

	<ul style="list-style-type: none"> • Networking; hierarchical structures. • Introduction to Field bus systems. • Profibus • Device-net • Introduction to Industrial Ethernet technology. 	Data show Text book PC	MPI <ul style="list-style-type: none"> • Profibus DP
Week 13-14	9. An introduction to process visualization 10. Definition, explanation the DCS systems in industrial application 11. An overview of SCADA system		
	Specific Learning Outcomes	Resources	Practical
	<ul style="list-style-type: none"> • Process visualization, The man (human)–machine interface (HMI) • Distributed Control System (DCS) • SCADA system 	Board Data show Text book PC	

Subject	Hydraulic and Pneumatic	Course Code	CT322	Theoretical	3hrs / wk
Semester	6	Prerequisite	NT220	Practical	3hrs / wk

Program Learning Component:

Theoretical classes

	Specific Learning Outcomes	Resources
Week 1	<p>Introduction to pneumatics, i.e. Basic physical concepts.</p> <ol style="list-style-type: none"> 1. Fluid properties: compressibility, incompressibility; pressure, pressure scales, relative pressure, atmospheric pressure, vacuum pressure, pressure gages; flow rate, relation between flow rate, speed, and pressure. 2. Gas laws: Boyle's law; Charles' law; gay-Lussac's law; the general gas law. 3. Force transmission through a fluid, Pascal's law; the basic concept of a pneumatic system. 4. Advantages and disadvantages of pneumatic systems. 	Data show
Week 2-3	<p>Pneumatic energy control, control valves:</p> <ol style="list-style-type: none"> 1. Directional control valves (DCV): <ul style="list-style-type: none"> • Symbols according to ISO 1219 • Different types of DCV: cross sections to show their internal parts, operating principles, methods of actuation. 2. Pressure valves: pressure reducing valve, quick exhaust valve, two - pressure valve, shuttle valve. 3. Flow control valves: one-way valve, variable flow control valve, one-way variable flow control valve. 4. Compound valves: time-delay valve, sequence valve, vacuum valve. 5. Simple examples, simple pneumatic machines. 	Data show
Week	Specific Learning Outcomes	Resources

4-5	Design of pneumatic machines: 6. Motion (step) diagram. 7. Simple (one - cylinder) machines. 8. Compound (more than a cylinder) machines. 9. Over-lapped machines. 10. Different examples; methods of overcoming the problem of over-lapping.	Data show
Week 6	Specific Learning Outcomes	Resources
	<ul style="list-style-type: none"> • Pneumatic energy generation. <ol style="list-style-type: none"> 1. General concepts: free air, air compression process. 2. Compressor design principles. 3. A brief description of the mechanism of different types of compressors: <ul style="list-style-type: none"> • Positive displacement compressors: piston compressor; diaphragm compressor; vane compressor; screw compressor. • Dynamic compressors: centrifugal compressor, axial flow compressor. 4. Compressor staging. 5. Compressor capacity control. 6. Compressor house ventilation. 7. Selecting a Compressor for a system. 8. Installation of Compressor. 9. Compressor ancillary equipments: intake/ silencer filter; after cooler; moisture separator; intercooler; air receiver(tank), air receiver sizing; compressed air dryers, refrigeration dryers, absorption dryers; compressed air distribution. • Compressed air servicing (service unit): <ol style="list-style-type: none"> 1. The importance of the service unit for a pneumatic machine. 2. The main parts of a service unit: <ul style="list-style-type: none"> • Air filter. • Pressure regulator. • Pressure gauge. • Lubricator 	Data show

Week 7	Specific Learning Outcomes	Resources
	Linear pneumatic actuators(pneumatic cylinders): <ol style="list-style-type: none"> 1. Single-acting cylinder, diaphragm cylinder. 2. Double-acting cylinders: <ul style="list-style-type: none"> • Pneumatic end-position cushioned cylinders. • Rodless cylinders: magnetically coupled, mechanically coupled, belt coupled. • Impact cylinders. • Swivel (semi-rotary) cylinders. 3. Seals in linear actuators. 4. Linear actuators sizing: calculation of external forces, static thrust force calculations, dynamic force calculation, piston rod buckling, air consumption calculation. 	Data show
Week 8	Specific Learning Outcomes	Resources
	Rotary pneumatic actuators(pneumatic motors): <ol style="list-style-type: none"> 1. Motor torque, motor output power, motor speed. 2. Different types of air motors: vane motor; gear motor; radial piston motor; axial piston motor; turbine motor. 3. Air motor sizing and torque calculations. 4. Air motor performance. 5. Pressure and flow regulation on air motors. 	Data show
Week 9	Specific Learning Outcomes	Resources
	Electropneumatics (electropneumatic systems): <ol style="list-style-type: none"> 1. Components and assemblies in the electrical signal control section: power supply, switches different types), proximity switches: reed switch, capacitive switch, inductive switch, optical switch), pressure switches. 2. Application of magnetic effect of electrical current, solenoid. 3. Control relays, time delayed relays. 4. Solenoid directional control valves, brief study of different types, piloted valves. 5. Over-lapped machines. 6. Different examples. 	Data show
Week	Specific Learning Outcomes	Resources

10	<p>Hydraulics (hydraulic systems): Introduction to hydraulics, i.e. Basic physical concepts.</p> <ol style="list-style-type: none"> 1. Pressure in liquids, flow rate and velocity, force transmission by liquids (force multipliers), Pascal's law, pressure intensifier, viscosity, flow types, Reynold's number, friction, heat, pressure drop through hydraulic systems, cavitations, power calculation in hydraulic systems. 2. Hydraulic fluids, their task, types. 3. The concept of power transmission. 4. Advantages and disadvantages of hydraulic systems. 5. The main parts of a hydraulic system. 	Data show
Week 11	Specific Learning Outcomes	Resources
	<p>Hydraulic power generation (Hydraulic power pack):</p> <ol style="list-style-type: none"> 1. Hydraulic pumps: the role of a pump in a hydraulic system, pumping theory, pump characteristics. 2. Pump types: <ul style="list-style-type: none"> • Fixed displacement pumps: vane pump, piston pump. • Variable displacement pumps: variable displacement vane pump, : variable displacement vane pump. • Control of variable displacement pumps. 3. Others: filter, heater, cooler, reservoir. 	Data show
Week 12	Specific Learning Outcomes	Resources
	<p>Hydraulic valves:</p> <ol style="list-style-type: none"> 1. Directional control valves DCV): <ul style="list-style-type: none"> • Symbols according to ISO 1219 • Different types of DCV: cross sections to show their internal parts, operating principles, methods of actuation. 2. Pressure valves: pressure relief valve, pressure regulating valve, shuttle valve. 3. Flow control valves: one-way valve (check valve), piloted-check valve, variable flow control valve, one-way 	Data show

	variable flow control valve, two-way flow control valve with throttle, two-way flow control valve with orifice, three-way flow control valve, on-off valve.	
Week 13	Specific Learning Outcomes	Resources
	<p>Linear hydraulic actuators(hydraulic cylinders):</p> <ol style="list-style-type: none"> 1. Cylinder construction. 2. Actuator types: <ul style="list-style-type: none"> ✓ Single-acting cylinder, telescopic cylinder. ✓ Double-acting cylinders: <ul style="list-style-type: none"> • Double-acting cylinder with rods on both ends. • Double-acting cylinder with cushioning. • Double-acting cylinder with adjustable cushioning. • Double-acting telescopic cylinder. • Tandem cylinder. 3. Seals in linear hydraulic actuators, stop tubes. 4. Actuators sizing 5. Piston rod buckling. 	Data show
Week 14	Specific Learning Outcomes	Resources
	<p>Rotary hydraulic actuators(hydraulic motors):</p> <ol style="list-style-type: none"> 1. Motor torque, motor displacement (geometric volume), motor output power, motor speed. 2. Different types of air motors: vane motor; external gear motor; internal gear motor; radial piston motor; axial piston motor. 3. Hydraulic motor sizing and torque calculations. 4. Hydraulic motor performance. 5. Motor sizing. 6. Hydraulic motor control: speed control, reversal control. 	Data show
Week 15	Specific Learning Outcomes	Resources
	<p>Hydraulic accumulators:</p> <ol style="list-style-type: none"> 1. Role of a hydraulic accumulator in a hydraulic machine. 2. Accumulator sizing. 3. Accumulator calculation. 	Data show

	<p>4. Types of accumulator:</p> <ul style="list-style-type: none"> • Spring accumulator. • Weight-loaded accumulator. • Piston accumulator. • Diaphragm accumulator. <p>5. Accumulators in hydraulic circuits.</p>	
Week 16	Specific Learning Outcomes	Resources
	Examples of hydraulic and electrohydraulic machines.	Data show
Practical classes		
Week 3	Specific Learning Outcomes	Resources
	Performing some experiments to practice the function of directional control valves, and how they control the motion of pneumatic cylinders and motors.	Lab.
Week 4	Specific Learning Outcomes	Resources
	Experimenting the function of the variable flow control valve, and how it controls the speed of pneumatic cylinders and motors.	Lab.
Week 5	Specific Learning Outcomes	Resources
	Controlling the advance and return of pneumatic cylinders with time-delay and sequence valve.	Lab.
Week 6	Specific Learning Outcomes	Resources
	Design, simulation and realization of some compound pneumatic machines.	Lab.
Week 7	Specific Learning Outcomes	Resources
	Experimenting the function of electrically actuated (solenoid) directional control valves, and how they control the motion of pneumatic cylinders.	Lab.
Week 8	Specific Learning Outcomes	Resources
	Simple electropneumatic machines with different types of limit switches.	Lab.
Week	Specific Learning Outcomes	Resources

9	Performing some experiments to practice the function of control relays, and how they control Simple electropneumatic machines.	Lab.
Week 10-11	Specific Learning Outcomes	Resources
	<ul style="list-style-type: none"> • Realization of simple hydraulic machines. • Determining the operating pressure by adjusting the pressure relieve valve. • Practicing the function of hydraulic directional control valves, and how they control the motion of hydraulic cylinders and motors. 	Lab.
Week 12	Specific Learning Outcomes	Resources
	Practicing the function of pressure regulating valves, and how they control they regulate the pressure in hydraulic machines.	Lab.
Week 13	Specific Learning Outcomes	Resources
	Practicing the function of flow control valves, and how they control they regulate the flow in hydraulic machines.	Lab.
Week 14	Specific Learning Outcomes	Resources
	Practicing the role of hydraulic accumulator in hydraulic machines.	Lab.
Week 15-16	Specific Learning Outcomes	Resources
	Different examples of hydraulic and electrohydraulic machines.	Lab.

Text books:

- Pneumatic Control for Industrial Automation, by: Peter Rohner& Gordon Smith.
- Industrial Hydraulic Control, by: Peter Rohner.
- Prepared by engineer Emhemmed Al-dardar.