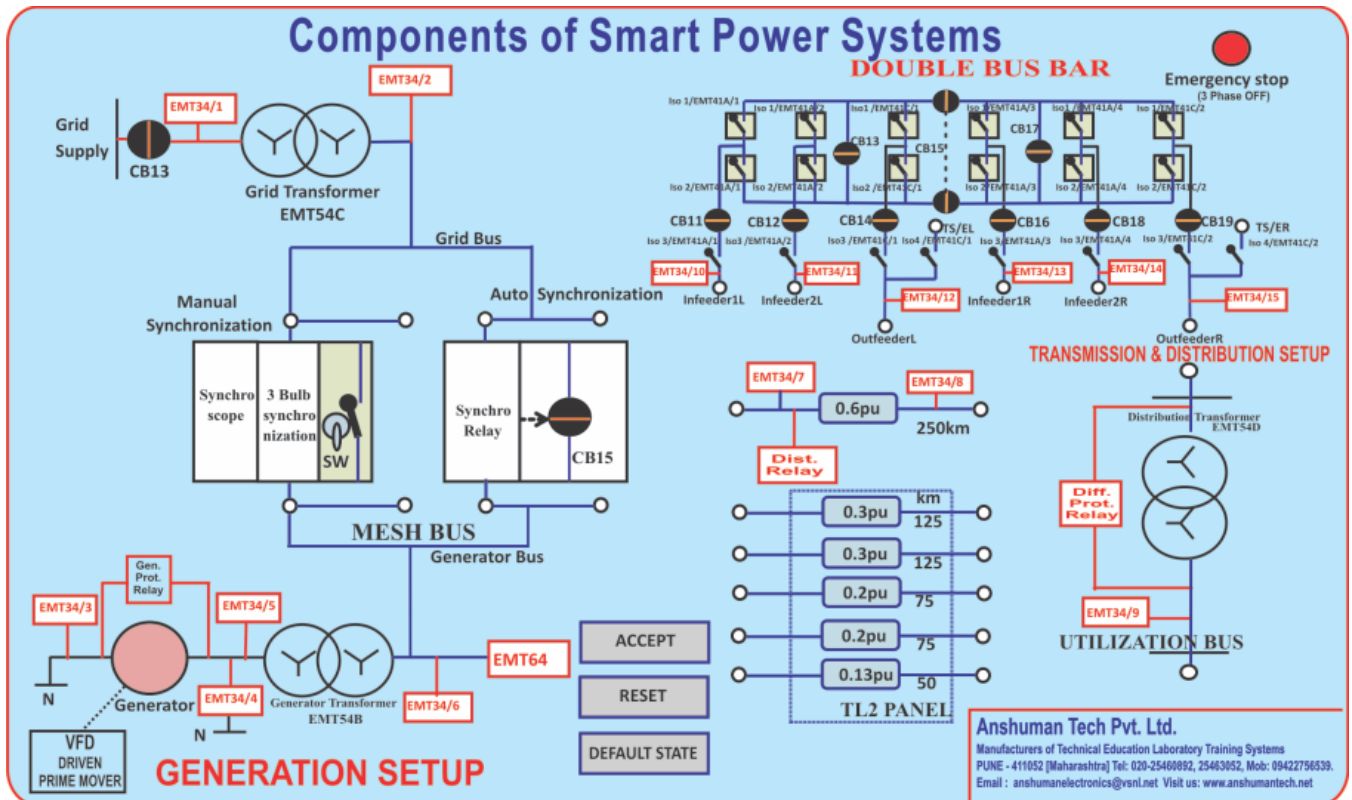




SALIENT FEATURES

1. SPS; application trainer useful to teach how a real world, SCADA based power system network in your city operates; consists of 8 tables, 4 RTUs, 4 Setups all integrated through SCADA software & LAN communication network. Hence can not be purchased in parts.
2. The objective of this trainer is to develop a real time automated power system network and control test-bed at the laboratory level to enhance student understanding about the power system testing and validation.
3. Trainer offers laboratory experiments and their analysis giving students a high level of knowledge to understand the concepts of power system engineering fundamentals and the required demonstrations needed for smart grid implementation in the real world.
4. SPS system consists of 4 nos. of power engineering setups viz; **Generation, Synchronisation, Double Bus Bar, Transmission & Distribution**, 4 Nos. of integrated Numeric protection relays like Generator Protection, Synchronisation relay, distance protection, Transformer protection, 3 nos. of RTU with Ethernet & RS485/MODBUS ports, 3 nos. of touch panel local station HMI's, 1 No. of supervisory controller / touch panel PC with latest SCADA software, preformed patch cords/cables to integrate seamlessly various parts into single system, 8 nos of aluminum profile tables with under trolleys / drawers etc.
5. Table top resources needed by respective setups are placed on Trolley below the table having wiring access through slot provided in the centre of setup tables.
6. Facilitates easy and safe wiring by students due to use of 4mm sturdy Shrouded banana patch cords for high voltage circuits.
7. **Options:** a) 2nd Generating Station may be added using three phase alternator using two more setups, of generation & synchronization respectively, with additional HMI & RTU. b) A DFIG setup may be included to simulate wind power generation. The generation setup here will include AC to AC IGBT based VFD to illustrate wind power grid tied generator. c) A lab scaled solar power based grid tied setup may be included.
8. Useful for Under Graduate Practicals, Post Graduate Projects and Research Purpose.
9. Student friendly Instructor Guide & Student Workbooks giving detail experiment procedures, wiring schedule & tabular results.



Technical Specifications

1) SCADA components:

- a) **PCs:** 4th generation Intel® Core™, 2.9 GHz, 2-core, OS: Windows 8.1, Memory: 8GB, HDD:500GB, Smart space-saving All-in-One design with a full-metal V-stand - 4 nos.
- i) Supervisor's desk: Touch panel PC with 8 port Ethernet switch – - 1 no.
- ii) HMIs as local stations: Touch panel PC placed near each RTU unit with convenient swivel angle – - 3 nos.
- iii) Uninterruptable Power Supply: Provided (500VA/30 min. backup) one each for supervisory PC & 3 HMI stations to prevent corruption due to brownouts. - 4 nos.

b) Software:

- i) Multi drop SCADA software with 4 numbers of USB based runtime hard keys, of which 2 are for unlimited tags & two are of 300 tags.
- ii) SCADA screens supported: Generator control panel screen, synchronization screen, Generator differential protection relay screen, load selection screen, Double bus bar screen, transmission line screen, symmetrical & unsymmetrical fault screen, Distance protection screen, Distribution Transformer differential protection screen, power measurement screen, Alarm and event management screen etc.

c) RTUs: Table top aluminum profile rack of 3X1 panels consisting

- 3 nos.

- i) Each PLC (48 I/O) has 24 inputs (24V) & 24 outputs (Relay with common to 24Vdc) while generation PLC has additionally 2AI & 2AO. Each PLC has RS485 modbus interface, Ethernet interface, 8 relay output card (max 3nos) with contacts at 230vac with terminal strip for easy servicing.
- ii) Converter cum distribution panel (CDP) supporting 37 pin & 9 pin D connectors for control & collecting trip signal from protection relays if any.



- iii) 3 phase 4P/16A@415vac contactors for power topology control, fault insertions & CB control- 20 nos (max).
- iv) Goggle coloured transparent Perspex glass cover to protect students from HV components/contactors.
- v) **Mechanical Dimension (mm)/ Wt. (Kg) :**
 Rack : 700 (L) x 300 (W) x 970 (H)
 Net Wt. : 25 Kg., Gross Wt. : 35 Kg.

d) IEDs:

- i) Multifunction meter EMT34: Consist of (96 X 96 mm) Digital meters for 3 phase, Measures V, I, PF (0.2 lag – unity 0.2 lead), Hz, watts, VARs, energy etc, with RS485 modbus communication interface facility – - 15 nos.
- ii) Phase angle measurement meters - 2nos.
- iii) Protection Relays : Numeric relays with modbus RS485 interface. - 4 nos.
 - a) Generator protection differential relay provides differential, over/under voltage, over/under frequency, reverse power, earth fault, directional/non directional over current protections.
 - b) Distance protection relay provides distance zone, directional/non directional over current, earth fault, Under/Over voltage protections, auto reclose function etc.
 - c) Transformer differential protection relay provides differential protection & over current protection for distribution transformer.
 - d) Automatic synchronization relay provide automatic synchronization between generator & Grid supply.
- e) VFD: Variable voltage variable frequency drive (7KW) to control prime mover, having modbus communication over RS485 interface facility and with analog input 0-10V for frequency synchronization & 0 – 2.5V to control excitation of alternator through EMT-9 (0 – 100VDC O/P).

- a) **Generation trainer** - Refer XPO-SPS/Gen catalogue for generation trainer .
- b) **Synchronization trainer** - Refer XPO-SPS/Sync catalogue for Synchronization trainer.
- c) **Transmission & Distribution trainer** - Refer XPO-SPS/TLD catalogue for Transmission & Distribution trainer
- d) **Double bus Bar** - Refer XPO-SPS/DBB catalogue for substation double bus bar trainer

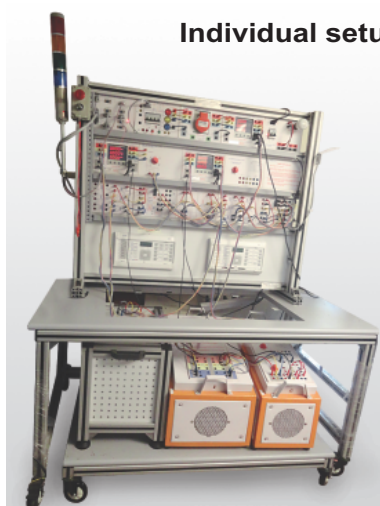
3) Transformers:

- a) **Generator group** - 3 phase power transformer 3KVA/5KVA, YY11 connection, with multi-tapped secondary windings.
- b) **Grid transformer** - 3 phase power transformer with connection group YY11, 5KVA, with multi-tapped secondary windings.
- c) **Distribution transformer** - 3 phase transformer, 3KVA, phasor group YY11, with multi-tapped secondary.



Transformer

2) Power engineering stations/ Setups (supplied mounted on aluminum profile slotted table, with under trolley.



Individual setup



Under Trolley resources

4) Accessories:

a) **Tables for RTU : 4 nos, consists of Pi type holding frame, table top, drawers etc.**

i) **Frame:** 45X45 aluminum profile square block (Heavy duty) Colour: anodized white.

ii) **Table top material/colour:** The nova pan or Rubber wood with white/Silver gray with smooth finish veneer finish table top (25 mm thickness).

iii) **Drawers:** Out of 3 drawers, one is open type & would double up as PC keyboard carrier with mouse pad on its side. Other two drawers are closed type, lockable of these two, bottom drawer has double height to accommodate tall components. Pull out writing pad provided above upper drawer.

iv) **Mechanical:** Four sturdy castor wheels with locking mechanism are provided so that table can be easily moved, **Dimension:** 1200 mm (L) X 750 mm (W) X 760 mm (H).

b) Cables:

i) 9 pin D male to 9 pin D female with 9 core cable, length up to 6 meter - 21 nos.

ii) 37 pin D male to 37 pin D female patch cable, length up to 4 meters - 3 nos.

iii) 3 phase power extension: 5 pin 3phase plug male to 5 pin 3 phase plug male cable, 1.5 meter - 3 nos.

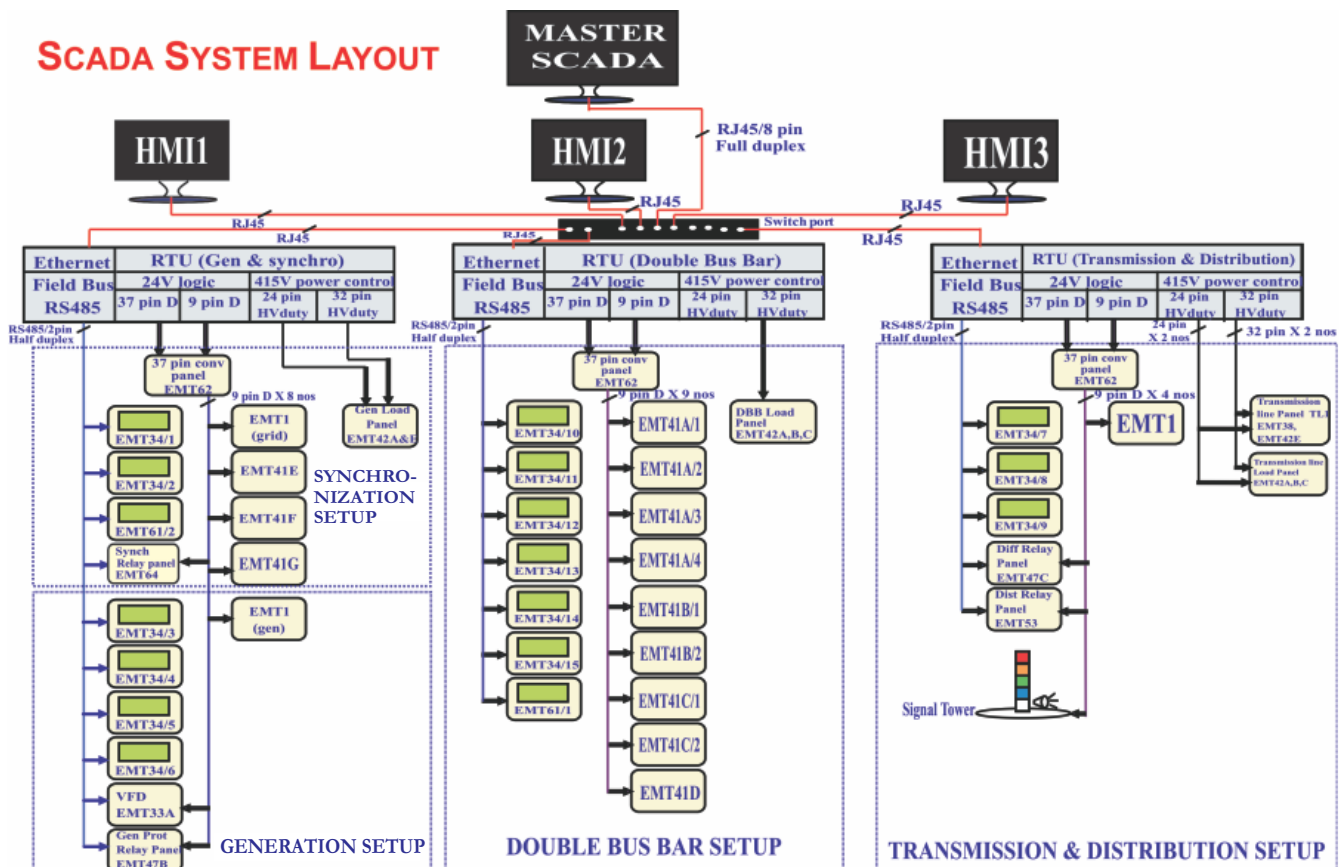
iv) RS485 patch cable: 6 pin mini DIN male to 6 pin mini DIN male, length up to 1200mm - 22 nos.

List of experiments

- i) Automatic as well as manual Synchronization of generator with grid supply.
- ii) Study of V curve & inverted V curve.
- iii) Study of Generator performance chart.
- iv) Study of generator protection for differential, over current, over/under voltage, over/under frequency, reverse power and earth faults using generator protection relay..
- v) Study of voltage variation & control.
- vi) Study of voltage regulation for constant $\cos \phi$.
- vii) 3 bus load flow study.
- viii) Study of No load test and Ferranti effects on transmission line.
- ix) Load test and calculation of efficiency, regulation and power flow in pi model of TL.
- x) Load test and calculation of efficiency, regulation and power flow in short model of TL
- xi) Study of symmetrical and asymmetrical faults on transmission line.
- xii) Study of distance protection using distance relay.
- xiii) Study of Auto reclose function of distance relay.
- xiv) Study of Distribution transformer protection for differential & over current faults.
- xv) 4 bus load flow study.

Total weight = 1.8 Tons / Volume Kg = 3.6 Tons

SCADA SYSTEM LAYOUT



GENERATION TRAINER (Model : XPO-SPS/Gen)

Note : This is the part of XPO-SPS Training System.

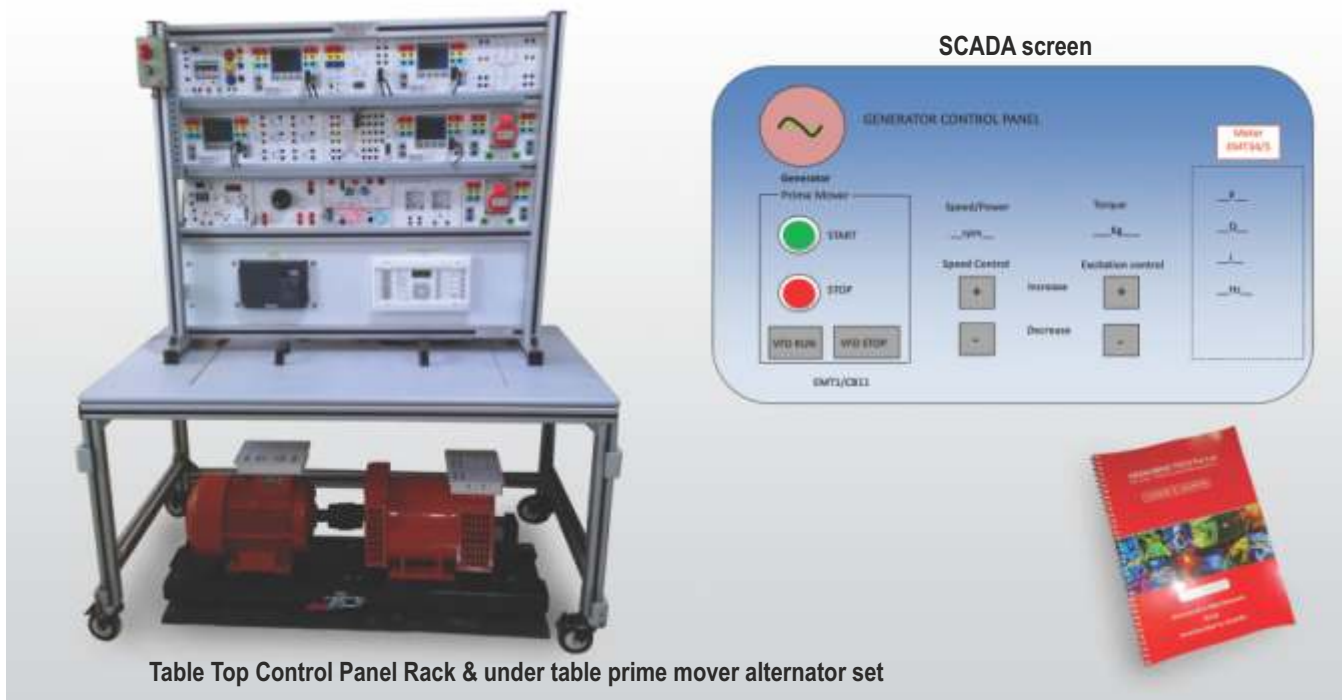


Table Top Control Panel Rack & under table prime mover alternator set

SALIENT FEATURES

- ◆ VFD drive is used to control brush less prime mover's speed in manual using RTU / SCADA as well as in auto mode using **synchronization relay**.
- ◆ Facilitate generator protection differential, over current, over/under frequency, reverse power, earth fault using generator protection relay. Auto manual synchronisation with grid (need sync. setup), Study of V/inverted V-curve, study of generator performance etc. voltage Multi function meters read the input voltage & frequency of generator output along with power analyser data on MODBUS.
- ◆ The Generator/ alternator coupled with prime mover have brought out six terminals from three phase 3 windings (RYBs). The every alternate terminal of RYB is shorted and connected together to form Star connection (Neutral) at the output of generator.

Technical Specifications

XPO- SPS/Gen trainer can work in standalone mode with simulated grid sources as well as in conjunction with synchronization setup, HMI, RTU SCADA software and consists of following panels:

- ◆ **Input 3 phase DOL Starter panel (EMT1) X 1 Nos**
 - 4 pole MCB of 415 V/20A.
 - DOL 16A Contactor with 24DCV / 11VACOIL
 - Bimetallic thermal O/L relay with range 9A- 15A
 - RYB inputs indicators.
 - 9 pin D (M) connector for SCADA interface.
 - Manual start / stop with local trip contact
 - Power ON LED indicator
 - Green SBS5 socket is provided for extend earth.
- ◆ **DC Volt meter & DC ammeter Panel (EMT6B) X 1 Nos.**
 - DC voltmeter 0-300VDC
 - DC ammeter 0-5A

- ◆ The relay panel carries shrouded sockets to connect **Generator Protection relay** mounted below. The CT panel and PT panel provide necessary interface between real world & relay.
- ◆ Emergency stop mushroom switch is provided with security key lock on the profile rack.
- ◆ Facilitates easy and safe wiring by students due to use of 4mm sturdy Shrouded banana patch cords and shrouded socket arrangements for high voltage circuits
- ◆ Each panel has ABS molded plastic sturdy enclosure, and colorful screwless overlays showing circuits diagrams & its connection tag numbers for easy understanding and connection
- ◆ Useful for Under Graduate Practicals, Post Graduate Projects and Research Purpose.
- ◆ Set of Instructor Guide & Student Workbook.

- 4A circuit breaker.
- ◆ **Instrumentation power supply cum multichannel DPM panel (EMT 8) X 1 No.**
 - Power supply +12V, -12V, 500 mA, +5V/300mA
 - Unregulated 17VDC /750 mA
 - line synchronizing signal.
 - Multi channel DPM for digital display of torque & speed.
 - Green SBS5 socket is provided for extend earth.
- ◆ **Variable AC and DC supply panel (EMT 23) X 1 No.**
 - Input 0-230VAC, 50Hz
 - Variable O/P: AC 0-270V/3A
 - Variable O/P: DC 0-250V/3A.
- ◆ **IGBT Controlled VVVF Drive panel (EMT 33A) X 1 No.**
 - Input voltage: 3 phase, 415VAC. 50Hz
 - Output voltage: 3 phase 415VAC
 - Range (Frequency Control) : 0.1 Hz to 100 (400)Hz
 - Control Mode : Sine Wave PWM

- Capacity : 10 HP
 - With Reverse And Forward Direction
 - 3 phase EMI Inductor.
 - Mod bus RS485 interface.
 - 9 pin D (M) connector for RTU/SCADA interface.
 - ◆ **3 Phase Bidirectional Power cum Energy meter panel (EMT 34) X 4 Nos.**
 - Bidirectional Multifunction
 - 3 phase 3/4 wire, 415VAC, CT Input 5A
 - LCD/LED display, Aux. supply 230V, 45-65Hz, 5W
 - Measure V. I., Hz, Pf, KVA, KW, KWH
 - Modbus RTU RS 485 for RTU/SCADA interface.
 - Green SBS5 socket is provided for extend earth.
 - ◆ **SCR Actuator (variable DC) cum sensor signal conditioning panel (EMT 9) X 1 No.**
 - Full bridge SCR based 0V-195V / 3 Amp cosine firing with linear characteristics.
 - Supports signal conditioning circuit for speed, torque in kg to give output 0-2.5Vdc (FS).
 - External control signal (0 - 2.5VDC) to set O/P volt (0-100VDC) to control excitation.
 - ◆ **Generator Protection Relay panel (EMT 47B) X 1 No.**
 - Protections: Differential, Over current, Under/Over voltage, Under/Over frequency, Reverse power, Earth fault.
 - 9 pin D (M) connector to interface with RTU/SCADA for automation.
 - Modbus RTU RS 485 for RTU/SCADA interface.
 - ◆ **CT panel (EMT48) X 1 No.**
 - Consist of 5/5 Amp. CT 6 Nos.
 - Primary side of CTs are brought on 3 x 2 x 2 SBS-5 sockets.
 - Secondary side of CTs are Star connected in group of 3 & brought out on 4 x 2 SBS-5 sockets
 - ◆ **415/110VAC, 50VA PT panel (EMT 54) X 1 No.**
 - Consisting of potential transformer,
 - Input 415VAC, star connected, Output 110VAC, star connected, 50VA.
 - ◆ **5 pin to shrouded socket converter panel (EMT 63) X 2 Nos.**
 - Consist of 5 pin 3 phase, 5 wires industrial female socket to connect 415VAC 3 phase supply.
 - Shrouded banana sockets 18 nos to extend the 3 phase supply into individual setups.
 - It's used as bidirectional 3 phase extension board between two setups.
- Table top panels:**
- ◆ **Generator transformer Panel (EMT54B) X 1 No.**
 - 3 phase power transformer with connection group Yy11,
 - Input 415VAC, Output 415VAC, 5KVA,
 - Secondary winding with tapping at $\pm 2.5\%$ and $\pm 5\%$.
 - ◆ **3 phase Squirrel cage Induction Motor Panel (EMT65) X 1 No.**
 - Voltage: 3 phase Delta connected, 415 VAC, 50Hz,
 - Capacity/RPM /Terminals: 10HP/4 Pole m/c / 1500RPM/ 6 terminals.
 - Rotor Construction: Diecast Squirrel cage rotor.
 - Stator construction: 3x2 terminals,
 - Frame/ Mounting Shaft dia : 132 Frame, Chasis mounted 38mm dia. with easily swappable gear coupling.
 - Green SBS5 socket is provided for extend earth.
 - ◆ **3 phase cylindrical rotor Alternator Panel (EMT66) X 1 No.**
 - Voltage : 3 phase, star connected, 415VAC, 50Hz
 - Capacity/RPM /Terminals : 3KVA/4 Pole m/c / 1500RPM
 - Rotor Construction: Rotor excited 180Vdc/2.65A, two terminals brought out on 2 slip rings mounted on shaft.
 - Stator construction: Six terminals brought out for star connection.
 - Frame/ Mounting Shaft dia : 132 Frame, Chasis mounted 28mm dia. With easily swappable gear coupling
 - Green SBS5 socket is provided for extend earth.
 - ◆ **Mechanical Dimension (mm) / Wt. (kg):**
 - Rack: 1165(L) x 300(W) x 990(H) / Net Wt.: 65, Gross Wt.:73.
 - Coupled machine: 1250(L) x 450(W) x 500(H) / Net Wt.: 80
 - Gen X'mer: 770(L) x 275(W) x 435(H) / Net Wt.: 53
- Accessories:**
- a) Tables for Generation Setup : 1 no. consist of Pi type frame.**
- i) Frame: 45X45 aluminum profile (Heavy duty) Colour: anodized white.
 - ii) Table top material/colour: The nova pan or Rubber wood with white/Silver gray with smooth finish veneer finish table top (25 mm thickness) with removable slot cover (900X500mm).
 - iii) Provision to insert MS Sturdy mesh cover on front side to protect students from rotating machines below.
 - iv) Dimension: Table: 1450 mm (L) X 750 mm (W) X 760 mm (H).
 - v) Caster wheels: Four sturdy castor wheels with locking mechanism are provided so that table can be positioned conveniently.
- b) Cables:**
- i) 9 pin D male to 9 pin D female with 9 core cable, length up to 6 meter – 3 nos.
 - ii) 37 pin D male to 37 pin D female patch cable, length = 4 meters – 1 no.
 - iii) RS485 patch cable: 6 pin mini DIN male to 6 pin mini DIN male, length up to 1100mm – 3 nos.
- List of experiments:**
- i) Automatic as well as manual Synchronization of generator with grid supply.
 - ii) Study of V curve & inverted V curve.
 - iii) Study of Generator performance chart.
 - iv) Study of generator protection for differential, over current, over/under voltage, over/under frequency, reverse power and earth faults using generator protection relay.

SYNCHRONIZATION TRAINER (Model : XPO-SPS/Sync)

Note : This is the part of XPO-SPS Training System.



Table top control panel Rack & under table Grid X'mer, TL2 & R load & fault panel

SALIENT FEATURES

- ◆ To synchronize the Generator with grid, this synchronization setup is used.
- ◆ Automatic operation can be performed in two ways namely; from screen based generator control panel using increment and decrement screen buttons or using **synchronization relay** whose 4 contacts (incr/decr) are read by RTU through 9 pin D (M) connector on synchronising relay panel & outputs two AO's through 9 pin D connector on VFD panel one for excitation (V) control & second for speed (f) control.

Technical Specifications

XPO- SPS/Sync trainer work only in conjunction with Generation setup, HMI, RTU SCADA software and consists of following panels:

◆ Input 3 phase DOL Starter panel (EMT1) X 1 Nos

- 4 pole MCB of 415 V/20A.
- DOL 16A Contactor with 24DCV / 11VAC COIL
- Bimetallic thermal O/L relay with range 9A- 15A
- RYB inputs indicators.
- 9 pin D (M) connector for SCADA interface.
- Manual start / stop with local trip contact
- Power ON LED indicator
- Green SBS5 socket is provided for extend earth.

◆ Synchronization Panel (EMT26A/B) X 1 Nos.

- Consisting of synchronization digital meter (Synchroscope),
- Manual Synchronization switch.
- 15W lamps X 6 nos..

- ◆ Emergency stop mushroom switch is provided with security key lock on the vertical profile member.
- ◆ Facilitates easy and safe wiring by students due to use of 4mm sturdy Shrouded banana patch cords and shrouded socket arrangements for high voltage circuits
- ◆ Each panel has ABS molded plastic sturdy enclosure, and colorful screwless overlays showing circuits diagrams & its connection tag numbers for easy understanding and connection
- ◆ Useful for Under Graduate Practicals, Post Graduate Projects and Research Purpose.
- ◆ Set of Instructor Guide & Student Workbook.

- Manual start / stop with local trip contact

◆ 3 Phase Bidirectional Power cum Energy meter panel (EMT 34) X 2 Nos.

- Bidirectional Multifunction
- 3 phase 3/4 wire, 415VAC, CT Input 5A
- LCD/LED display, Aux. supply 230V, 45-65Hz, 5W
- Measure V. I., Hz, Pf, KVA, KW, KWH
- Modbus RTU RS 485 for SCADA.

◆ Mesh bus Generator panel (EMT 41E) X 1 No.

- Consisting of 2-isolator switches,
- Circuit breaker, Generator bus, Grid bus, generator in feeder.
- 9 pin D (M) connector to interface with SCADA for automation.
- Manual start / stop with local trip contact.
- Power ON LED indicator

◆ **Mesh bus Grid panel (EMT 41F) X 1 No.**

- Consisting of 2-isolator switches,
- Circuit breaker, Generator bus, Grid bus, Grid in feeder.
- 9 pin D (M) connector to interface with SCADA for automation.
- Manual start / stop with local trip contact.
- Power ON LED indicator

◆ **Synchronization bus switch panel (EMT 41G) X 1 No.**

- Consisting of Circuit breaker, Main bus, Reserve bus.
- 9 pin D (M) connector to interface with SCADA for automation.
- Power ON LED indicator

◆ **415/110VAC, 50VA PT panel (EMT 54) X 2 No.**

- Consisting of potential transformer,
- Input 415VAC, star connected, Output 110VAC, star connected, 50VA.

◆ **Phase Angle meter panel (EMT 61) X 1 No.**

- Measure phase angle between two voltages
- Internally 2 PTs for isolation.
- Modbus RTU RS485 interface for SCADA.

◆ **37 pin D(M) to 9 pin D(F) converter panel (EMT 62) X 1 No.**

- Consist of 37 pin D type male 1 no., 9 pin D type male 1 no.
- 9 pin D type female connectors 9 nos.
- Power ON LED.

◆ **5 pin to shrouded socket converter panel (EMT 63) X 2 Nos.**

- Consist of 5 pin 3 phase, 5 wires industrial female socket to connect 415VAC 3 phase supply.
- Shrouded banana sockets 18 nos to extend the 3 phase supply into individual setups.
- It's used as bidirectional 3 phase extension board between two setups.

◆ **Synchronization relay panel (EMT 64) X 1 No.**

- Consist of automatic synchronization relay, Generator bus, Grid bus.
- 9 pin D (M) connector to interface with RTU/SCADA for automation.
- Auto/Manual switch selection.

Table top panels

◆ **Transmission line panel TL2 (EMT38A/B/C) X 1 No.**

- Consisting of 5 numbers of transmission lines.
- 2 Transmission lines of 0.3pu for 125Km.
- 2 Transmission lines of 0.2pu for 75Km.
- 1 Transmission line of 0.13pu for 50Km.

◆ **R load Panel (EMT42A & 42E) X 1 No.**

- 3 nos of 600W resistors with switch selectable 6 nos of taps at 100, 112, 150, 175, 200 & 225 ohm.
- Fault resistor 100ohm/600W.
- Multi pin heavy duty connector 32 pin & 24 pin to establish control from RTU/SCADA.

◆ **Grid transformer Panel (EMT54C) X 1 No.**

- 3 phase power transformer with connection group YY11,
- Input 415VAC, Output 415VAC, 5KVA,
- Secondary winding with tapping at 2.5% and 5%.

◆ **Mechanical Dimension (mm) / Wt. (Kg):**

- **Rack:** 1165(L) x 300(W) x 990(H) / **Net Wt.:** 65, **Gross Wt.:** 73
- **TL2:** 600(L) x 385(W) x 500(H) / **Net Wt.:** 103
- **Load & fault panel:** 600(L) x 275(W) x 500(H) / **Net Wt.:** 60
- **Grid X'mer:** 770(L) x 275(W) x 435(H) / **Net Wt.:** 53

Accessories:

a) **Tables for synchronization Setup : 1 no. consists of Pi type frame, Under trolley.**

- Frame:** 45X45 aluminum profile (Heavy duty) Colour: anodized white.
- Table top material/colour:** The nova pan or Rubber wood with white/Silver gray with smooth finish veneer finish table top (25 mm thickness) with removable central slot cover (900X500mm).
- Under Trolley:** Located under individual setup table to house respective load panel, transmission line panel variac panel, transformer etc as applicable.
- Dimension:** Table: 1450 mm (L) X 750 mm (W) X 760 mm (H). Under Trolley: 1200X700X185mm
- Caster wheels:** Four sturdy castor wheels with locking mechanism are provided so that table can be positioned conveniently.

b) **Cables:**

- 9 pin D male to 9 pin D female with 9 core cable, length = 0.450 to 6 meter - 6 nos.
- 37 pin D male to 37 pin D female patch cable, length = 4 meters - 1 no.
- RS485 patch cable: 6 pin mini DIN male to 6 pin mini DIN male, length 0.480 to 1.180 meter - 3 nos.

List of experiments:

- Automatic as well as manual Synchronization of generator with grid supply.
- Study of V curve & inverted V curve.
- Study of Generator performance chart.

DOUBLE BUS BAR TRAINER (Model : XPO-SPS/DBB)

Note : This is the part of XPO-SPS Training System.



Table top control panel Rack & under table variac, TL2 & RLC load panel

SALIENT FEATURES

- ◆ The Model represents a double bus bar switching station with 9 switching bays. It is equipped in such a way that the requirements of the both the grid and the power station operation are dealt in practice oriented way. Two bus bar segments are represented. Here the interlocking conditions in a switching station can be learned in order to conduct safe switching operations, as the situation requires, on the grid and power plant.
- ◆ The Double bus bar setup is used for 3 bus and four bus load flow study, study of voltage variation, control & voltage regulation for constant $\cos \phi$.
- ◆ Can use different KVA rating grid transformer in absence of actual generation setup to simulate source of power.
- ◆ Facilitates easy and safe wiring by students due to use of 4mm sturdy Shrouded banana patch cords and shrouded socket arrangements for high voltage circuits
- ◆ Each panel has ABS molded plastic sturdy enclosure, and colorful screwless overlays showing circuits diagrams & its connection tag numbers for easy understanding and connection
- ◆ Useful for Under Graduate Practicals, Post Graduate Projects and Research Purpose.
- ◆ Set of Instructor Guide & Student Workbook.

Technical Specifications

XPO-SPS/DBB trainer can work in standalone mode with simulated grid sources as well as in conjunction with Generation setup, Synchronisation Setup, HMI, RTU SCADA software and consists of following panels:

◆ In feeder Panel (EMT41A) X 4 Nos.

- Consisting of 3-isolator switches.
- Circuit breaker, Main bus, Reserve bus, Feeder.
- 9 pin D connector to interface with SCADA automation.
- Manual start/ stop with local trip contact.

◆ Bus Coupler Panel (EMT41B) X 2 Nos.

- Consisting of Circuit breaker, Main bus, Reserve bus.

- 9 pin D connector to interface with SCADA automation.
- Manual start/ stop with local trip contact
- ◆ **Out feeder Panel (EMT41C) X 2 Nos.**
- Consisting of 4-isolator switches,
- Circuit breaker, Main bus, Reserve bus, Transfer bus/Earth switch, Feeder.
- 9 pin D connector to interface with SCADA for automation.
- Manual start/ stop with local trip contact
- ◆ **Section Coupler Panel (EMT41D) X 1 No.**
- Consisting of 2 Circuit breakers, Main bus, Reserve bus.
- 9 pin D connector to interface with SCADA for automation.
- Manual start/ stop with local trip contact

◆ **3 Phase Bidirectional Power cum Energy meter panel**

(EMT 34) X 6 Nos.

- Bidirectional Multifunction
- 3 phase 3/4 wire, 415VAC, CT Input 5A
- LCD/LED display, Aux. supply 230V, 45-65Hz, 5W
- Measure V. I., Hz, Pf, KVA, KW, KWH
- Modbus RTU RS 485 for SCADA.

◆ **Phase Angle meter panel (EMT 61) X 1 No.**

- Measure phase angle between two voltages
- Internally 2 PTs for isolation.
- Modbus RTU RS 485 interface for SCADA.
- Green SBS5 socket is provided for extend earth.

◆ **37 pin D(M) to 9 pin D(F) converter panel (EMT 62) X 1 No.**

- Consist of 37 pin D type male 1 no., 9 pin D type male 1 no.
- 9 pin D type female connectors 9 nos.
- Power ON LED.

◆ **5 pin to shrouded socket converter panel (EMT 63) X 3 Nos.**

Text

- Consist of 5 pin 3 phase, 5 wires industrial female socket to connect 415VAC 3 phase supply.
- Shrouded banana sockets 18 nos to extend the 3 phase supply into individual setups.
- It's used as bidirectional 3 phase extension board between two setups.

Table top panels:

◆ **3 phase Dimmer panel (EMT20D) X 1 No**

- Consisting of 3 numbers of 1 phase dimmers connected in star.
- Input 415VAC, 60 Hz, Output 0-470VAC, 6A, 3 phase.

◆ **Transmission line panel TL2 (EMT38A/B/C) X 1 No.**

- Consisting of 5 numbers of transmission lines.
- 2 Transmission lines of 0.3pu for 125Km.
- 2 Transmission lines of 0.2pu for 75Km.
- 1 Transmission line of 0.13pu for 50Km.

◆ **RLC load Panel (EMT42A/B/C) X 1 No.**

- 3 nos of 600W resistors with switch selectable 6 nos of taps at 100, 112, 150, 175, 200 & 225 ohm.
- 3 nos of inductor 1.5H/1A with switch selectable 6 nos of taps at 0.3, 0.6, 0.75, 0.9, 1.2 & 1.5H.

- Capacitors 440VAC rating (3 nos, one per phase) with switch selectable 7 nos of value of 2, 5, 10, 15, 20, 30 & 50 μ F.
- Multi pin heavy duty connector 32 pin & 24 pin to establish control from RTU/SCADA.

Accessories:

a) Tables for DBB Setup : 1 no. consist of Pi type frame, Under trolley.

- i) Frame: 45X45 aluminum profile (Heavy duty) Colour: anodized white.
- ii) Table top material/colour: The nova pan or Rubber wood with white/Silver gray with smooth finish veneer finish table top (25 mm thickness) with removable slot cover (900X500mm).
- iii) Under Trolley: Located under individual setup table to house respective load panel, transmission line panel variac panel, transformer etc as applicable.
- iv) Dimension: Table: 1450 mm (L) X 750 mm (W) X 760 mm (H). Under Trolley: 1200X700X185mm
- v) Caster wheels: Four sturdy castor wheels with locking mechanism are provided so that table can be positioned conveniently.

b) Cables:

- i) 9 pin D male to 9 pin D female with 9 core cable, length up to 6 meter – -9 nos.
- ii) 37 pin D male to 37 pin D female patch cable, length 4 meters – -1 no.
- iii) RS485 patch cable: 6 pin mini DIN male to 6 pin mini DIN male, length up to 1230mm -6 nos.
- iv) 3 phase power extension: 5 pin 3phase plug male to 5 pin 3 phase plug male cable, 1.5 meter -1 nos.

◆ **Mechanical Dimension (mm) / Wt. (Kg):**

- **Rack:** 1165(L) x 300(W) x 990(H) / **Net Wt.:** 65, **Gross Wt.:** 73.
- **Variac panel:** 600(L) x 275(W) x 500(H) / **Net Wt.:** 53
- **TL2:** 600(L) x 385(W) x 500(H) / **Net Wt.:** 103
- **RLC Load panel:** 600(L) x 275(W) x 500(H) / **Net Wt.:** 60

List of experiments:

- i) Study of voltage variation & control.
- ii) Study of voltage regulation for constant cos Φ .
- iii) 3 bus load flow study.
- iv) 4 bus load flow study.

POWER TRANSMISSION & DISTRIBUTION TRAINER (Model : XPO-SPS/TLD)

NOTE: This is part of XPO-SPS Training System.



Table top control panel Rack & under table Distri. X'mer, TL1 & RLC load panel

SALIENT FEATURES

- ◆ This setup is used for transmission line study for short as well as long line Pi model, ferranti effects, load regulation / efficiency calculations, symmetric/asymmetric fault study. This setup also covers protection of transmission line using multi function **numeric distance protection relay** and of distribution transformer using multi function **numeric transformer protection relay**.
- ◆ The protection relays are connected to RTU/SCADA over RS485 to display all fault records on SCADA screen.
- ◆ Emergency stop mushroom switch is provided with security key lock on the profile rack.
- ◆ Facilitates easy and safe wiring by students due to use of 4mm sturdy Shrouded banana patch cords and shrouded socket arrangements for high voltage circuits
- ◆ Each panel has ABS molded plastic sturdy enclosure, and colorful screwless overlays showing circuits diagrams & its connection tag numbers for easy understanding and connection
- ◆ Useful for Under Graduate Practicals, Post Graduate Projects and Research Purpose.
- ◆ Set of Instructor Guide & Student Workbook.

Technical Specifications

XPO- SPS/TLD trainer can work in standalone mode as well as in conjunction with HMI, RTU SCADA software and consists of following panels:

◆ Input 3 phase DOL Starter panel (EMT1) X 1 No

- 4 pole MCB of 415 V/4A.
- DOL 16A Contactor with 24DCV / 11VACOIL
- Bimetallic thermal O/L relay with range 2.5A - 6A
- RYB inputs indicators.
- 9 pin D (M) connector for RTU/SCADA interface.
- Manual start / stop with local trip contact
- Power ON LED indicator
- Green SBS5 socket is provided for extend earth.

◆ FWD-OFF-REV, Switch Panel (EMT 4A) X 1 No.

- FWD/REV, 3 pole 3 way switch with center OFF, 6A/440V.
- ◆ **3 Phase Bidirectional Power cum Energy meter panel (EMT 34) X 3 Nos.**
- Bidirectional Multifunction
- 3 phase 3/4 wire, 415VAC, CT Input 5A

- LCD/LED display, Aux. supply 230V, 45-65Hz, 5W
- Measure V. I., Hz, Pf, KVA, KW, KWH
- Modbus RTU RS 485 for RTU/SCADA interface.

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- Modbus RTU RS 485 for RTU/SCADA interface.

◆ VAR Compensation panel (dual panel) (EMT43) X 1 No.

- Consisting of VAR compensating capacitors of 2, 4, 6, 8, 10 & 15 μ F each of 3 nos with 3 pole 7 way switch for selection.

◆ Differential Relay (Transformer protection) panel (EMT 47C) X 1 No.

- Protections: Differential, Over current, Under/Over voltage, Under/Over frequency, Reverse power, Earth fault.
- 9 pin D (M) connector to interface with RTU/SCADA for automation.
- Modbus RTU RS 485 for RTU/SCADA interface.

◆ CT panel (EMT48) X 2 No.

- Consist of 5/5 Amp. CT 6 Nos.
- Primary side of CTs are brought on 3 x 2 x 2 SBS-5 sockets.
- Secondary side of CTs are Star connected in group of 3 & brought out on 4 x 2 SBS-5 sockets

◆ Distance protection Relay panel (EMT 53) X 1 No.

- Protections: Distance, Over current, Under/Over voltage, Earth fault.
- Auto reclose function of relay
- 9 pin D (M) connector to interface with RTU/SCADA for automation.
- Modbus RTU RS 485 for RTU/SCADA interface.
- ◆ **415/110VAC, 50VA PT panel (EMT 54) X 1 No.**
- Consisting of potential transformer,
- Input 415VAC, star connected, Output 110VAC, star connected, 50VA.
- ◆ **37 pin D(M) to 9 pin D(F) converter panel (EMT 62) X 1 No.**
- Consist of 37 pin D type male 1 no., 9 pin D type male 1 no.
- 9 pin D type female connectors 9 nos.
- Power ON LED.
- ◆ **5 pin to shrouded socket converter panel (EMT 63) X 2 Nos.**
- Consist of 5 pin 3 phase, 5 wires industrial female socket to connect 415VAC 3 phase supply.
- Shrouded banana sockets 18 nos to extend the 3 phase supply into individual setups.
- It's used as bidirectional 3 phase extension board between two setups.

Table top panels:

◆ Distribution transformer Panel (EMT54D) X 1 No.

- 3 phase power transformer with connection group Yy11,
- Input 415VAC, Output 415VAC, 3KVA,
- Secondary winding with tapping at $\pm 2.5\%$ and $\pm 5\%$.

◆ Transmission line Panel (EMT38 & 42E)

Table Top Panel consisting of:

- Simulated model for transmission line (250kms) using R(10 ohm/600W), L(0.15H/5A) & C (2.2uF/630V) 6 No. each component.
- Simulated model for medium/long length transmission line for pi model.
- Simulated model for medium/long length transmission line for T model
- Fault resistor 100ohm/600W.
- Multi pin heavy duty connector 32 pin & 24 pin to establish control from RTU/SCADA.
- ◆ **RLC load Panel (EMT42A/B/C) X 1 No.**
- 3 nos of 600W resistors with switch selectable 6 nos of taps at 100, 112, 150, 175, 200 & 225 ohm.
- 3 nos of inductor 1.5H/1A with switch selectable 6 nos of taps at 0.3, 0.6, 0.75, 0.9, 1.2 & 1.5H.
- Capacitors 440VAC rating (3 nos, one per phase) with switch selectable 7 nos of value of 2, 5, 10, 15, 20, 30 & 50 μ F.
- Multi pin heavy duty connector 32 pin & 24 pin to establish control from RTU/SCADA.
- ◆ **Mechanical Dimension (mm) / Wt. (Kg):**
- **Rack:** 1165(L) x 300(W) x 990(H) / **Net Wt.:** 65, **Gross Wt.:** 73.
- **TL1:** 600(L) x 385(W) x 500(H) / **Net Wt.:** 103
- **RLC Load panel:** 600(L) x 275(W) x 500(H) / **Net Wt.:** 60

- **Distri. X'mer:** 770(L) x 275(W) x 435(H) / **Net Wt.:** 53

Accessories:

- Tables for Transmission & Distribution Setup : 1 no. consists of Pi type frame, under trolley.
 - Frame:** 45X45 aluminum profile (Heavy duty) Colour: anodized white.
 - Table top material/colour:** The nova pan or Rubber wood with white/Silver gray with smooth finish veneer finish table top (25 mm thickness) with removable slot cover (900X500mm).
 - Under Trolley:** Located under individual setup table to house respective load panel, transmission line panel variac panel, transformer etc as applicable.
 - Dimension:** Table: 1450 mm (L) X 750 mm (W) X 760 mm (H). Under Trolley: 1200X700X185mm
 - Caster wheels:** Four sturdy castor wheels with locking mechanism are provided so that table can be positioned conveniently.
- b) Cables:**
- 9 pin D male to 9 pin D female with 9 core cable, length up to 4 meter -4 nos.
 - 37 pin D male to 37 pin D female patch cable, length = 4 meters -1 no.
 - RS485 patch cable: 6 pin mini DIN male to 6 pin mini DIN male, length up to 4 meters -5 nos.
- c) Signal tower:** 4 nos. of fixed function lamps and 1 Alarm sound all mounted one above another in classic bayonet system by means of a simple half rotation manual operation, mounted on right vertical member of the TLD rack and are driven from 24V DC output of PLC using 37 pin D converter panel. The signal tower is used to indicate following conditions-
- **Red lamp paralleled with sounder** - When any Relay trips, Red lamp will flash at 0.75Hz and the alarm is sounded until fault accept button is pressed.
 - **Orange lamp** - When an Emergency stop button is pressed, the 3 Ph. supply of Grid and Generator is made OFF and Orange lamp will flash at 0.75Hz until fault accept button is pressed.
 - **Green lamp** - When Default state is pressed Green lamp will ON for 1sec & OFF for 3sec which indicate all CB's and isolators OFF. When any of the CB or isolator is switched ON then green light will flash at 0.75Hz indicating SCADA in operation.
 - **Blue lamp** - When Grid is AUTO synchronized with Generator the Blue will flash at 0.75Hz.
- List of experiments:**
- Study of No load test and Ferranti effects on transmission line.
 - Load test and calculation of efficiency, regulation and power flow in pi model of TL.
 - Load test and calculation of efficiency, regulation and power flow in short model of TL
 - Study of symmetrical and asymmetrical faults on transmission line.
 - Study of distance protection using distance relay.
 - Study of Auto reclose function of distance relay.
 - Study of Distribution transformer protection for differential &