NATIONAL UNIVERSITY OF ENGINEERING
COLLEGE OF MECHANICAL ENGINEERING
MECHANICAL-ELECTRICAL ENGINEERING PROGRAM

MT242 – ELECTRO-HYDRAULIC AND ELECTRO-PNEUMATIC SYSTEMS

I. GENERAL INFORMATION

CODE	**:**	MT242 Electro-Hydraulic and Electro-Pneumatic Systems
SEMESTER	**:**	8-10
CREDITS	**:**	4
HOURS PER WEEK	**:**	6 (Theory – Workshop)
PREREQUISITES	**:**	ML121 Laboratory of Electric Circuits MN217 Fluid Mechanics II
CONDITION	**:**	Elective

II. COURSE DESCRIPTION

This exclusively practical course provides students with fundamental principles of industrial automation, dealing with industrial pneumatics, hydraulics, industrial electro-pneumatics, process control with PLCs. Its objective is to effectively analyze, design, control, implement and manage automated production systems. It encourages team work. This course is divided in 3 learning units: Pneumatic automation tools, electro-pneumatics, hydraulics and process control with PLCs.

III. COURSE OUTCOMES

1. Formulate, elaborate, assess and implement projects of productive infrastructure improvement, process optimization generating value and productivity encouraging, at the same time, a quality culture involving personal participation and suppliers' collaboration.
2. Identify, organize and lead research and development projects with the aim of generating competitive advantages for the company, coordinating with the related functional areas.

IV. LEARNING UNITS

1. PNEUMATIC AUTOMATION AND ELECTRO-PNEUMATIC TOOLS / 28 HOURS

Introduction to automation. Pneumatics actuators. Pneumatic valves. Pneumatic timers. Contact breaker. Relays. Sensors. Selenoid valves. Transducer. Positioning systems. Latching switch: push button. Unlatching switches. Mechanical switches. Electrical limit switch. Proximity switch: Magnetic Switch. Capacitive. Inductive. Optical switch, Relay and timer connected to port. 2/2-way Selenoid valve (closed at rest position). Normally open and closed 3/2-way solenoid valve. Servo-operated 3/2-way solenoid valve (Closed at rest position). Servo-operated 5/2-way solenoid valve. Electro-pneumatic circuits: Electrical symbology. Electro-pneumatic diagram. Relay circuits. Performance of logic functions. Control systems. Dual-control circuits. Direct control of a single and double acting circuit. Double-acting cylinder control, contacts in series (function) and contacts in parallel. Start latch circuit. Stop latch circuit. Control of auto- return with electrical limit detector. Bilateral and indirect control of an activated cylinder with bistable valve. Swinging movement of a double-acting cylinder. cylinder return using a pressure switch. Using a signal-delay timer for connection.

2. HYDRAULICS AND ELECTRO-HYDRALICS / 12 HOURS

What is hydraulics? Energy transformation in a hydraulic system. Comparison with other way of power transmission. Fluid statics: Concept of pressure. Pascal's law. Hydro-dynamics: Concept of discharge. Continuity equation. Bernoulli's principle. Basic form of a hydraulic circuit. Requirements to be meet. Different types of fluids. Selection of a hydraulic oil. Causes of water pollution. Fineness filter selection.

Filter quality. Filter placement possibilities. Types of filters: return, pressure and suction filters. Classification. Construction principles. Internal and external gear pumps. Radial piston pump. Vane pump. Geared motors. Planet geared motors. Radian piston motors. Hydraulic cylinders. Different types. Constructive forms. Damping. Fixing methods. Bulge check. Oscillating drives. Faucets. Different types. Simple non-return valve. Piloted non-return valve. Pre-fill valve. Poppet valve. Direct-acting and pilot operated gate valves. Pressure valves. Different types. Direct-acting and piloted relief valves. Connection and shutoff valve. Direct acting and piloted reducing valve. Flow valve. Concept of discharge variation. Choke and regulating valves. Pressure switch. Manometer.

3. PROCESS CONTROL WITH PLCS / 16 HOURS

Definition of PLCs. Simatic S7 family. Automation system components. Program cycle. Memory area. Mnemonic. Numeral systems. Bit, byte, word, double word. SOFTWARE STEP 7. Creation of a new project. Linear and structured programming. Programming block S7. Organization block. Instruction cycle. Full boot. Event interrupt. Regular clock interrupt. Parametrizable functions and functions block. Ways of representation: KOP, FUP, AWL. Hardware configuration. Mounting and connection directives. Available module range of S7-200 and S7-300 families. S7-200 and S7-300 centralized architecture. Symbol editor. PLC connection. Establishing link. Program loading to PLC. PLC program backup in PC. Visualize and force variables. On-line diagnosis. Operating state change from PC. PLC hour and date setup. See properties, used memory and on-line PLC cycle time. Operations with contacts, coil, timer and counter. Comparison contacts. Set/reset and target detection. Program control: conditional and unconditional calls. Arithmetical operations. Conversion operation. Several programming exercises.

V. LABORATORY EXPERIENCES

Lab 1: Pneumatics and Electro-pneumatic.
Lab 2: Hydraulics and electro-hydraulics.
Lab 3: PLC programming.

VI. METHODOLOGY

This course is carried out in theory and workshop sessions. In theory sessions, the instructor introduces concepts and applications. In workshop sessions, several problems are solved and their solutions are analyzed. In all sessions, students' active participation is encouraged.

VII. EVALUATION FORMULA

The average grade PF is calculated as follows:

PF = (EP + EF + (P1 + P2 + P3 + P4)/4 + (T1 + T2 + T3 + T4)/4 + 2*TF)/6

EP: Mid-Term Exam EF: Final Exam TF: Final paper

P#: Quizzes T#: Workshop

VIII. BIBLIOGRAPHY

1. **MARTÍNEZ SÁNCHEZ, VICTORIANO**
   Modern Industrial Automation
   Alfa Omega Editorial, 2010

2. **RAMÍREZ QUIROZ, ELMER**
   Programmable Logic Controllers - An Alternative for Modern Automation (Spanish)
   CONCYTEC, Lima - 1997