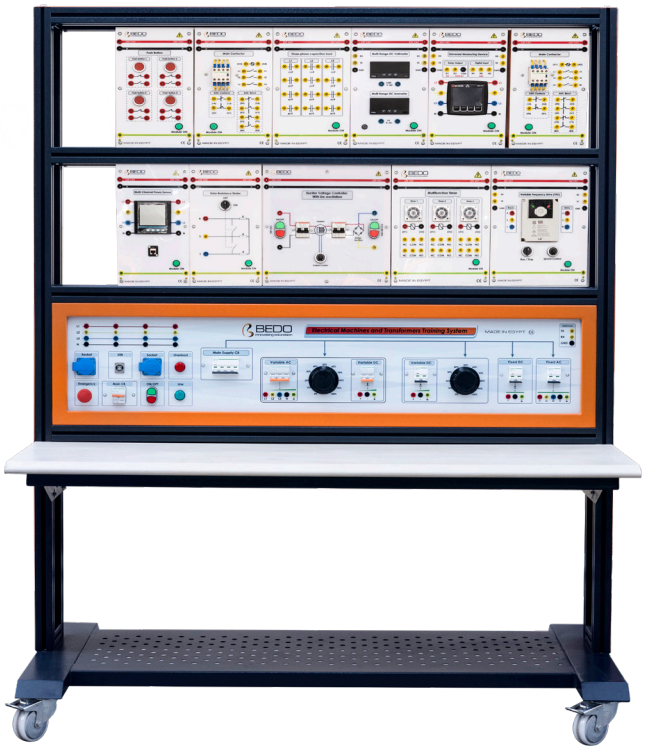
ML-500

Electrical Machines & Transformer Lab 500 Watts

Overview

This laboratory is designed to allow students to learn about DC and AC machines and transformers.The Laboratory is supplied with Different type of components such as motors, load units, measuring units and universal power supplies.The trainees can perform various types of experiments by connecting set of cable to a 4mm safety banana socket.The laboratory includes interactive softwares which can display measured units and plot the results.





Specifications

Main Modules Kit

Code: (ML-500.1)

AC digital multimeter (ML-500.1.1)

- Technical Data:
  - » Input: 220 V, 50Hz via 4 mm safety banana socket
  - » measurement inputs:
  - » 10 - 300 V AC
  - » 0.2 – 5.50 A AC
  - » 30 - 100 Hz
  - » accuracy: volts-amps-hz: 0.5% digits
  - » Fuse Protection

Universal measuring device (ML-500.1.2)

- Technical Data
  - » true rms measurements, 0.2% accuracy

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- » 3.5" tft lcd, 320x240 pixels
- » harmonic distortion display (63 harmonics)
- » oscilloscope, waveform display
- » phasor diagram display
- » internal battery backed-up real time clock
- » max demand display
- » user configurable display screen
- » 2 configurable relay outputs
- » energy pulse output capability
- » 2 opto-isolated, configurable digital inputs
- » dual active-reactive power counters
- » both mains/generator energy metering
- » configurable user counters
- » voltage transformer ratio for mv applications
- » password protected front panel programming
- » reduced panel depth
- » sealed front panel (ip54)
- » measurements:
  - Phase to phase voltages: u12-u23-u31-uavg
  - Phase to neutral voltages: v1-v2-v3-vavg
  - Phase currents: i1-i2-i3-in-iavg-itot
  - Active power: p1-p2-p3-∑p
  - Reactive power: q1-q2-q3-∑q
  - Apparent power: s1-s2-s3-∑s
  - Power factor: cos1-cos2-cos3-∑cos
  - Active power counters: pc1-pc2
  - Reactive power counters: qc1-qc2
  - User counters: usr1-usr2-usr3-usr4
  - 2...63 harmonics of any voltage or current
  - Phase to neutral voltages vector angles
  - Phase to phase voltages vector angles
  - Phasor vector diagram

Variable Frequency Drive (VFD) (ML-500.1.3)

- Technical Data:
  - » 3 phase 380V Input
  - » 3 phase 380V Output
  - » Control Speed of three phase induction motor squirrel cage and slip ring
  - » Input and outputs from 4 mm banana sockets
  - » 3.5 HP

Universal switch unit (ML-500.1.4)

- Universal switch unit with all necessary switches and push-buttons for switching various motors with a power rating up to 3kW.
- Switch elements:
  - » 1x Emergency STOP push-button
  - » 2X Push-button 1 NO/1 NC, green
  - » 1X Push-button 1 NO/1 NC, red
  - » 1X Cut off switch, 3-pole
  - » 1X Pole change-over switch, Dahlander
  - » 1X Pole change-over switch for separate windings
  - » Nominal voltage: 230/400V, max 500V
  - » Nominal current: 16A
  - » Frequency: 50/60Hz
  - » Inputs & outputs: 4 mm safety sockets

Squirrel cage motor fault simulator (ML-500.1.5)

- The ends of the stator windings are connected to a series of switchesthat, when activated, simulate common faults on the motor.
- The instructor activates the switches to simulate faults and assigns to the student the task of analyzing and explaining them.
- When all switches are in their normal position, the motor behaves as a typical cage motor.
- Technical Data:
  - » Nominal power approx.: 0,25 kW
  - » Nominal speed approx. 1500 rpm
  - » input voltage volts (Δ/y) 230/400 V
  - » Frequency: 50 Hz

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Three-phase transformer (ML-500.1.6)

- Can be used as single phase, Auto transformer, Step up or down and three-phase transformer
- Technical Data:
  - » Input voltage: 3x 230, 50/60Hz,
  - » Output voltage: 6x 115V
  - » Power: 3000VA
  - » Protection via motor protection switch
  - » Inputs and Outputs Via 4mm Safety Sockets
  - » Contains a special isolating transformer with a thermal protection switch

Regulating transformer, exciter 0-200V (ML-500.1.7)

- Variable isolating transformer as exciter 0-200 V for field excitation of DC, synchronous and multi-function machines.
- Output voltage: 0...200 V, 2 A AC/DC, 0...30 V, 10 A AC/DC
- Voltage supply: 230 V, 50 Hz via 2mm mains cable or 4mm sockets.

Exciter voltage controller with de-excitation (ML-500.1.8)

- The exciter voltage controller is used in experiments involving synchronization.
- The de-excitation switch is used in generator protection measures and is responsible for the disconnection of the generator from the grid and its de-excitation in the event of a fault.
- Technical Data:
  - » Output: DC 200 V/2 A
  - » 2X Inputs for voltage boosting and decreasing
  - » 1X Input for de-excitation using a relay
  - » 1X Input for switching the DC voltage on
  - » 2X Push-buttons for switching the DC voltage on and off
  - » Incremental rotary encoder for setting the voltage
  - » Inputs and outputs: 4-mm safety sockets
  - » Power supply: 230 V, 50/60 Hz

Synchronization unit (ML-500.1.9)

- The Synchronization Unit consist of:
- Synchronizer display (comprising 3 lamps) is used to display voltage and phase angles between generator and power supply circuit (light-dark indication)
- Zero voltmeter 0….400V
- Double frequency meter FROM 47 TO 53 HZ
- Double voltmeter 0 TO 500 V
- Digital synchronoscope
  - Technical Data:
    - » Generator voltage: 300 V-AC max. (Ph-N)
    - » Generator frequency: 0-100 Hz.
    - » Busbar voltage: 300 V-AC max. (Ph-N)
    - » Busbar frequency: 50/60 Hz.
    - » Digital inputs: 0 - 30 V-DC DC
    - » Supply Range: 9.0 to 33.0 V-DC
    - » synchronization switch
    - » Operating voltage: 400V

Software

Code: (ML-500.2)

- Electrical machines & transformers trainer interactive software with remote learning facility.
- Measurements and graphics can be saved within the experiment instructions by means of drag and drop .
- The software can detect the machine under test, and display its name plate.

500 Watts Machines 3000 RPM (Not Included)

Code: (ML-500.3)

- The windings ends are connected to 4 mm safety sockets in a metal housing on top of which a clear electrical drawing shows the internal Logic of the machine.
- The students can therefore easily understand operation and windings connections.
- Include electronic name plate for machine parameters for automatic machine identification.
- Relevant machine data is automatically uploaded
- Pre-setting of scaling in the software
- **DC. Brake Test Bench (ML-500.3.1)**
  - » A full test bench used to perform experiments of loading on different machines to determine the characteristics of any motor like torque-speed characteristics.

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» The test bench is powered from the main trainer through power cable and protected with on/off, emergency switches.

» The trainer is connected to the main software through a RS-485 Connection via 4mm safety bananas

» The trainer is capable of automatically identify the machine under test via audio socket cable.

» The Test Bench consists of :

- **Resistive potentiometer to apply electrical load on the machine under test**
- **Digital meter to show the speed of the shaft**
- **Braking DC Generator:**
  - » Nominal shaft speed: 3000 rpm
  - » Rated braking power: 500W
  - » Rated generated output voltage: 220VDC
  - » Nominal excitation voltage: 220VDC
- **Tacho-Generator :**
  - » 20V/1000RPM
  - » rated Speed: 3000RPM
- **Load Cell:**
  - » 20Kg, 2mV/V

- **Three-Phase Asynchronous Squirrel Cage Motor (ML-500.3.2)**
  - » Nominal shaft speed: 3000 rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VAC / 380VAC
  - » Rated operating frequency: 50Hz
- **Three-Phase Slip Ring Motor (ML-500.3.3)**
  - » Nominal shaft speed: 3000 rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VAC / 380VAC
  - » Rated operating frequency: 50Hz
- **Three-Phase Synchronous Machine (ML-500.3.4)**
  - » Nominal shaft speed: 3000 rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VAC / 380VAC
  - » Rated operating frequency: 50Hz
- **Three-Phase Double Speed Induction Motor (ML-500.3.5)**
  - » Nominal shaft speed: 3000/1500 rpm
  - » Rated output power: 500/350W
  - » Rated input voltage: 380VAC
  - » Rated operating frequency: 50Hz
- **Single-Phase Universal Motor (ML-500.3.6)**
  - » Nominal shaft speed: 3000 rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VAC/VDC
  - » Rated operating frequency: 50Hz
- **Single-Phase Capacitor-Start Motor (ML-500.3.7)**
  - » Nominal shaft speed: 3000 rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VAC
  - » Rated operating frequency: 50Hz
- **DC Compound Machine (ML-500.3.8)**
  - » Nominal shaft speed: 3000 rpm
  - » Rated output power: 500W
  - » Rated armature voltage: 220VDC
  - » Rated field voltage: 220VDC
- **DC Series Machine (ML-500.3.9)**
  - » Nominal shaft speed: 3000 rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VD
- **DC Shunt/Separately Excited Machine (ML-500.3.10)**
  - » Nominal shaft speed: 3000 rpm
  - » Rated output power: 500W
  - » Rated armature voltage: 220VDC
  - » Rated field voltage: 220VDC
- **Braking DC Generator(ML-500.3.11)**
  - » Nominal shaft speed: 3000 rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VDC
- **Dynobrake Dc Generator (ML-500.3.12)**
  - » Nominal shaft speed: 3000 rpm
  - » Rated output power: 500W
  - » Rated generated output voltage: 220VDC
  - » Nominal excitation voltage: 220VDC
- **Three-Phase Squirrel Cage Induction Motor Cutaway (ML-500.3.13)**
  - » Nominal power approx.: 0,25 kW
  - » Nominal speed approx. 1400 rpm

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» Nominal input voltage volts (Δ/y) 230/400V

» Frequency: 50 Hz

Additional modules for 500watt 3000 rpm machines (ML-500.3.15)

- **Motor Protection Switch**

  Power circuit breaker including thermal overload trip and overcurrent trip

  » 1X Motor protection switch, 1...1.6A

  » Contact rating: 500V, 10A

- **Resistive Load**

  » **Resistive load for DC generator (with rotary switching)**

  - Rated operating voltage: 220VDC
  - Number of steps: 7
  - Loading capability at first step: 75W
  - Loading capability at last step: 500W

  » **Resistive load for DC generator (with continuous variation)**

  - Rated operating voltage: 220VDC
  - Range of resistance value: 95ohm (min) to 300ohm (max)
  - Loading capability at max resistance value: 161W
  - Loading capability at minimum resistance: 500W

  » **Resistive load for 3-phase synchronous generator (with rotary switching)**

  - Rated operating voltage: 220VAC / 380VAC
  - Number of steps per phase: 5
  - Minimum loading capability per phase: 53W
  - Maximum loading capability per phase: 165W

  » **Resistive load for 3-phase synchronous generator (with continuous variation)**

  - Rated operating voltage: 220VAC / 380VACRange of resistance value per phase: 295ohm (min) to 0.91Kohm (max)
  - Minimum loading capability per phase: 53W
  - Maximum loading capability per phase: 165W

- **Inductive Load**

  » **Inductive load for 3-phase synchronous generator (with rotary switching)**

  - Rated operating voltage: 220VAC / 380VAC
  - Number of steps per phase: 7
  - Minimum loading capability per phase: 53VAR
  - Maximum loading capability per phase: 165VAR

- **Capacitive Load**

  » **Capacitive load for 3-phase synchronous generator (with rotary switching)**

  - Rated operating voltage: 220VAC / 380VAC
  - Number of steps per phase: 5
  - Minimum loading capability per phase: 53VAR
  - Maximum loading capability per phase: 165VAR

500 Watts Machines 1500 RPM (Not Included)

Code: (ML-500.4)

- The windings ends are connected to 4 mm safety sockets in a metal housing on top of which a clear electrical drawing shows the internal Logic of the machine.
- The students can therefore easily understand operation and windings connections.
- Include electronic name plate for machine parameters for automatic machine identification.
- Relevant machine data is automatically uploaded
- Pre-setting of scaling in the software
- **DC. Brake Test Bench (ML-500.4.1)**

  » A full test bench used to perform experiments of loading on different machines to determine the characteristics of any motor like torque-speed characteristics.

  » The test bench is powered from the main trainer through power cable and protected with on/off, emergency switches.

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» The trainer is connected to the main software through a RS-485 Connection via 4mm safety bananas

» The trainer is capable of automatically identify the machine under test via audio socket cable.

» The Test Bench consists of :

- **Resistive potentiometer to apply electrical load on the machine under test**
- **Digital meter to show the speed of the shaft**
- **Braking DC Generator:**
  - » Nominal shaft speed: 1500 rpm
  - » Rated braking power: 500W
  - » Rated generated output voltage: 220VDC
  - » Nominal excitation voltage: 220VDC
- **Tacho-Generator :**
  - » 20V/1000RPM
  - » rated Speed: 3000RPM
- **Load Cell:**
  - » 20Kg, 2mV/V

- **Three-Phase Asynchronous Squirrel Cage Motor (ML-500.4.2)**
  - » Nominal shaft speed: 1500rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VAC / 380VAC
  - » Rated operating frequency: 50Hz
- **Three-Phase Slip Ring Motor (ML-500.4.3)**
  - » Nominal shaft speed: 1500rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VAC / 380VAC
  - » Rated operating frequency: 50Hz
- **Three-Phase Synchronous Machine (ML-500.4.4)**
  - » Nominal shaft speed: 1500rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VAC / 380VAC
  - » Rated operating frequency: 50Hz
- **Three-Phase Double Speed Induction Motor (ML-500.4.5)**
  - » Nominal shaft speed: 3000/1500rpm
  - » Rated output power: 500/350W
  - » Rated input voltage: 380VAC
  - » Rated operating frequency: 50Hz
- **Single-Phase Capacitor-Start Motor (ML-500.4.6)**
  - » Nominal shaft speed: 1500rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VAC/VDC
  - » Rated operating frequency: 50Hz
- **DC Compound Machine (ML.002.5.7)**
  - » Nominal shaft speed: 1500rpm
  - » Rated output power: 500W
  - » Rated armature voltage: 220VDC
  - » Rated field voltage: 220VDC
- **DC Series Machine (ML-500.4.8)**
  - » Nominal shaft speed: 1500rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VDC
- **DC Shunt/Separately Excited Machine (ML-500.4.9)**
  - » Nominal shaft speed: 1500rpm
  - » Rated output power: 500W
  - » Rated armature voltage: 220VDC
  - » Rated field voltage: 220VDC
- **DC Permanent Magnet Machine (ML-500.4.10)**
  - » Nominal shaft speed: 1500rpm
  - » Rated output power: 500W
  - » Rated input voltage: 220VDC
- **Braking DC Generator (ML-500.4.11)**
  - » Nominal shaft speed: 1500rpm
  - » Rated output power: 500W
  - » Rated generated output voltage: 220VDC
  - » Nominal excitation voltage: 220VDC
- **Three-Phase Squirrel Cage Induction Motor Cutaway (ML-500.4.12)**
  - » Nominal power approx.: 0,25 kW
  - » Nominal speed approx. 1400 rpm
  - » Nominal input voltage volts (Δ/y) 230/400V
  - » Frequency: 50 Hz

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- **Additional modules for 500 watt 1500 rpm machines (ML-500.4.14)**
  - **Motor Protection Switch**

    Power circuit breaker including thermal overload trip and overcurrent trip
    - » 1X Motor protection switch, 1...1.6A
    - » Contact rating: 500V, 10A
  - **Resistive Load**
    - » **Resistive load for DC generator (with rotary switching)**
      - Rated operating voltage: 220VDC
      - Number of steps: 7
      - Loading capability at first step: 75W
      - Loading capability at last step: 500W
    - » **Resistive load for DC generator (with continuous variation)**
      - Rated operating voltage: 220VDC
      - Range of resistance value: 95ohm (min) to 300ohm (max)
      - Loading capability at max resistance value: 161W
      - Loading capability at minimum resistance: 500W
    - » **Resistive load for 3-phase synchronous generator (with rotary switching)**
      - Rated operating voltage: 220 VAC / 380 VAC
      - Number of steps per phase: 5
      - Minimum loading capability per phase: 53W
      - Maximum loading capability per phase: 165W
    - » **Resistive load for 3-phase synchronous generator (with continuous variation)**
      - Rated operating voltage: 220VAC / 380VACRange of resistance value per phase: 295ohm (min) to 0.91Kohm (max)
      - Minimum loading capability per phase: 53W
      - Maximum loading capability per phase: 165W
  - **Inductive Load**
    - » **Inductive load for 3-phase synchronous generator (with rotary switching)**
      - Rated operating voltage: 220VAC / 380VAC
      - Number of steps per phase: 7
      - Minimum loading capability per phase: 53VAR
      - Maximum loading capability per phase: 165VAR
  - **Capacitive Load**
    - » **Capacitive load for 3-phase synchronous generator (with rotary switching)**
      - Rated operating voltage: 220VAC / 380VAC
      - Number of steps per phase: 5
      - Minimum loading capability per phase: 53VAR
      - Maximum loading capability per phase: 165VAR

Servo machine test Stand (Not Included) Code: (ML-500.5)

- The servo-machine test bench is a complete testing system for examining electrical machines and drives. It consists of a digital controller, a brake and the software. The system combines state-of-the-art technology with ease of operation.
- The system also allows manual and automated synchronization to be carried out.
- The controller has the following features:
  - » Dynamic and static four-quadrant operation
  - » Selectable operating modes/ machine models (torque control, speed control.
  - » Interface for reading electronic nameplates EDD of the machines under test
  - » Integrated galvanically isolated amplifier for voltage and current measurement
  - » Colour touch display
  - » Four-quadrant monitor
  - » Isolated USB interface
  - » Connection voltage: 400V, 45...65Hz
- The motor and sensor leads are connected via polarity-safe plugs. The machine has thermal monitoring and, in conjunction with the controller, it constitutes a driving and braking system that is free of drift and requires no calibration.

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- **Technical Data:**
  - » Maximum speed: 3000 RPM
  - » Maximum Voltage: 3~, 220V
  - » Maximum Current: 12.75A
  - » Motor Capacity : 3.5 kw
  - » Resolver resolution: 3000 pulses/ revolution
- **Software features**
  - » Measurement, calculation and display of mechanical and electrical variables (Speed, torque, mechanical power output, current, voltage, active, apparent and reactive power, efficiency, power factor).
  - » Reading Electronic nameplates of the machines under test.
  - » Simultaneous display of measured and calculated values (e.g. instant display of efficiency)
  - » Measurement of voltage and current (including RMS values even for non-sinusoidal waveforms)
  - » Speed or torque-controlled operation
  - » Recording of variables over time
  - » Programming of limiting values of speed or torque to prevent inappropriate loading of the machine under test.
  - » Operation in all four quadrants (display of generated torque)
  - » Export of graphics and measurements

Special Machines (ML-500.6)

- » Upon customer request

Experiments

DC Machines

- **Motor Operation:**
  - Connection for Series, Shunt and Compound Motors.
  - Reversing Direction of rotation by Reversing voltage polarity
  - Open Loop Speed Control of DC Motors by Varying armature and field Current.
  - Study Characteristics of Dc Motors
    - » Torque VS Speed.
    - » Torque Vs Armature Current
    - » Torque Vs Field Current
    - » Armature Current VS Field Current
  - Swinburne's test.
  - Retardation test.
- Generator Operation:
  - Connection for Series, Shunt and Compound Machines.
  - Difference between self-excited and separately excited DC Machines.
  - Function and application of field regulator
  - Study Characteristics of Dc Generators.
    - » Armature voltage Vs Speed of prime over (no-load condition).
    - » Armature voltage Vs Field Current
    - » Speed of prime over Vs Load Current
    - » Armature Voltage VS Load Current
  - Retardation test
  - Determination of Armature Current and Armature Voltage at constant speed and constant exciter current.

Transformers

- Study of excitation phenomena in single phase transformers
- Open circuits and short circuits tests of single-phase transformer
- Load test and parallel operations of single-phase transformer.
- Back to back testing of single-phase transformer (Sumpner's Test).
- Separation of Hysteresis and Eddy Current Losses In Single Phase Transformer
- Three phase and multi winding transformer connections for 3 – phase circuit
- Three-phase Transformer Vector groups.
- Three phase to two phase transformer and open delta connection

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- Measurements of The Transformation Ratio
- Operation of Isolating Transformers and autotransformer.

AC Machines

- Asynchronous AC Machines
  - » Motor Connection for single and three phase motors.
  - » Reverse rotation of single and three phase motors.
  - » Manual Switching for single and three phase induction motors.
  - » Speed control of Three phase Induction motor by
    - Rotor injected EMF
    - Rotor Impedance Control
    - Varying Supply Frequency
  - » Determination of torque-speed characteristics of three-phase induction machine in braking, motoring and generating regions.
  - » Determination of parameters (No load, Locked Rotor) and performance (Load Test) of single and three phase machines.
  - » Grid and stand-alone connections For Three Phase Induction Generator
  - » Starting Three-Phase Induction Motor Slip Ring By Rotor Resistance Starter

Special Machines

- Connecting and operating universal motor by Ac And DC Supply
- load test For universal motors
- Synchronous AC Machine
  - Motor Operation
    - » Motor Connection for Three-Phase Salient Pole Synchronous Motor
    - » Starting Three-Phase Salient Pole Synchronous Motor
    - » Reversing Rotation of Three-Phase Salient Pole Synchronous Motor
    - » V and Λ curves of Three-Phase Salient Pole Synchronous Motor
  - Generator Operation
    - » V and Λ curves (No load and Loaded)
    - » Under and over excitation
    - » Connecting and Starting Synchronous Motor as Alternator.
    - » Voltage setting via exciter current.
    - » Open circuit, Short circuit and zero power factor characteristics.
    - » Stability limits And Power Angle Curve of Synchronous Generator.
    - » Excitation and Load Angel.
    - » Determination of Xd and Xq of a salient pole synchronous machine from slip test.

Synchronization Experiments

- Load sharing of 3 phase induction generator and the grid.
- Design and connecting of synchronization unit.
- Comparison of bright, dark and three-lamp synchronizing circuit .

Fault Simulation on Electrical machines

- Winding breaks in the coils
- Insulation faults winding to winding
- Insulation faults winding to frame
- Combination of different faults

Manual Switching and Contactor switching circuits:

- Switching three-phase induction motor squirrel cage on and off
- Star-delta and star-delta reversing of three phase induction motor squirrel cages.
- Dahlander connecting for two speed motor (Y/Y)

Contactors and switching circuits:

- On/Off Switch for different motors
- Star/delta and star/delta reversing switch and circuit
  - Automatic star/delta and star/delta reverse circuit
- Motor protection circuit breaker
- Contractor circuit with
  - » Latching relay
  - » Relay and fault indication
  - » Latching fault indication

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- » Time delay relay (Delay Drop out)
- » Time delay relay (Delay Pull on)
- Pulsed contactor circuit
- Reversing contactor with
- » Contactor interlock
- » Contactor and button interlock
- Limit control with mechanical end-limit and reversing switching

Scope of Delivery

- Electrical Machines &Transformer 500 Watts (ML-500)
  - » Main Modules Kit (ML-500.1)
  - » Software (ML-500.2)
- Hard copy user manual

Required for Operation

- Machine & Drive Lab Supply Unit (ML-100)
- To Perform the trainer experiments you must choose one of the following Machine sets:
  - » 500 Watts Machines 3000 RPM (ML-500.3)
  - » 500 Watts Machines 1500 RPM (ML-500.4)
- Laboratery PC

Options

- Servo machine test Stand (ML-500.5)
- Special Machines (ML-500.6)
- 500W AC Drives kit (AD-500)
- 500W DC Drives kit (DD-500)
- Digital content (BI-01)
- Storage Unit (BI-03)

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