ON/OFF operations, start/stop logic, push-button control, timers, traffic signal lights and elevator control.

Grade 11	**Grade 12**
Benchmark I: Students will be able to demonstrate skills and knowledge required to install PLC software and Simulator and Program apply using simulator. They will be able to get basic knowledge and competence to program and understand ladder logic.	
Student Learning Outcomes	
	Install PLC software and Simulator Students will be able to demonstrate skills to: [SLO:GIE-12-K-01]: install the plc programming [SLO:GIE-12-K-02]: software as per PLC manufacturer such as PRs Logic 5000 and PRs links classic etc. [SLO:GIE-12-K-03]: select the best and most frequently used Simulator for programming [SLO:GIE-12-K-04]: select the module

	[SLO:GIE-12-K-05]: input the generic value as per universal settings (check from internet/helped) [SLO:GIE-12-K-06]: start The Simulator. [SLO:GIE-12-K-07]: open PLC programming software
	Program a PLC using simulator Students will be able to demonstrate skills to: [SLO:GIE-12-K-08]: open the programming software as per PLC manufacturer [SLO:GIE-12-K-09]: ensure that the Simulator is connected and is in ON condition [SLO:GIE-12-K-10]: create a basic ladder logic program for ON/OFF of a bulb using Examine ON and Examine OFF switch [SLO:GIE-12-K-11]: create a basic ladder logic program for Simple Start/Stop Ladder Logic Relay [SLO:GIE-12-K-12]: create a basic ladder logic program for Single Push Button On/Off Ladder Logic [SLO:GIE-12-K-13]: create a basic ladder logic program for with On Delay Timer

	[SLO:GIE-12-K-14]: create a basic ladder logic program for with Off Delay Timer [SLO:GIE-12-K-15]: create a basic ladder logic program for Traffic signal lights [SLO:GIE-12-K-16]: create a basic ladder logic program for Elevator Control.
	Construct three phase bridge inverter and observe its output Students will be able to demonstrate skills to: [SLO:GIE-12-K-17]: draw circuit diagram of three-phase bridge inverter. [SLO:GIE-12-K-18]: make connection as per diagram. [SLO:GIE-12-K-19]: apply output of controller IC to the gates of MOSFET's for triggering pulses. [SLO:GIE-12-K-20]: connect oscilloscope across the load resistor and record the output wave shape

Standard II: Demonstrate skills in PLC analysis, design, programming, testing, quality assurance, installation, commissioning and maintenance for automation, ensuring they can proficiently design, develop and maintain control systems.

Grade 11	Grade 12
Benchmark I: Students will be able to demonstrate skills and knowledge required to analyze user requirements and specification, prepare work plan, design and program PLC, Test the PLC, ensure quality and productivity standards, installation and Commissioning and Carry out maintenance of PLC. They will also be able to design, develop, install and maintain the automation and control system needed for Automation and Control.	
Student Learning Outcomes	
	Analyse user requirements and specifications for PLC installation Students will be able to demonstrate skills to: [SLO:GIE-12-K-21]: draw the general value chain of the end user industry [SLO:GIE-12-K-22]: highlight the set of activities that a firm operating in a specific industry performs in the value chain drawing [SLO:GIE-12-K-23]: enlist the equipment/gauges/sensors/actuators/transducers used in different stages of the process [SLO:GIE-12-K-24]: identify critical stages in the process [SLO:GIE-12-K-25]: identify the safety aspect required in the critical stages of the process

	[SLO:GIE-12-K-26]: analyse the possible automation in the existing processes and global trends in automation [SLO:GIE-12-K-27]: analyse the client requirement at broad level from the proposal [SLO:GIE-12-K-28]: generate a report of various industrial processes involved in industry [SLO:GIE-12-K-29]: collect the required specification of the equipment (if already prepared by the user) and clarify the technical specification.
	Prepare work plan for PLC Installation Students will be able to demonstrate skills to: [SLO:GIE-12-K-30]: suggest globally practiced and accepted automation systems if the user is not aware of the technical specifications [SLO:GIE-12-K-31]: list down the sub systems that are involved in the process [SLO:GIE-12-K-32]: list down sensors and actuators requirement. [SLO:GIE-12-K-33]: collect information on process logic SLO:GIE-12-K-34]: collect information for operator station screens

	[SLO:GIE-12-K-35]: decide on whether the system can be developed as per the user requirement [SLO:GIE-12-K-36]: support the project manager in calculating the time required for each stage to ensure completion of project [SLO:GIE-12-K-37]: assist in preparing the work plan with deliverables and timelines [SLO:GIE-12-K-38]: explain the expected output to the user [SLO:GIE-12-K-39]: calculate the number of days needed for commissioning of the panel at site [SLO:GIE-12-K-40]: summarize the user requirement.
	Design and program PLC Students will be able to demonstrate skills to: [SLO:GIE-12-K-41]: develop PLC application as per user requirement by following the standard operating procedure (SOP) of the organization [SLO:GIE-12-K-42]: apply approved engineering concepts, processes and principles in developing the PLC application

	[SLO:GIE-12-K-43]: install organization approved software (system and application software) to develop the system [SLO:GIE-12-K-44]: identify the requirement of indications, switchgears and accessories [SLO:GIE-12-K-45]: develop the control circuit drawing [SLO:GIE-12-K-46]: prepare wiring plans [SLO:GIE-12-K-47]: integrate the main process system with the sub-systems as per the user requirement (e.g., using communication protocol) [SLO:GIE-12-K-48]: ensure that safety aspect of the process is captured in the design plan [SLO:GIE-12-K-49]: P9. Program PLC as per FDF [SLO:GIE-12-K-01]: Program SCADA Application [SLO:GIE-12-K-50]: PLC-SCADA Communication [SLO:GIE-12-K-51]: P12. Create backup copies of all designs developed for control panel and store in a secure location [SLO:GIE-12-K-52]:

	prepare a product manual and store them for future references
	Test the PLC Students will be able to demonstrate skills to: [SLO:GIE-12-K-53]: locate field devices and their interface to PLC [SLO:GIE-12-K-54]: test the system in off line mode using simulator [SLO:GIE-12-K-55]: test the gauges independently [SLO:GIE-12-K-56]: for integration of main system with the sub-systems (if applicable) [SLO:GIE-12-K-57]: verify that the system conforms with all the user specifications during testing [SLO:GIE-12-K-58]: rework if there are any issues found and fix them [SLO:GIE-12-K-59]: send the test report for review to the customer [SLO:GIE-12-K-60]: perform Factory Acceptance Test (FAT) [SLO:GIE-12-K-61]: perform site acceptance test plan
	Ensure quality and productivity standards

	Students will be able to demonstrate skills to: [SLO:GIE-12-K-62]: ensure timely delivery of the control panel design as per agreed timeline [SLO:GIE-12-K-63]: ensure that total cost and man hours spent is as per the budget planned [SLO:GIE-12-K-64]: ensure compliance with relevant regulations, standards and codes of practices [SLO:GIE-12-K-65]: ensure compliance of the application with manufacturing requirements and process capabilities analysis of the organization [SLO:GIE-12-K-66]: ensure that the design conforms with normal safety standards [SLO:GIE-12-K-67]: develop reliable panels so that the system does not fail during the usage
	Installation and Commissioning Students will be able to demonstrate skills to: [SLO:GIE-12-K-68]: check availability of panel and tools required for installation

	[SLO:GIE-12-K-69]: check the internal panel wiring and ensure that it is in accordance with the design drawing [SLO:GIE-12-K-70]: carry out insulation check of internal panel wiring and devices within the panel [SLO:GIE-12-K-71]: check if batteries and chargers have been assembled in accordance with the manufacturers recommended procedures [SLO:GIE-12-K-72]: identify the conductors size and capacity for installation [SLO:GIE-12-K-73]: ensure that the panel is positioned as prescribed, following safety norms [SLO:GIE-12-K-74]: make connections to socket outlets, switches and protective conductors [SLO:GIE-12-K-75]: perform settings as per customer requirements on the equipment in each of the panels [SLO:GIE-12-K-76]: test all control system interlocks [SLO:GIE-12-K-77]: check each digital control point by comparing the command at the control panel and status of the device that it controls

	[SLO:GIE-12-K-78]: ensure that fuses, switches and other protective devices are labelled correctly [SLO:GIE-12-K-79]: follow the grounding and earthling procedures while commissioning [SLO:GIE-12-K-80]: put danger and warning notices, (if necessary)
	Carry out maintenance of PLC Students will be able to demonstrate skills to: [SLO:GIE-12-K-81]: select and use required tools and equipment as per the job requirement [SLO:GIE-12-K-82]: identify the faults as per the LED indications on module [SLO:GIE-12-K-83]: identify different signal modules (DI, DO, AI, AO) and take necessary action as per job requirement [SLO:GIE-12-K-84]: identify & Check the terminals inside IO panels and take necessary action as per the job requirement

	[SLO:GIE-12-K-85]: check & test the condition of input power supply to IO panel, input/output power of SMPS and take necessary action as per job requirement [SLO:GIE-12-K-86]: check the conditions of breakers and fuses and take necessary action as per the job requirement

Standard III: Demonstrate skill in installing PLC software and simulators, programming PLCs using simulators and analyzing user requirements and specifications for industrial automation.

Grade 11	**Grade 12**
Benchmark I: Students will demonstrate the skills and knowledge required to install PLC software and Simulator, program a PLC using simulator and analyse user requirements and specifications.	
Student Learning Outcomes	
	Install PLC software and Simulator Students will be able to demonstrate skills to: [SLO:GIE-12-K-87]: install the PLC Programming

	[SLO:GIE-12-K-88]: software as per PLC manufacturer such as Rs Logic 5000 and Rs links classic etc. [SLO:GIE-12-K-89]: select the best and most frequently used Simulator for programming [SLO:GIE-12-K-90]: select the module [SLO:GIE-12-K-91]: input the generic value as per universal settings (check from internet/helped) [SLO:GIE-12-K-92]: start The Simulator. [SLO:GIE-12-K-93]: open PLC programming software
	Program a PLC using simulator Students will be able to demonstrate skills to: [SLO:GIE-12-K-94]: open the programming software as per PLC manufacturer [SLO:GIE-12-K-95]: ensure that the Simulator is connected and is in ON condition [SLO:GIE-12-K-96]: create a basic ladder logic program for ON/OFF of a bulb using Examine ON and Examine OFF switch

	[SLO:GIE-12-K-97]: create a basic ladder logic program for Simple Start/Stop Ladder Logic Relay [SLO:GIE-12-K-98]: create a basic ladder logic program for Single Push Button On/Off Ladder Logic [SLO:GIE-12-K-99]: create a basic ladder logic program for with On Delay Timer [SLO:GIE-12-K-100]: create a basic ladder logic program for with Off Delay Timer [SLO:GIE-12-K-101]: create a basic ladder logic program for Traffic signal lights [SLO:GIE-12-K-102]: create a basic ladder logic program for Elevator Control
	Analyse user requirements and specifications Students will be able to demonstrate skills to: [SLO:GIE-12-K-103]: draw the general value chain of the end user industry [SLO:GIE-12-K-104]: highlight the set of activities that a firm operating in a specific industry performs in the value chain drawing [SLO:GIE-12-K-105]: enlist the equipment/gauges/sensors/actuators/transducers used in different stages of the process

	[SLO:GIE-12-K-106]: identify critical stages in the process [SLO:GIE-12-K-107]: identify the safety aspect required in the critical stages of the process [SLO:GIE-12-K-108]: analyse the possible automation in the existing processes and global trends in automation [SLO:GIE-12-K-109]: analyse the client requirement at broad level from the proposal [SLO:GIE-12-K-110]: generate a report of various industrial processes involved in industry [SLO:GIE-12-K-111]: collect the required specification of the equipment (if already prepared by the user) and clarify the technical specification.

Standard IV: Demonstrate skills to prepare work plans, design and program PLCs and conduct comprehensive testing, ensuring the seamless integration of main and sub-systems, adherence to user specifications and successful implementation of industrial automation solutions.

Grade 11	Grade 12

Benchmark I: Students will be able to demonstrate skills and knowledge required to formulate work plans, design and program PLCs to meet user specifications and execute rigorous testing protocols, demonstrating their competency in the end-to-end process of industrial automation system development.	
Student Learning Outcomes	
	Prepare work plan Students will be able to demonstrate skills to: [SLO:GIE-12-K-112]: suggest globally practiced and accepted automation systems if the user is not aware of the technical specifications [SLO:GIE-12-K-113]: list down the sub systems that are involved in the process [SLO:GIE-12-K-114]: list down sensors and actuators requirement. [SLO:GIE-12-K-115]: collect information on process logic [SLO:GIE-12-K-116]: collect information for operator station screens [SLO:GIE-12-K-117]: decide on whether the system can be developed as per the user requirement [SLO:GIE-12-K-118]: support the project manager in calculating the time required for each stage to ensure completion of project

	[SLO:GIE-12-K-119]: assist in preparing the work plan with deliverables and timelines [SLO:GIE-12-K-120]: explain the expected output to the user [SLO:GIE-12-K-121]: calculate the number of days needed for commissioning of the panel at site [SLO:GIE-12-K-122]: summarize the user requirement.
	Design and program PLC Students will be able to demonstrate skills to: [SLO:GIE-12-K-123]: develop PLC application as per user requirement by following the standard operating procedure (SOP) of the organization [SLO:GIE-12-K-124]: apply approved engineering concepts, processes and principles in developing the PLC application [SLO:GIE-12-K-125]: install organization approved software (system and application software) to develop the system [SLO:GIE-12-K-126]: identify the requirement of indications, switchgears and accessories [SLO:GIE-12-K-127]: develop the control circuit drawing

	[SLO:GIE-12-K-128]: prepare wiring plans [SLO:GIE-12-K-129]: integrate the main process system with the sub-systems as per the user requirement (e.g., using communication protocol) [SLO:GIE-12-K-130]: ensure that safety aspect of the process is captured in the design plan [SLO:GIE-12-K-131]: program PLC as per FDF [SLO:GIE-12-K-132]: Program SCADA Application [SLO:GIE-12-K-133]: PLC-SCADA Communication [SLO:GIE-12-K-134]: create backup copies of all designs developed for control panel and store in a secure location [SLO:GIE-12-K-135]: prepare a product manual and store them for future references
	Test the PLC Students will be able to demonstrate skills to: [SLO:GIE-12-K-136]: locate field devices and their interface to PLC

	[SLO:GIE-12-K-137]: test the system in off line mode using simulator [SLO:GIE-12-K-138]: test the gauges independently for integration of main system with the sub-systems (if applicable) [SLO:GIE-12-K-139]: verify that the system conforms with all the user specifications during testing [SLO:GIE-12-K-140]: rework if there are any issues found and fix them [SLO:GIE-12-K-141]: send the test report for review to the customer [SLO:GIE-12-K-142]: perform Factory Acceptance Test (FAT) [SLO:GIE-12-K-143]: perform site acceptance test plan

Standard V: Demonstrate skills to ensure quality and productivity standards in control panel design, adeptly execute installation and commissioning procedures with a focus on safety and functionality and effectively carry out maintenance tasks for PLC systems, showcasing comprehensive expertise in the entire lifecycle of industrial automation.

Grade 11	Grade 12

Benchmark I: Students will be able to demonstrate skills and knowledge required in industrial automation, seamlessly navigating from ensuring quality in control panel design and proficiently executing installation and commissioning procedures to adeptly conducting maintenance for PLC systems.	
Student Learning Outcomes	
	Ensure quality and productivity standards students will be able to demonstrate skills to: [SLO:GIE-12-K-144]: ensure timely delivery of the control panel design as per agreed timeline [SLO:GIE-12-K-145]: ensure that total cost and man hours spent is as per the budget planned [SLO:GIE-12-K-146]: ensure compliance with relevant regulations, standards and codes of practices [SLO:GIE-12-K-147]: ensure compliance of the application with manufacturing requirements and process capabilities analysis of the organization [SLO:GIE-12-K-148]: ensure that the design conforms with normal safety standards [SLO:GIE-12-K-149]: develop reliable panels so that the system does not fail during the usage

	Installation and commissioning Students will be able to demonstrate skills to: [SLO:GIE-12-K-150]: check availability of panel and tools required for installation [SLO:GIE-12-K-151]: check the internal panel wiring and ensure that it is in accordance with the design drawing [SLO:GIE-12-K-152]: carry out insulation check of internal panel wiring and devices within the panel [SLO:GIE-12-K-153]: check if batteries and chargers have been assembled in accordance with the manufacturers recommended procedures [SLO:GIE-12-K-154]: identify the conductors size and capacity for installation [SLO:GIE-12-K-155]: ensure that the panel is positioned as prescribed, following safety norms [SLO:GIE-12-K-156]: make connections to socket outlets, switches and protective conductors [SLO:GIE-12-K-157]: perform settings as per customer requirements on the equipment in each of the panels

	[SLO:GIE-12-K-158]: test all control system interlocks [SLO:GIE-12-K-159]: check each digital control point by comparing the command at the control panel and status of the device that it controls [SLO:GIE-12-K-160]: ensure that fuses, switches and other protective devices are labelled correctly [SLO:GIE-12-K-161]: follow the grounding and earthling procedures while commissioning [SLO:GIE-12-K-162]: put danger and warning notices, (if necessary) [SLO:GIE-12-K-163]: test continuity, insulation resistance, functions of all devices, etc., after completion of installation
	Carry out maintenance of PLC Students will be able to demonstrate skills to: [SLO:GIE-12-K-164]: select and use required tools and equipment as per the job requirement [SLO:GIE-12-K-165]: identify the faults as per the LED indications on module

	[SLO:GIE-12-K-166]: identify different signal modules (DI, DO, AI, AO) and take necessary action as per job requirement [SLO:GIE-12-K-167]: identify & Check the terminals inside IO panels and take necessary action as per the job requirement [SLO:GIE-12-K-168]: check & test the condition of input power supply to IO panel, input/output power of SMPS and take necessary action as per job requirement [SLO:GIE-12-K-169]: check the conditions of breakers and fuses and take necessary action as per the job requirement

Domain L: Operate Solar Power Plant

Standard I: Demonstrate skills to execute solar power plant operations, encompassing thorough inspections, adept equipment handling, timely response to emergencies, effective maintenance and accurate report generation, ensuring safe, efficient and reliable functioning of the solar power plant.

Grade 11	**Grade 12**
Benchmark I: Students will be able to demonstrate skills and knowledge required to carry out General Inspection of the power plant, Operate Solar plant equipment, respond to equipment emergencies and alarms, perform maintenance activities and Generate Report. They will Operate and monitor plant generating equipment and take appropriate actions to ensure safe, efficient and reliable operation of the Solar Power Plant.	

Student Learning Outcomes	
	Carry out General Inspection of the power plant Students will be able to demonstrate skills to: [SLO:GIE-12-L-01]: adopt health and safety measures, as per standards. [SLO:GIE-12-L-02]: identify PV Cells, Inverter Batteries, Circuits and other Auxiliary equipment. [SLO:GIE-12-L-03]: ensure the PV cells are clean and placed at a maximum absorption position. [SLO:GIE-12-L-04]: identify Control and Switching Panel. [SLO:GIE-12-L-05]: identify voltage meter, load indicator, battery gravity indicator, charging/discharging meter. [SLO:GIE-12-L-06]: monitor readings of indicator gauges and meters regularly [SLO:GIE-12-L-07]: perform calibration check for scale accuracy. [SLO:GIE-12-L-08]: examine the sounds, smells and vibrations of equipment.

	[SLO:GIE-12-L-09]: report Problem (If any) and take appropriate preventive measures.
	Operate Solar plant equipment. Students will be able to demonstrate skills to: [SLO:GIE-12-L-10]: follow safety measures, as per standards. [SLO:GIE-12-L-11]: perform switching as per requirement [SLO:GIE-12-L-12]: carry out shifting of the load according to the load management requirement at the time of peak load and base load. [SLO:GIE-12-L-13]: switch to alternative source during unfavorable weather conditions. [SLO:GIE-12-L-14]: analyze its smooth and efficient operation [SLO:GIE-12-L-15]: generate a report of switching operations and loads on generators, electrical lines and transformers
	Respond to equipment emergencies and alarms. Students will be able to demonstrate skills to:

	[SLO:GIE-12-L-16]: identify emergency alarms and switches. [SLO:GIE-12-L-17]: response to alarm in emergency. [SLO:GIE-12-L-18]: turn OFF power in emergency. [SLO:GIE-12-L-19]: take timely corrective measures. [SLO:GIE-12-L-20]: turn ON power when fault is removed. [SLO:GIE-12-L-21]: use of fire extinguisher and emergency exit.
	Perform maintenance activities. [SLO:GIE-12-L-22]: Follow safety measures, as per standards [SLO:GIE-12-L-23]: Investigate malfunction in accordance with company policies and procedures [SLO:GIE-12-L-24]: Identify nature of fault. [SLO:GIE-12-L-25]: Check the charging and gravity level of the battery [SLO:GIE-12-L-26]: Ensure there is no breakage in the circuit.

	[SLO:GIE-12-L-27]: Ensure that the PV cells are clean. [SLO:GIE-12-L-28]: Inform higher authority for major fault (on time) [SLO:GIE-12-L-29]: Test the equipment after it's repaired and ready to be placed back. [SLO:GIE-12-L-30]: Generate a document and mention the fault and the measures taken, for future use.
	Generate Report Students will be able to demonstrate skills to: [SLO:GIE-12-L-31]: follow safety measures, as per standards. [SLO:GIE-12-L-32]: prepare Visit Report as per technical specifications of the plants

Domain M: Design Solar System and Calculate Tariffs their Economics

Standard I: Demonstrate skills to ensure personal safety, calculate solar PV system loads, plan and install panels, conduct testing, diagnose and remove faults and perform electrical operations for off-grid solar PV systems, showcasing expertise in power generation tariff calculations and comparative analyses of hydel, solar and thermal power plants.

Grade 11	**Grade 12**
Benchmark I: Students will be able to demonstrate the skills and knowledge required to ensure Personal safety, calculate load for solar PV system design, Plan for installation of solar panel, Install the solar panel, Install the solar panel, perform testing and Diagnose and remove the fault. Carry out electrical operations, including installation and commissioning of off-grid solar PV systems. In addition, they will be able to: Plan and prepare for installation; mount a photovoltaic array on a roof; install and commission solar photovoltaic array; carry out maintenance on off-grid solar PV system; and complete work.	
Student Learning Outcomes	
	Ensure Personal safety Students will be able to demonstrate skills to: [SLO:GIE-12-M-01]: arrange PPEs as per requirements [SLO:GIE-12-M-02]: wear proper PPE as per nature of job [SLO:GIE-12-M-03]: store PPEs at appropriate place after use [SLO:GIE-12-M-04]: ensure availability of first aid box
	Calculate load for solar PV system design

	Students will be able to demonstrate skills to: [SLO:GIE-12-M-05]: enlist the No. of appliances to be operated [SLO:GIE-12-M-06]: calculate the PV system load [SLO:GIE-12-M-07]: record the PV system load.
	Plan for installation of solar panel Students will be able to demonstrate skills to: [SLO:GIE-12-M-08]: identify and obtain safety and other regulatory requirements for installation [SLO:GIE-12-M-09]: choose suitable location for the PV array and other components [SLO:GIE-12-M-10]: obtain tools, equipment and testing devices [SLO:GIE-12-M-11]: specify installation requirements for all system components to ensure correct operation, long life, safety and ease of Maintenance
	Install the solar panel Frame Students will be able to demonstrate skills to:

	[SLO:GIE-12-M-12]: interpret and confirm installation in terms of roof construction and suitable mounting methods [SLO:GIE-12-M-13]: choose appropriate array frame for the roof type and determine and set correct tilt angle adjustments [SLO:GIE-12-M-14]: ensure the frame is properly fitted, eliminating vibration in the frame [SLO:GIE-12-M-15]: place flashing and other waterproofing measures
	Install the solar panel Students will be able to demonstrate skills to: [SLO:GIE-12-M-16]: install system components in suitable location [SLO:GIE-12-M-17]: connect PV panels and electrical components and minimize cable route length to minimize power loss [SLO:GIE-12-M-18]: perform earthling [SLO:GIE-12-M-19]: make connections of wires [SLO:GIE-12-M-20]: confirm installation

	Perform testing Students will be able to demonstrate skills to: [SLO:GIE-12-M-21]: test and adjust component and/or parts [SLO:GIE-12-M-22]: confirm operation of PV system [SLO:GIE-12-M-23]: check the voltage and current at receiver end.
	Diagnose and remove the fault Students will be able to demonstrate skills to: [SLO:GIE-12-M-24]: verify safety circuits [SLO:GIE-12-M-25]: check status of wiring [SLO:GIE-12-M-26]: verify status of battery [SLO:GIE-12-M-27]: check status of PV Panels [SLO:GIE-12-M-28]: identify nature of the fault (if any) [SLO:GIE-12-M-29]: remove the fault

	Calculate Tariff for Hydro Power Plant Students will be able to demonstrate skills to: [SLO:GIE-12-M-30]: determine factors influencing cost (Types of Load, Maximum demand, the power factor of the load as per Go tariff regulation). [SLO:GIE-12-M-31]: check the latest Tariff (per unit cost), imposed by regulatory authority [SLO:GIE-12-M-32]: calculate per unit cost of hydro power plant
	Calculate Tariff for Solar Power Plant [SLO:GIE-12-M-33]: determine the efficiency of PV cell [SLO:GIE-12-M-34]: calculate the per unit cost of Generation (neglecting losses)
	Calculate Tariff for Thermal Power Plant [SLO:GIE-12-M-35]: calculate the running cost of the plant [SLO:GIE-12-M-36]: calculate the operational cost of the plant

	[SLO:GIE-12-M-37]: calculate the per unit cost of Generation
	Comparative Analysis [SLO:GIE-12-M-38]: compare the efficiency of Hydel, Solar and Thermal Power Plant [SLO:GIE-12-M-39]: compare the minimum and maximum generation capacity of Hydro, Solar and Thermal Power Plant [SLO:GIE-12-M-40]: compare the per unit generation cost of Hydel, Solar and Thermal Power Plant [SLO:GIE-12-M-41]: analyze sustainable and environment-friendly power generation system

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