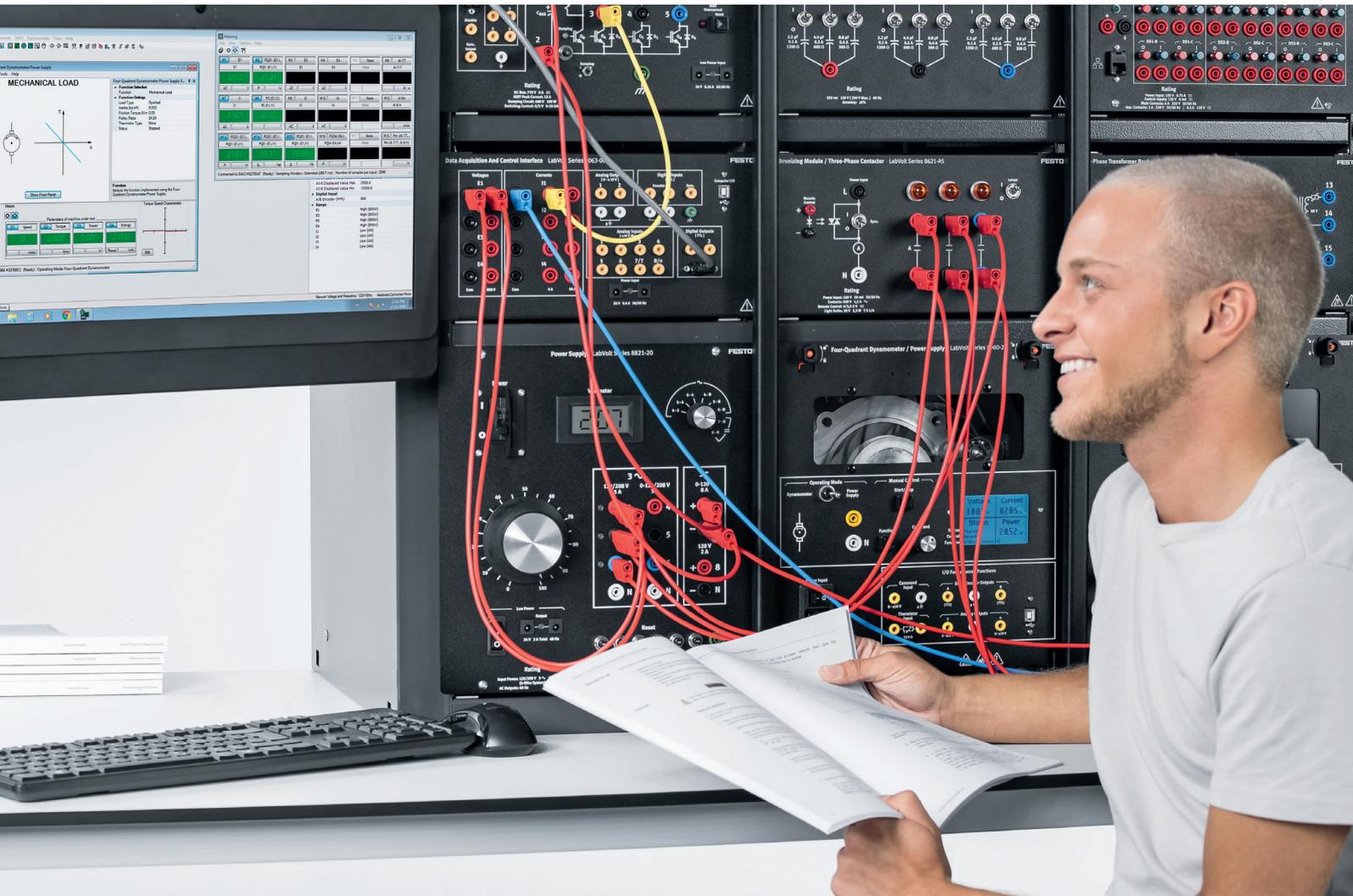


Electric Power Technology Training Program Flowchart



Strengthening Education in Electrical Engineering

Practical Training in the Field of Electrical Energy

Training Aligned to Industry

Demand for electricity is booming and several trends change the energy landscape. The production of energy using renewable natural resources such as wind, sunlight, water, etc. has gained in importance in recent years as an effective means of reducing greenhouse gas emissions. The popularity of electric vehicles is rising. Power grids are getting smarter. The electrification of buildings and industrial or commercial processes and applications continues. Energy efficiency is a boiling issue. These trends directly impact on the number of qualified workers needed and training requirements.

Electrical engineering intersects with a growing number of occupations. Strengthening education in this discipline is paramount; training programs and courses need to be closely aligned with the industry and cover all relevant topics. This is precisely the aim of the Electric Power Technology Training Program from Festo Didactic.

A Unique Program

The Electric Power Technology Training Program was developed to answer the increasingly diversified training needs in the wide field of electrical energy. Carefully elaborated courses around core technology topics combine theory with practical exercises.

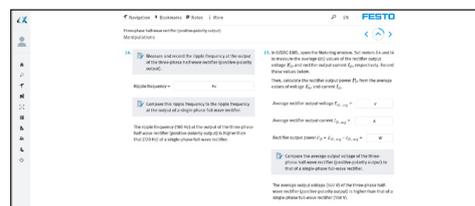
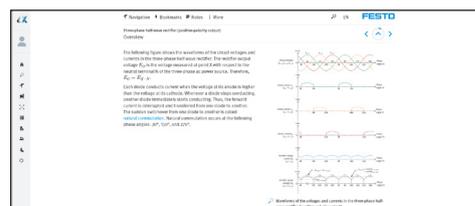
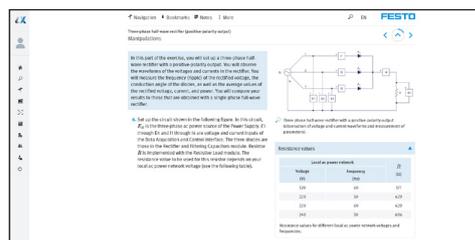
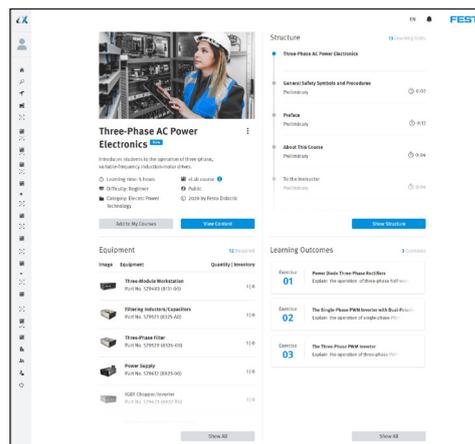
Courses are organized in a gradual learning path: from the basics to advanced topics. New courses are regularly added to the program to keep up with emerging needs and topics.

The modular philosophy of the program gives instructors full flexibility over the integration of content into their lesson plans: they can choose pre-defined learning paths with complete courses, customize courses, or even create their own path, exercise by exercise.

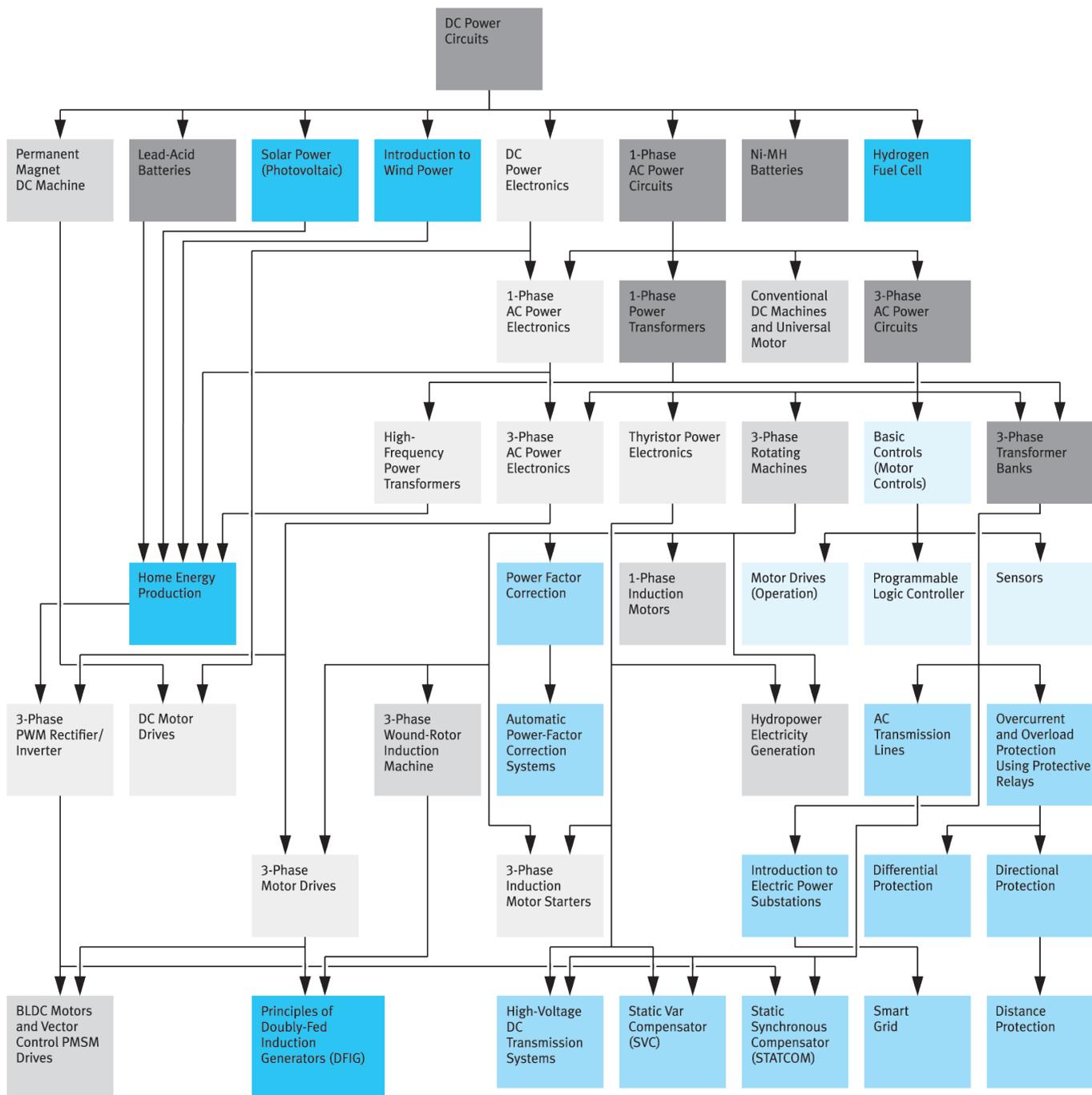
Each course represents one workbook (available in PDF, print, or as an eLab course on Festo LX) that features practical exercises accompanied by theoretical notions. Students are guided through practical experimentation with step-by-step, illustrated laboratory procedures and questions, followed by reviewing quizzes. Instructors have access to lab results, answers, and didactic notes.

- 44 courses offer over 150 laboratory exercises (approximately 300 hours)
- Aimed at technical institutions, colleges, and universities that offer study and research programs in electrical engineering

Screen captures of the eLab course “Three-Phase AC Power Electronics” on Festo LX.



Arrows show the suggested path; they do not set strict prerequisites.



Courses, From A to Z

General Topic Coverage

AC Transmission Line

Equivalent circuits and characteristics of AC transmission lines for resistive, inductive, and capacitive loads. Voltage compensation. Active power transmission. Shunt-capacitor substations. Control of the flow of active and reactive power.

Basic Controls

Basic principles and control circuits. Circuit layouts and specifications. Jogging control circuits. Reversing/manual reversing starters. Reduced AC voltage starters. Time relay circuits.

BLDC Motors and Vector Control PMSM Drives

Permanent magnet synchronous machines. PMSM control using a three-phase, six-step 120° modulation inverter. BDLC motor. Vector control PMSM drive.

Conventional DC Machines and Universal Motor

Fundamentals of rotating machines. Prime mover and brake operation. DC motors and generators. Series, shunt, compound, separately-excited motors. Shunt, separately-excited, and compound DC generators. Armature reaction and saturation effect. Universal motor.

DC Motor Drives

Basic PWM DC motor drives. Bidirectional PWM DC motor drives with regenerative braking. Speed feedback and current control in PWM DC motor drives.

DC Power Circuits

Voltages and currents in electrical circuits. Ohm's and Kirchhoff's laws. Concept of equivalent resistance. Equivalent resistance of a combination of resistors. Power dissipated in a DC circuit. Solution of complex series and parallel circuits using fundamental laws.

DC Power Electronics

Operation and characteristics of diodes and switching transistors. Buck, boost, buck/boost, and four-quadrant choppers. Concept of voltage-type and current-type circuits, and free-wheeling diodes. Ripple phenomenon in a chopper. Implement a lead-acid battery charger using a buck chopper with feedback loop.

Differential Protection

Fundamentals of differential protection. Percentage restrained differential protection.

Directional Protection

Introduction. Directional overcurrent, comparison and power protection.

Distance Protection

Introduction to distance protection. Distance relay impedance characteristics. Conventional time-stepped distance protection. Distance protection using communication-assisted tripping schemes.

High-Frequency Power Transformers

High-frequency power transformers and their uses. Effect of frequency on the power rating of transformers. Analysis of high-frequency power transformers in switched-mode power supplies and insulated DC-to-DC converters

High-Voltage DC Transmission Systems

Voltage regulation and displacement power factor (DPF) in thyristor three-phase bridges. Basic operation of HVDC transmission systems. DC current regulation and power flow control in HVDC transmission systems. Commutation failure at the inverter bridge. Harmonic reduction using thyristor 12-pulse converters.

To see reading samples (PDF), visit:
 → bitly.com/EMS-course-samples and scroll down to the section “Downloads”

Home Energy Production

Stand-Alone home energy production. Single-phase grid-tied inverter (PWM rectifier/inverter). Grid-tied home energy production using a solar or wind power inverter without DC-to-DC converter. Large-scale energy storage: a step in the implementation of the smart grid.

Hydrogen Fuel Cell

Basic functions of the fuel cell system. Characteristic curve. Parameters influencing the characteristic curve. Determination of the hydrogen current curve. Efficiency of the fuel cell stack. Set-up of a fuel cell power supply. Efficiency of a fuel cell power supply.

Hydropower Electricity Generation

Hydropower electricity generation. Generator frequency and voltage control principles. Generator synchronization using a synchro-check relay. Generator operation with speed and voltage regulation. Droop. Generator parallel operation and load sharing.

Introduction to Electric Power Substations

Electric power substations. High-voltage disconnecting switches and circuit breakers. Single-bus scheme. Double-bus, single breaker scheme.

Introduction to Wind Power

Wind turbines and small-scale wind power. Voltage-speed and torque-current characteristics of a wind turbine generator. Wind power variation with wind speed. Energy storage in batteries.

Lead-Acid Batteries

Fundamental principles of batteries. Types and features of lead-acid batteries. Charge and discharge characteristics. Methods for charging lead-acid batteries (constant-current, constant-voltage, modified constant-voltage, float charging, trickle).

Motor Drives (Operation)

AC drives. Volts per Hertz characteristics. Ramp and voltage boost. Protection. Braking and jogging. Remote controls. DC drives. Current limiting and IR compensation.

Ni-MH Batteries

Reactions occurring during charge and discharge cycles. Battery characteristics during discharge. Calculation of energy released during a discharge cycle. Effects of charge input, charge rate, and ambient temperature on the voltage and temperature profiles during a charge cycle. Charging methods and charge-control techniques.

Overcurrent and Overload Protection Using Protective Relays

Overcurrent protection. Overcurrent and overload protection of AC machines, power transformers, radial feeders.

Permanent Magnet DC Motor

Prime mover and brake operation. Basic functions of the 4-quadrant dynamometer/power supply. Polarity of speed, torque, and mechanical power. Construction of permanent magnet DC machines and their operation as generators. Voltage-speed and torque-current characteristics of a permanent magnet DC machine operating as a generator or as a motor.

Power Factor

Types of power corrections: plant-wide versus distributed. Using banks of switched capacitors. Correction in three-phase circuits.

Principle of Doubly-Fed Induction Generators (DFIG)

Three-phase wound-rotor induction machine used as a synchronous machine. Doubly-fed induction motors and generators.

Courses, From A to Z

General Topic Coverage

Programmable Logic Controllers (PLC)

Control and timing relay functions. Boolean logic and markers. Counter and comparator functions. PLC control circuits. Interfacing voltages. Motor and reversing motor starters with jogging.

Sensors

Background suppression photoelectric switch. Polarized retroreflective photo-electric switch. Capacitive proximity, inductive proximity, and limit switches. Motor-operated circuits using sensors. PLC-controlled circuits using sensors.

Static Synchronous Compensator (STATCOM)

Voltage Compensation of AC transmission lines using a STATCOM. Dynamic power factor correction using a STATCOM.

Single-Phase AC Power Electronics

Operation of power diode. Single-phase rectifiers. Half-wave and full-wave rectifier. Average DC voltage. Operation of the single-phase PWM inverter.

Single-Phase AC Power Circuits

Voltage and current sine waves. Power dissipated in a resistive load. Inductive reactance and capacitive reactance. Relationship between the source frequency and the reactance of an inductor or a capacitor. Active, reactive, and apparent power. Impedance calculation method and the power triangle method.

Single-Phase Induction Motors

AC induction motors. Operation and characteristics of single-phase induction motors.

Single-Phase Power Transformer

Turns, voltage, and current ratios. Characteristics of step-up and step-down power transformers. Polarity of power transformer windings. Equivalent diagram of a power transformer. Voltage, current, and power ratings. Effect of saturation on the magnetizing current and no-load power losses of a power transformer.

Smart Grid

The Smart Grid and what makes it smart. Reducing power losses and improving substation power efficiency. Upgrading and operating a substation for operation in the Smart Grid. Automated control of the distribution station operation. Fast restoration of power to loads after a bus fault. Dynamic load sharing.

Solar Power (Photovoltaic)

Diode. Solar panel. Effect of temperature on solar panel performance. Energy storage into lead-acid batteries. Effect of shading on solar panel operation. Solar panel orientation. Insolation and performance.

Static Var Compensator (SVC)

Main Components of a SVC. Voltage compensation of AC transmission lines using an SVC. Dynamic power factor correction using a SVC.

To see reading samples (PDF), visit:

→ bitly.com/EMS-course-samples and scroll down to the section “Downloads”

Three-Phase AC Power Circuits

Difference between line and phase voltages and currents. Active power dissipated in each phase of a three-phase circuit and the total active power dissipated. Phase sequence and wye and delta circuit configuration. Active, reactive, and apparent power in balanced, wye- or delta-connected, three-phase circuits.

Three-Phase AC Power Electronics

Analysis of three-phase half-wave and full-wave rectifiers, as well as single- and three-phase PWM inverters. Voltage and current waveforms. Advantages of three-phase rectifiers over single-phase rectifiers. Dual polarity DC power supply.

Three-Phase Induction Motor Starters

Induction to motor starters. DOL starters and soft starters. Advanced features of soft starters.

Three-Phase Motor Drives

Principles and operation of 3-phase variable-frequency induction motor drive. Three-phase variable-frequency induction motor drive with a constant Volt-per-Hertz (V/f) ratio.

Three-Phase PWM Rectifier/Inverter

Three-phase PWM rectifier/inverter Block diagram. Most common applications. Active current and reactive current command variation. Active and reactive power control.

Three-Phase Rotating Machines

Prime mover and brake operation. Three-phase squirrel-cage induction machines. Eddy-current braked and asynchronous generator. Synchronous motor. Synchronous generators (alternators). Voltage, torque. Generator synchronization.

Three-Phase Transformer Banks

Operation of three-phase transformer banks. Connection of the windings of 3-phase transformer banks in wye, delta, wye-wye, delta-delta, wye-delta, or delta-wye configuration. Voltage, current, and phase relationships between the primary and secondary windings. Uses of three-phase transformer banks in 3-phase AC power circuits.

Three-Phase Wound-Rotor Induction Machines

Three-phase wound-rotor induction machine with a short-circuited rotor. Three-phase wound-rotor induction machine with rotor resistance.

Thyristor Power Electronics

Diodes. Single-phase half-wave rectifier and single-phase full-wave (bridge) rectifier. Voltage and current waveforms. Thyristor in AC circuits with loads. Thyristor three-phase rectifier/inverter.

Troubleshooting

Troubleshooting: introduction and methods. Troubleshooting basic motor control circuits (manual reversing starter circuit, motor starter with jogging circuit, plugging with time relay circuit). Troubleshooting PLC circuits (PLC circuit, PLC reversing motor starter with jogging circuit, PLC motor starter with jogging circuit). Troubleshooting AC and DC drive circuits (AC drive circuit, AC drive braking and jogging circuit, DC drive circuit). Note: this course does not appear in the flowchart because it is included with the courses Motor Drives, PLC, and Sensors.

Create Your Ideal Learning Environment



Lab activities featured in the courses are designed to be performed on the Electric Power Technology Training Systems (also known as the EMS).

This flexible platform, enhanced with software tools, can be configured to exactly match your training requirements. Complementary services – train-the-trainer sessions, installation and commissioning, etc. – and outstanding technical assistance will help you get the most out of your investment.

Contact your nearest sales representative for guidance and more information about course selection.



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