Electrical Technology

Electrical Power Specialization

Rabei Awal 1431 H

Table of Contents

The Study Plan Distributed on Six Trimesters

Dep.: Electrical Technology **Maj.: Electrical Power**

Sem	Seq.	Course Code	Course Title	Prerequisites	Equivalents	No. of Units				
						C.u.	Lec.	Lab.	Tut.	Con
1	1	ISL 101	Islamic Culture-I		ISL 101	2	2			2
	2	ARB 101	Arabic Language		ARB 101	2	2			2
	3	ENG 106	General English Language		ENG 101	4	4		2	6
	4	MAT 113	General Mathematics			4	4			4
	5	COM 101	Computer Applications		COM 101	2		4		4
	6	PHY 115	General Physics			3	3	0	1	4
	7	VOC 107	Vocational Guidance & Excellence			2	2			2
Totals Per Trimester						19	17	4	3	24

Sem	Seq.	Course Code	Course Title	Prerequisites	Equivalents	No. of Units				
						C.u.	Lec.	Lab.	Tut.	Con
2	1	ENG 145	Specialized English Language-1	ENG 106	ENG 142	4	4		2	6
	2	MAT 114	Specialized Mathematics	MAT 113	MAT 181	3	3		1	4
	3	PHY 117	Specialized Physics	PHY 115	PHY 105	3	3	0	1	4
	4	ELT 108	Electrical Drawing		ELT 104	2	1	2		3
	5	ELT 106	Electrical circuits-I		ELT 101	3	3		1	4
	6	ELT 186	Basic Electrical		ELT 180	4		8		8

			W/S								
Totals Per Trimester						**19**	**14**	**10**	**5**	**29**	

Sem	Seq.	Course Code	Course Title	Prerequisites	Equivalents	No. of Units				
						C.u.	Lec.	Lab.	Tut.	Con
3	1	ENG 244	Specialized English Language-2	ENG 144	ENG 243	4	4		2	6
	2	ELT 107	Electrical circuits-II	ELT 106	ELT 102	3	3		1	4
	3	ELT 103	Electrical Instruments & Measurements	ELT 106	ELT 103	2		4		4
	4	ELT 118	DC Machines &Transformers		ELT 135	4	3	2	1	6
		ELT 182	Residential Installation W/S		ELT 182	2		4		4
	6	ELT 188	Industrial Installation W/S	ELT 186	ELT 184	3		6		6
Totals Per Trimester						18	10	16	4	30

Sem	Seq.	Course Code	Course Title	Prerequisites	Equivalents	No. of Units				
						C.u.	Lec.	Lab.	Tut.	Con
4	1	ISL 102	Islamic Culture-II	ISL 101	ISL 102	2	2			2
	2	ELT 205	Programmable Control Technology	ELT 107	ELT 201	3	2	2		4
	3	ELT 207	Automatic Control Technology	ELT 107	ELT 204	3	2	2		4
	4	ELT 208	Power Electronics	ELT 107	ELT 202	4	3	2		5
	5	ELT 218	AC Machines	ELT 118	ELT 235	4	3	2	1	6
	6	ELT 261	Electrical Distribution Technology	ELT 107	ELT 221	3	3			3
	7	ELT 289	Special places installation & Protection W/S	ELT 186	ELT 282	3		6		6
Totals Per Trimester						22	15	14	1	30

Sem	Seq.	Course Code	Course Title	Prerequisites	Equivalents	No. of Units				
						C.u.	Lec.	Lab.	Tut.	Con
5	1	MGT 101	Professional Ethics & Communication Skills		MGT 101	2	2			2
	2	ELT 105	Industrial Safety		ELT 105	1	1			1
	3	ELT 262	Electrical Transmission Networks	ELT 107	ELT 222	3	3			3
	4	ELT 263	Maintenance of Power Systems	ELT 261	ELT 223	3	3			3
	5	ELT 264	Generation & Main Substations	ELT 107	ELT 224	3	3			3
	6	ELT 265	Power Systems Protection	ELT 107	ELT 225	4	3	2		5
	7	ELT 266	Power Systems lab.	ELT 107	ELT 226	2		4		4
	8	ELT 288	Electrical Programmable Control W/S	ELT 205	ELT 284	4		8		8
Totals Per Trimester						22	15	14		29

Sem	Seq	Course Code	Course Title	Prerequisites	Equivalents	Units				
						C.u.	Lec.	Lab.	Tut.	Con.
6	1	299 ELT	Co-operative Training			4	At Least 420 Hours			

Totals Per Plan	Units				
	C.u.	Lec.	Lab.	Tut.	Con.
	104	71	58	13	142

Department	**Electrical Technology**	**Specialization**	**Electrical Machinery & Equipment**
Course Name	**Electric Circuits-I**	**Course Code**	**ELT 106**
Prerequisites	**none**		

Course Description:

This course describes six main topics:

- Fundamentals of electrostatics.
- Batteries.
- Principles of DC circuits
- DC circuits analysis.
- Electromagnetism.
- Magnetic circuits.

The course contains an explanation of electrostatics laws, batteries, DC circuit analysis, electromagnetism and magnetic circuits. The course contents include: capacitors, Ohm's law, Kirchoff's laws, series& parallel circuits, power, and DC bridges.

Trimester			2		
Credit Hours			3		
Contact Hours (h/w)	**L**		3		
	P		0		
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General objective of the course:

The course is designed to give the trainees basic knowledge of electrostatic, batteries, and fundamentals of DC current. Also covered are analysis of DC circuits, electromagnetism, and magnetic circuits.

Behavioral Objectives:
The trainees should be able to:

1. Explain the terms used in basic electrostatics.
2. Describe the types of capacitors and how to determine the total capacity for different capacitor connections.
3. Describe the types of batteries and their construction and connections.
4. Explain the different resistor connections and calculate the total resistance.
5. Explain and apply Ohm's law.
6. Represent Ohm's law graphically.
7. Apply Kickoff's laws, and voltage and current division rules
8. Solve simple DC circuit.
9. Explain the principles of electromagnetism.
10. Solve simple magnetic circuits.

Contents (Theoretical):

- **Basic electrostatics**
- **Batteries**
- **Principles of DC circuits**
- **DC circuits analysis**
- **Electromagnetism**

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
8	**1-Electrostatics:** Electric charge: • Electric charge • Coulomb's law • Force between two charges • Electric field • Electric potential • Potential difference Capacitors: • Capacitance of an isolated ball • Capacitance of an earthed ball capacitor • Capacitance of a parallel plate capacitor • Series and parallel connections of capacitors • Energy stored in capacitors	Basic Knowledge
4	**2-Batteries:** • Primary cells • Secondary cells • Definitions of the capacity of the battery and the charging current • Charging and discharging curves • Connection of cells in series and parallel	Basic Knowledge A4, B3, B4, B6, B7, B8, B9, C2, C3, C6, C7, D5, D9, E3, E4, E5, F3, F5, H2, H11, J5

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
12	**3-DC circuits:** Electrical Quantities: • Quantity of charge • Current and current intensity • DC voltage and current • Resistance and resistors • Ohm's law Differentiation between conductors and semi-conductors and insulators with respect to properties and atomic construction: • Metallic conductors • Electrolytic conductors • Semi conductors • Insulators Factors affecting conductor resistance: • Conductor length, cross-sectional area, and type of material • Effect of temperature on resistance • Positive and negative temperature coefficient of resistance • Calculation of homogenous conductor resistance Methods of connecting resistors: • Series connection of resistors • Parallel connection of resistors • Series-parallel connection of resistors • Calculation of resistances connected in series-parallel connections Kirchhoff's laws: • Kirchhoff's current laws. • Kirchhoff's voltage laws. Simple circuit calculations: • Series connection • Voltage divider rule • Parallel connection • Current divider rule • Series parallel connection • Star or delta connection • Star or delta transformations	Basic Knowledge A4,A8, B3, B4, B6, B7, B8, B9, C2, C3, C6, C7, D5, D9, E3, E4, E5,F1,F2, F3, F5, H2, H11, J5

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
8	**4-DC circuit analysis:** • Methods of DC circuit analysis • Kirchhoff's current and voltage laws • Mesh current method • Node voltage method • Superposition method Note: not more than two equations	Basic Knowledge A4,A8, B3, B4, B6, B7, B8, B9, C2, C3, C6, C7, D5, D9, E3, E4, E5,F1,F2, F3, F5, H2, H11, J5
11	**5- Electromagnetism:** • Natural and magnetic fields • Magnetic field due to current carrying conductor and the right hand rule • Magnetic field due to a coil • Magnetic field density, magnetic field intensity, and permeability • Mechanical force acting on a conductor carrying DC current in a magnetic field, and factors affecting this force • Direction of force acting on a conductor carrying DC current • Elector-magnetic force generated in a conductor moving vertically to a magnetic field • Direction of EMF generated in a conductor moving vertically to a magnetic field • Self and mutual induction • Lenz's la	Basic Knowledge
9	**6- Magnetic circuits:** • Magnetic reluctance and the factors affecting it • The electro-magnetic force • Ohm's law for the magnetic circuit • Comparison between electric and magnetic circuits • Classification of the magnetic materials according to its magnetic properties • Magnetization curve for some magnetic materials • Kirchhoff's laws for magnetic circuits • Application on simple magnetic circuits	Basic Knowledge

References	• Electrical Technology, Edward Hughes • Introductory Circuit Analysis, Robert L. Boylestad, 2000 • Principles of Electric circuits, Thomas L. Floyd, 1999 • Fundamentals of Electric Circuits, Charles K. Alexander, N. O. Sadiaka, 2000 • Electric Circuits, Joseph Edminister, Mahmood Nahoi, 1997

<table>
<tr><td>Department</td><td colspan="3">Electrical Technology</td><td>Specialization</td><td colspan="5">Electrical Machinery & Equipment</td></tr>
<tr><td>Course Name</td><td colspan="3">Technical Electrical Drawing</td><td>Course Code</td><td colspan="5">ELT 4108</td></tr>
<tr><td>Prerequisites</td><td colspan="8">None</td></tr>
<tr><td colspan="4" rowspan="5">Course Description:
The course describes the electrical and electronic symbols, and the wiring diagrams for residential and industrial installations. The course also includes the connection diagrams of control and protection circuits. Computers programs may be used to draw such circuits and diagrams.</td><td colspan="2">Trimester</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td colspan="2">Credit Hours</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td rowspan="3">Contact Hours (h/w)</td><td>L</td><td></td><td>1</td><td></td><td></td></tr>
<tr><td>P</td><td></td><td>2</td><td></td><td></td></tr>
<tr><td>T</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="9">General objective of the course:
The course aims to introduce the trainees to the basics of technical electrical drawing to enable them to read layouts of electrical installations, and control and protection circuit diagrams.</td></tr>
<tr><td colspan="9">Behavioral Objectives:
The trainees should be able to:</td></tr>
<tr><td colspan="9">1. Identify the electrical and electronic symbols.
2. Be familiar with the classifications of electrical circuits and layouts.
3. Read electrical circuits and installations layouts.
4. Read and draw control and protection circuits.
5. Draw single line and execution diagrams for domestic installations.
6. Draw single line and execution diagrams of industrial installations.
7. Draw the equivalent circuits for the different types of DC machines.
8. Draw the equivalent circuits for the different types of three-phase synchronous and asynchronous machines.
9. Draw the circuit diagrams for the different methods of starting of DC and AC machines.
10. Draw the circuit diagram for the different methods of speed control of DC and AC machines.
11. Draw single line diagrams for electrical networks.
12. Draw the wiring diagrams for the protection circuits for the elements of an electrical network.</td></tr>
</table>

Contents (Practical):
• Elements and symbols of electrical circuits • Single line and execution diagrams for domestic installations • Single line and execution diagrams for industrial installations and their distribution networks • Connection diagrams for electrical machines and equipment • Connection diagrams for the methods of starting and speed control of electrical motors • Layouts of power system networks and their protection schemes

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
9	**1- Elements and symbols of electrical circuits:** • Symbols of the basic elements Voltage and current sources, resistors, inductors, capacitors, switches, and measuring instruments • Symbols of power electronic elements: Diodes, transistors, diac, thyistors, triac MOSFET, etc. • Symbols of control and protection circuit elements Contactors, relays, circuit breakers, timers, etc. • Electrical machines symbols: DC & AC machines and transformers	Basic knowledge I2, E2, C2, E1, H1, I2
6	**2-Single line and execution diagrams for domestic installations:** • Schematic diagram for domestic circuits • Lightening and equipment installation diagrams • Domestic distribution boards	Basic knowledge I2, E2, C2, E1, H1, I2
6	**3- Single line and execution diagrams for industrial installations and its distribution networks:** • Layouts of industrial feeding networks • Industrial distribution boards	Basic knowledge I2, E2, C2, E1, H1, I2

6	**4- Connection diagrams for electrical machines and equipments:** • DC machines: 1. Separately excited DC machine 2. Series DC machine 3. Shunt DC machine 4. Compound DC machine • AC machines: 1. Single-phase synchronous generators 2. Three-phase synchronous generators 3. Single-phase induction motor 4. Three-phase induction motor	Basic knowledge I2, E2, C2, E1, H1, I2

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
6	**5- Connection diagrams for the methods of starting and speed control of electrical motors:** • Starting and speed control circuits of dc motors • Starting and speed control circuits of three-phase induction motors	Basic knowledge I2, E2, C2, E1, H1, I2
6	**6- Layouts of power system networks and its protection schemes.** • Single line diagram for electrical networks • Substations • Electrical networks • Motor protection circuits • Transformers protection circuits • Generators protection circuits • Transmission lines protection circuits	Basic knowledge I2, E2, C2, E1, H1, I2

References	• Technical drawing, Park German Training Program. • Engineering Drawing, By Prof. Michel Ghalioungui and Dr. M. A. H. El-Rakabawy • Graphical Symbols for Electrical Power and Electronics, IC7 • Experimentier Bausteinsysteem, By Siemens • الرسم الفني للكهرباء – الجزء الثاني – الجزء الثالث، تكنولوجيا الطاقة

Department	**Electrical Technology**	**Specialization**	**Electrical Power**
Course Name	**Basic Electrical W/S**	**Course Code**	**ELT 186**
Prerequisites			

Course Description:

This practical course prepares the trainees to use mechanical hand tools, especially those used in electrical work. It also, introduces the trainees to the use of mechanical measuring tools. In addition, this course trains the trainees to implement simple electrical and mechanical jobs.

Trimester		1	2	3	4
Credit Hours			4		
Contact Hours (h/w)	**L**				
	P		8		
	T				

General objective of the course:

The course aims to enable the trainees to know and use mechanical hand tools and electrical equipment in a professional way. It also introduces the trainees to measuring instruments. In addition, it enables the trainees to execute the basic mechanical and electrical jobs.

Behavioral Objectives:

The trainees should be able to:

1. Identify workshop tools and use them.
2. Identify and use electrical equipment (drill, electric saw, etc).
3. Identify and use professional mechanical measuring tools.
4. Implement basic mechanical work
5. Implement basic electrical work
6. Write reports about the work done.

Contents (Practical):

- **Basic mechanical tools**
- **Measuring tools and measuring instruments**
- **Basic mechanical work**
- **Basic electrical work**

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
12	**1- Basic mechanical tools:** • Hand tools: a Files b Pincers c Chisels d Hand saws e Hammers f Screw drivers g Scissors h Solders • Mechanical tools: a Bending machine b Hydraulic scissors c Grinding machines d Drilling machine e Electrical sawing machines f Welding machine	**Basic Knowledge** A3, A4
	2- Measuring tools and measuring instruments: • Mechanical tools: a Ruler and Vernier caliper b Micrometer c Measuring angles d Scribers • Electrical measuring instruments: a Voltmeter b Ammeter c Ohmmeter	**Basic Knowledge** E2, E3, E5

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
32	**3-Basic mechanical work and its applications:** • Manufacturing of panel holder: - Manufacturing of panel body holder - Manufacturing of the transformer base - Manufacturing of the circuit barker holder - Fixing the end connectors • Exercise execution: - Cutting with chisel - Drilling - Sinking - Punching - Threading. - Forming angle - Forming curves - Filing - Welding - Sawing • Panel assembly: - Assembly of the panel holder with transformer base - Fixing the circuit breakers - Executing the electrical connections between circuit breakers and end connectors	**Basic Knowledge** A3, A4, E2, E3, E5
32	**4- Basic electrical work and its applications:** • Transformer: - Winding holders - Execution of transformer winding • Transformer fixing and connection: - Fixing the transformer to the panel - Executing the electrical connections between transformer and end connectors	**Basic Knowledge** A3, A4, E2, E3, E5

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
20	• Cable trimming and connections: - Types of cables - Cable peeling and trimming - Wires and cables joints (branching, fixing, etc) - Cable pending - Execution of joining rings • Exercises: - Fixing shoes to the wires and cables by pressing and by soldering - Soldering, wires and cables - Cable branching to form a Y joint	**Basic Knowledge** A3, A4, E2, E3, E5
8	• Panel Testing: - Assurance of no contact between panel body, circuit breakers, transformer, and end connectors using ohmmeter - Connecting the power source to the panel and measuring the voltage using voltmeter	**Basic Knowledge** A3, A4, E2, E3, E5

References	• Top 2 and 4: Electrical Power Engineering Proficiency Course, Deutsche Gesellschaft Fur Technische Zusammenarbeit (GTZ)

<table>
<tr><td>Department</td><td colspan="3">Electrical Technology</td><td>Specialization</td><td colspan="5">Electrical Power</td></tr>
<tr><td>Course Name</td><td colspan="3">Electric Circuits-II</td><td>Course Code</td><td colspan="5">ELT 107</td></tr>
<tr><td>Prerequisites</td><td colspan="8">Electric Circuits-I</td></tr>
<tr><td colspan="4" rowspan="4">Course Description:
This course describes two main topics; single-phase circuits, and three-phase circuits. It explains the fundamentals of AC circuits. It enables the trainee to analyze single and three-phase circuits.</td><td colspan="2">Trimester</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td colspan="2">Credit Hours</td><td></td><td></td><td>3</td><td></td></tr>
<tr><td rowspan="3">Contact Hours (h/w)</td><td>L</td><td></td><td></td><td>3</td><td></td></tr>
<tr><td>P</td><td></td><td></td><td></td><td></td></tr>
<tr><td>T</td><td></td><td></td><td>1</td><td></td></tr>
<tr><td colspan="9">General objective of the course:
The aim of the course is to enable the trainees to understand and analyze single and three-phase AC circuits.</td></tr>
<tr><td colspan="9">Behavioral Objectives:
The trainees should be able to:
• Understand the fundamentals alternating current.
• Explain the characteristics of AC current.
• Define the terms; resistance, inductive reactance, capacitive reactance, and impedance.
• Discriminate between resistive, capacitive, and inductive loads.
• Understand resonance in AC circuits.
• Differentiate between series and parallel connections in AC circuits.
• Understand the difference between apparent, active, and reactive power.
• Describe three-phase systems'.
• Explain what is meant by 'phase sequence'.
• Differentiate between Star and Delta connections.
• Recognize the relationship between line and phase quantities.
• Use a two-watt meter to measure three-phase power.</td></tr>
</table>

Contents (Theoretical):

- **Fundamentals of AC circuits and their analysis**
- **Three-phase circuits and their analysis**

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
30	***1.* Fundamentals of AC circuits and its analysis:** Alternating current: • Definition of AC current • Generation of AC voltage • Sinusoidal alternating current • Waveform, frequency, and periodic time • Instantaneous value • RMS value of AC voltage and current • Average value of AC voltage and current • Peak and form factors • Phasor representation of sinusoidal waveforms • Phasor Algebra • Addition and subtraction of phasor quantities • Multiplication and division of phasor quantities Resistance, inductive, and capacitive reactance's • Resistance in AC circuits • Inductive reactance in AC circuits • Capacitive reactance in AC circuits • Phasor diagram of restive, inductive and capacitive loads • Ohm's law in AC circuits • Series connection • Voltage divider rule • Resonance in series connected circuits • Parallel connection • Current divider rule • Resonance in parallel connected circuits • Series/Parallel connections • Application of Kirchoff's laws to simple circuits Work and power in single phase AC circuits • Apparent power • Active power • Reactive power • Power triangle • Power factor • Power measurement in single phase circuits	Basic Knowledge B1, F2, G2

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
22	2. The three-phase AC circuit and its analysis**:** • Description of three-phase system • Generation of three-phase voltage • Phase sequence • Representation of three-phase quantities. • Star and Delta connections. • Relation between line and phase quantities in case of Star and Delta connections. • Conversion from Star to Delta connections and vice versa • Power in balanced three-phase circuits • Two watt-meters method of measuring power	Basic Knowledge B1, F2, G2

References	• Electric Circuits, Joseph Edminister, Mahmood Nahoi, 1997 • Electrical Technology, Edward Hughas • Introductory Circuit Analysis, Robert L. Boylestad, 2000 • Principles of Electric circuits, Thomas L. Floyd, 1999 • Fundamentals of Electric Circuits, Charles K. Alexander, N. O. Sadiaka, 2000 • Electric Circuits, Joseph Edminister, Mahmood Nahoi, 1997 • القياسات الكهربائية وأجهزة القياس. د. زياد القاضي د. عبدالفتاح سليمان دار الشروق للنشر والتوزيع

<table>
<tr><td>Department</td><td colspan="3">Electrical Technology</td><td>Specialization</td><td colspan="5">Electrical Power</td></tr>
<tr><td>Course Name</td><td colspan="3">DC Machines & Transformers</td><td>Course Code</td><td colspan="5">ELT 118</td></tr>
<tr><td>Prerequisites</td><td colspan="8">Electric Circuits-I</td></tr>
<tr><td colspan="4" rowspan="5">Course Description:
This course describes two main topics:
• Direct current machines.
• Transformers.
This course covers construction, principles of operation, classification, equivalent circuits, parameters evaluation, characteristics, and applications of DC machines and single and three-phase transformers.</td><td colspan="2">Trimester</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td colspan="2">Credit Hours</td><td></td><td></td><td>4</td><td></td></tr>
<tr><td rowspan="3">Contact Hours (h/w)</td><td>L</td><td></td><td></td><td>3</td><td></td></tr>
<tr><td>P</td><td></td><td></td><td>2</td><td></td></tr>
<tr><td>T</td><td></td><td></td><td>1</td><td></td></tr>
<tr><td colspan="9">General objective of the course:
The course aims to give the trainees basic knowledge of construction, theory, performance analysis, and applications of DC machines and transformers.</td></tr>
<tr><td colspan="9">Behavioral Objectives:
The trainees should be able to:
1. Describe the components and construction of DC machines and transformers.
2. Describe the types and characteristics of DC motors and generators.
3. Explain the methods of controlling the generated voltage of DC generators.
4. Describe the methods of starting, speed control, and reversing the direction of rotation of DC motors.
5. Describe the types and characteristics of transformers.
6. Describe the equivalent circuit parameters of transformers.
7. Distinguish three-phase transformer connections.
8. Name the conditions of parallel operation of transformers.</td></tr>
</table>

Contents (Theoretical and Practical):

- DC machines
- DC generators characteristics
- DC motors characteristics
- Single-phase transformers
- Three-phase transformers

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
10	**1-DC machines:** • Construction of DC machines • Theory of operation of dc generators and motors • The magnetic circuit • E.M.F. equation • Calculation of losses and efficiency	Basic Knowledge B7
9	**2-DC Generators characteristics:** • Methods of excitation: Separately excited, series, shunt, and compound. • Characteristic curves and voltage regulation. • Voltage buildup and critical field resistance. • Applications.	Basic Knowledge B7
9	**3-DC Motors characteristics:** • Back EMF, and torque equation • Method of excitation • Torque / speed curves according to the method of excitation • Methods of starting • Applications	Basic Knowledge B7

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
15	**4-Single-phase transformers:** • Constructional features, types, and theory of operation of transformers • Winding construction • EMF equation and transformation ratio • The ideal transformer • Equivalent circuit • The equivalent circuit referred to either the primary or secondary winding • Phasor diagram at no-load and at full load • No-load and short-circuit tests • Load test • Determination of transformer parameters • Losses and efficiency • Conditions of parallel operation of single phase transformers • Auto-transformersVoltage regulators	Basic Knowledge B7
9	**4-Three-phase transformers** • Three-phase transformer construction and connections • Classifications if three-phase transformers • Parallel operation of three-phase transformers, and faults which may occur during connections • Transformation ratio for the different connections of three-phase transformers • Power transformers • Distribution transformers • Voltage regulators • Transformer tapings **Transformer cooling:** • Types of transformer cooling • Advantages of each type of transformer cooling • Effect of cooling on power output and efficiency	Basic Knowledge B7

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
10	**1-DC generators experiments:** • Separately excited generators: 1. No load characteristics (The relation between generated EMF and field current at different speeds) 2. Load characteristics (The relation between terminal voltage and load current) • Shunt generators: 1. No load characteristics 2. Load characteristics • Compound generators: 1. Load characteristics for both differentially and cumulatively compound generators	**Basic Knowledge B7, E5, F3**
8	**2-DC motor experiments:** • Load characteristics of shunt motors • Load characteristics of series motors • Load characteristics of both differentially and cumulatively compound motors • Speed Control of a separately excited motor	
8	**3-Transformer experiments:** • No-load and short-circuit tests for a single phase transformer • Load test for a single phase transformer • Parallel connection of single phase transformers	

References	• Electrical Technology, Edward Hughes, ISBN: 0-07-02134-5. • Electric Machines G. R. Slemon and A. Straughan, Eddison-Weslley, 1980. • Electrical Machines and Transformers-Principles and applications, P. F. Ryff, D. Platnick, and J. A. Karnas, Printice Hall. • Electric Machinery, M. S. Sarma, West Publishing Company, 1994.

<table>
<tr><td>Department</td><td>Electrical Technology</td><td>Specialization</td><td colspan="5">Electrical Power</td></tr>
<tr><td>Course Name</td><td>Electrical Instruments & Measurements</td><td>Course Code</td><td colspan="5">ELT 103</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Electric Circuits-I</td></tr>
<tr><td colspan="3" rowspan="4">Course Description:
This practical course introduces the basics of electrical measuring devices. It gives the trainees the basic knowledge required to use electrical measuring instruments. This is done by teaching the theoretical part and executing the necessary experiments in the laboratory.</td><td colspan="2">Trimester</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td colspan="2">Credit Hours</td><td></td><td></td><td>2</td><td></td></tr>
<tr><td rowspan="3">Contact Hours (h/w)</td><td>L</td><td></td><td></td><td></td><td></td></tr>
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<tr><td colspan="7">General objective of the course:
The course aims to teach the trainees the basics of electrical measurements and measuring instruments. It also enables the trainees to use different measuring instruments efficiently.</td></tr>
<tr><td colspan="7">Behavioral Objectives:
The trainees should be able to:
1. Identify the construction of different measuring instruments.
2. Use different measuring instruments.
3. Read correctly the different measuring instruments.
4. Identify the construction and the connections of the watt-meters and KWH meters.
5. Measure the power using two watt-meter method in three phase circuits.
6. Identify the construction of the oscilloscope.
7. Use the oscilloscope as a measuring device.
8. Identify the construction of the digital meters.
9. Measure the electrical quantities using digital meters.
10. Use Wheatstone and Maxwell bridges in measurements.
11. Identify the construction of potential and current transformers (P.T. & C.T.).
Use the P.T. and C.T. in measurements.
12. Write reports about the work done.</td></tr>
</table>

Contents (Practical):

- Measurements using moving coil instrument
- Measurements using moving iron instrument
- Measurements using digital meters
- Measurements using oscilloscope
- Measurements using Wheatstone and Maxwell bridges
- Electrical power measurements
- Measurements using P.Ts and C.Ts
- Electrical energy measurements

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
20	**1- Measurements using moving coil instruments:** • Construction • Using the moving coil instruments to measure the DC and AC quantities • Measuring the current • Internal resistance • Increasing the range for current measurement • Measuring the voltage • Increasing the range for voltage measurements • Measuring the resistance using moving coil instrument	Basic Knowledge B2, B6, F9, C6
	2- Measurements using moving iron instrument: • Construction • Using the moving iron instruments to measure the DC and AC quantities • Measuring the current • Measuring the voltage	Basic Knowledge B2, B6, F9, C6
4	**3- Measurements using digital meters:** • Measuring the voltage • Measuring the current • Measuring the resistance • Calibration	Basic Knowledge B2, B6, F9, C6
4	**4- Measurements using oscilloscope:** • DC voltage measurement • Using oscilloscope to study AC current characteristics - Measuring the peak and calculation of RMS value - Measuring the frequency and periodic time. • DC and AC currents measurements • Measuring the phase shift	Basic Knowledge B2, B6, F9, C6

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
4	**5- Measurements using Wheatstone and Maxwell bridges:** • Wheatstone bridge • Measuring the resistance using Wheatstone bridge • Maxwell bridge • Measuring the impedance using Maxwell bridge	Basic Knowledge B2, B6, F9, C6
8	**6- Electrical power measurements:** • Wattmeter. • Power measurements in DC circuits: - Measuring the power using the voltage and the current - Measuring the power using wattmeter • Measuring the power in single phase circuits: - Comparing the active power measured by wattmeter with that measured using voltmeter and ammeter - Power factor measurements for resistive, inductive and capacitive loads. • Measuring the power in three phase-circuits: - Measuring the power for resistive, inductive and capacitive loads using three-watt meters - Measuring the power for resistive, inductive and capacitive loads using two-watt meters - Reactive Power measurements	Basic Knowledge B2, B6, F9, C6
8	**7- Measurements using P.Ts and C.Ts** • Measuring the current using C.T. • Measuring the voltage using P.T. • Power measurements using C.T. and P.T.	Basic Knowledge B2, B6, F9, C6

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
8	**8- Measurements using P.Ts and C.Ts** • KWH meters: - Measuring the electrical energy using three phase KWH meter - Measuring the electrical energy using three phase KWH meter and C.Ts - Measuring the electrical energy using three phase KWH meter and C.Ts. and P.Ts	Basic Knowledge B2, B6, F9, C6

References	• Electrical Technology, Edwards Hughas • Introductory Circuit Analysis, Robert L. Boylestetad, 2000 • Principles of Electric Circuits, Thomas L. Floyd, 1999 • Fundamentals of Electric Circuits, Charles K. Alexander, N. O.Sadika, 2000 • Electric Circuits, Joseph Edminister, Mahmood Nhoi, 1997

Department	**Electrical Technology**	**Specialization**	**Electrical Power**
Course Name	**Industrial Safety**	**Course Code**	**ELT 105**
Prerequisites			

Course Description:

The course presents general rules for the safety of human beings and equipment. It also describes the effects of electricity on the human body. It also teaches the trainees first aid for those injured by electricity. In addition, it discusses fire alarm systems.

Trimester		1	2	3	4
Credit Hours					1
Contact Hours (h/w)	**L**				1
	P				
	T				

General objective of the course:

The course aims to teach the trainees the dangers of electricity and its effect on the human body. It also presents the general safety rules to avoid injuries. In addition, it describes fire alarm systems.

Behavioral Objectives:

The trainees should be able to:

1. Describe general regulation for safety of electrical and mechanical equipments.
2. Describe types of body injuries resulting from electrical current.
3. Presents how to rescue a person who suffered an electric shock.
4. Describe fire alarm systems.
5. Names building should have fire alarm systems.
6. Describe industrial safety guidelines.

Contents:

- **General regulation for safety of equipment**
- **Danger of electricity on the human body and how to perform a rescue**
- **Injuries resulting from passing electric current through the human body**
- **Fire alarm systems**
- **Industrial safety guidelines**

Detailed Contents		
Hours	**Contents**	**Related Tasks**
2	**1- General regulation for safety of equipments**	Basic knowledge A1-A13
2	**2- Safety rules for maintenance** • Coordination with other departments • Getting a work permit • Wearing suitable clothes • Keeping a safe distance • Using suitable tools • Making sure of the presence of another person during work • Disconnecting the source • Discharging the electricity • Using warning signs • Disconnecting the source • Discharging the electricity • Using warning signs	Basic knowledge A1-A13
4	**3- Danger of electricity on human body and how to rescue:** • Reasons for electric shocks • Electric current and the human body: a Electrical resistance of the human body b Intensity of electric current passing through the human body c Effect of voltage d Effect of frequency e Effect of passing electric current through the human body f The electric current pathway through the human body • Type of electrical injuries: a Electric shocks b Electric burns • Rescuing an injured person: a Freeing an injured person b Artificial breathing c Treatment of electrical burns d Treatment of electrical burns	Basic knowledge A1-A13

Detailed Contents		
Hours	**Contents**	**Related Tasks**
2	**4- Injuries resulting from passing electric current through the human body:** • Cases of harming the human body by electric current: a Touching two active lines b Touching one active line c Accidentally touching one voltage terminal d Touching and step voltages	Basic knowledge A1-A13
2	**5- - Causes of fire and fire alarm systems:** • Causes of fire and types: a Electric fires b Chemical fires • Components of fire alarm systems: a Control unit b Fire detectors c Thermal detectors d Smoke detectors e Fire alarms • Building should be provided with fire alarm system • Manually operated units • Installation of fire alarm system: a Types of fire distinguishers b Fire distinguishing methods	Basic knowledge A1-A13
1	**6- Industrial safety guidelines:** • Limiting unsafe behavior • Personal safety equipment a Eye protection b Ear protection. c Protective suits	Basic knowledge A1-A13

References	• Electrical Safety Engineering, W. Fordham, Butterworth-Heinemann, 1997 • الأمن الكهربائي – صبحي طه – دار المعرفة • التأريض الوقائي والحماية من الصواعق – د. عبد المنعم موسى – دار الراتب الجامعية

Department	**Electrical Technology**	**Specialization**	**Electrical Power**
Course Name	**Residential Installation W/S**	**Course Code**	**ELT 182**
Prerequisites	**Basic Electrical W/S**		

Course Description:

This practical course trains the trainees to plane, implement, and put into operation electrical installations of residential buildings. It also introduces the trainees to the installation of circuit breakers and KWH meters. In addition, it shows the trainees the proper distribution of building loads.

Trimester		1	2	3	4
Credit Hours				2	
Contact Hours (h/w)	**L**				
	P			4	
	T				

General objective of the course:

The course aims to enable the trainees to plan, install and put into operation domestic building installation. It trainees are also taught to install circuit breakers and KWH meters in domestic buildings.

Behavioral Objectives:

The trainees should be able to:

1. Read technical drawing and circuit documents.
2. Apply the rules for apartments and house installations.
3. Calculate the power load.
4. Choose the proper cables and wires needed.
5. Install the conduits.
6. Lay cables in conduits and ducts.
7. Install the proper circuit breaker in the proper place.
8. Install KWH meters.
9. Connect the power supply.

Contents (Practical):

- Rules and regulations for apartments and houses installations
- Domestic appliances
- Carrying out electrical installation circuits

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
8	**1- Rules and regulations for domestic installations:** • Safety regulations • Different industrial installations • Code of practice.	Basic knowledge B1, B2, C1-C6
12	**2- Domestic appliances:** • Reading of the symbolic technical drawing • Identifying the home appliances and their power • Studying the loads and the probability of different voltage levels • Power calculations and balanced distribution on the three phase • Identifying the circuit components and the proper cables and conductors cross-sections • Cost estimation • Determining installation time during construction • Setting up a proper period of time to carry out each stage of installation • Exercises: a Installing KWH meter and main circuit breakers b Installing main cables from distribution panel (obtained from ELT 180 W/S) to the supply	Basic knowledge B1, B2, C1-C6

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
32	**3- Carrying out electrical installation circuits:** • Cables and conductor size selections, taking into account specific transmission conditions, security measures, drop of voltage and thermal strain • Reading technical drawing and circuit documents and obtaining the symbolic circuit • Installing the operating means in its right position, taking into account the security measures • Exercises: a Installing and testing a simple circuit containing a socket and a lamp operated by one switch b Installing and testing a simple circuit containing a socket and two lamps operated by one switch c Installing and testing a simple circuit for two lamps operated by two switches d Installing and testing a simple circuit of lamp operated by two way switch e Installing and testing a fluorescent lamp operated with intermediate cross switch (three control points). f Installing and testing a door bell and door lock circuits using small step down transformers. g Installing and testing a three points socket (for washing machine or air condition).	Basic knowledge B1, B2, C1-C6

References	• Top 2 and 4: Electrical Power Engineering Proficiency Course, Deutsche Gesellschaft Fur Technische Zusammenarbeit (GTZ)

Department	Electrical Technology	Specialization	Electrical Power
Course Name	Industrial Installation W/S	Course Code	ELT 188
Prerequisites	Basic Electrical W/S		

Course Description:

This practical course contains the installation techniques used in industrial sectors and planning and installation of low voltage distribution panels. It also, contains the methods of testing and maintenance of low voltage distribution panels.

Trimester		1	2	3	4
Credit Hours				3	
Contact Hours (h/w)	L				
	P			6	
	T				

General objective of the course:

The course aims to enable the trainees to plan, install and put into operation electrical wiring in industrial buildings and workshops. It also trains the trainees to determine and distribute the industrial loads. In addition, it enables the trainees to install, test, and maintain low voltage distribution panels.

Behavioral Objectives:

The trainees should be able to:

1. Read technical drawing and circuit documents.
2. Apply the rules for apartments and houses installation.
3. Calculate the load power.
4. Choose the proper cables and wires needed.
5. Install the conduits.
6. Lay cables in conduits and ducts.
7. Install main and secondary distribution panels.
8. Carry out and document a function test under operating condition.

Contents (Practical):

- **Rules and regulations for industrial installations.**
- **Planning low voltage panels.**
- **Installation of low voltage panels.**
- **Operation and test of low voltage panels.**
- **Maintenance of low voltage panels.**

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
18	**1- Rules and regulations for industrial installations:** • Safety regulation • Different industrial installations: - Laying out wires in plastic or metal conduits fixed on walls - Laying out wires in plastic or metal conduits hidden in the walls - Laying out wires in plastic or metal conduits under false ceiling - Laying out wires in plastic or metal conduits on metal racks - Laying out wires in plastic or metal conduits in under-ground ducts • Code of practice • Exercises: - Fixing metal conduits above false ceilings or to walls with different connecting methods - Fixing metal racks above false ceilings or to walls with different connecting methods - Fixing plastic conduits above false ceilings or to walls with different connecting methods	B1-B13 E2, E4
15	**2- Low voltage distribution panel planning:** • Different methods for low voltage distribution panel planning • Selection of the needed components • Determination of execution procedures • Determination of the execution time • Drawing execution layouts	B1-B13 E2, E4
24	**3- Installation of low voltage distribution panel:** • Installing a low voltage panel • Selection of the needed components • Exercise; Execution of low distribution system	B1-B13 E2, E4

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
9	**4- Operation and testing of low voltage panels:** • Testing the connection of the different components • Operate the system	B1-B13 E2, E4
12	**5- Maintenance of low voltage panels:** • Maintenance of the main circuit breaker • Maintenance of secondary circuit breakers • Maintenance of the distribution bus bars • Maintenance of the end connectors	B1-B13 E2, E4

References	• Top 2 and 4: Electrical Power Engineering Proficiency Course, Deutsche Gesellschaft Fur Technische Zusammenarbeit (GTZ)

Department	**Electrical Technology**	**Specialization**	**Electrical Power**
Course Name	**Alternating Current Machines**	**Course Code**	**ELT 218**
Prerequisites	**DC Machines &Transformers (ELT 118)**		

Course Description:

This course describes two main topics:

- Three-phase induction motors.
- Synchronous machines.

This course covers construction, principles of operation, classification, equivalent circuits, parameters determination, characteristics, and applications of three-phase induction motors and synchronous machines.

Trimester		1	2	3	4
Credit Hours					4
Contact Hours (h/w)	**L**				3
	P				2
	T				1

General objective of the course:

The course aims to give trainees the basic knowledge of construction, theory, performance analysis, and applications of three phase induction motors and synchronous machines in industry.

Behavioral Objectives:

The trainees should be able to:

1. Describe the components and construction of three-phase induction motors.
2. Explain how the rotating magnetic field is produced in three-phase induction motors.
3. Describe the types and characteristics of three-phase induction motors.
4. Describe the methods of starting three-phase induction motors.
5. Describe the methods of speed control of three phase induction motors.
6. Describe the types and construction of synchronous machines.
7. Explain the working principle of synchronous generators.
8. Explain how the generated voltage and frequency of synchronous generators can be adjusted.
9. Name the conditions of parallel operations of alternators.
10. Describe the methods of synchronizing alternators with infinite Bus-bars.
11. Explain how synchronous motors are used as synchronous condensers in power systems.

Contents (Theoretical and Practical):

- **Three-phase induction machines**
- **Three-phase synchronous machines**

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
26	**1-Three-phase induction motors:** • Construction of three phase induction motors • Types of rotors • Production of the rotating magnetic field • Synchronous speed, rotor speed, and slip • Equivalent circuit • Power flow diagram • Losses and efficiency • Performance calculations • Theory of operation of polyphase induction motors • Torque speed relations • Methods of starting • Methods of speed control • Applications **Single-phase induction motors**	Basic Knowledge A, B, C, D, E, F, G, H, I
26	**2-Synchronous generators:** • Constructional of synchronous machines, (cylindrical rotor and salient pole machines) • Equivalent circuit and synchronous impedance • Phasor diagram of synchronous generators at different load conditions • Theory of operation of synchronous generators • Voltage regulation • Conditions of parallel operation and division of loads • Theory of operation as synchronous motors • Operation as synchronous condensers to improve the power factor	Basic Knowledge A, B, C, D, E, F, G, H, I

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
16	**1-Three-phase induction motors:** • Construction of Induction motors – winding types and arrangement – name plate understanding and readings • Rotating magnetic field - Synchronous speed – Slip – Effect of rotor speed on rotor voltage and frequency • Measurements in rotor circuits of slip ring induction motor • Determination of the equivalent circuit parameters: 1. No load test 2. Locked rotor test (short circuit test) • Load test; draw the characteristic curves: 1. Torque / Speed curve 2. Efficiency / Load current curve 3. Power factor / Load current curve • Methods of starting: 1. Direct starting 2. Auto-transformer starting 3. Star / Delta starting 4. Starting using rotor resistance 5. Effect of varying the rotor resistance on the motor performance	**Basic Knowledge** **B7, E5, F3**
6	**2-Synchronous generators:** • No-load test • Short circuit test • Load test • Synchronization of two alternators or an alternator with infinite system	
4	**3-Synchronous motors:** • Determination of the **V**-curves.	

References	• Electrical Technology, Edward Hughes, ISBN: 0-07-02134-5. • Electric Machines G. R. Slemon and A. Straughan, Eddison-Weslley, 1980. • Electrical Machines and Transformers-Principles and applications, P. F. Ryff, D. Platnick, and J. A. Karnas, Printice Hall. Electric Machinery, M. S. Sarma, West Publishing Company, 1994.

Department	**Electrical Technology**	**Specialization**	**Electrical Power**
Course Name	**Electrical Distribution Technology**	**Course Code**	**ELT 261**
Prerequisites	**Electrical Circuits II**		

Course Description:

The course provides an introduction to the components of different types of distribution systems, ring main units, lighting system installations, calculations, reactive power compensation and earthing of electrical distribution systems and equipment.

Trimester		1	2	3	4
Credit Hours					3
Contact Hours (h/w)	**L**				3
	P				
	T				

General objective of the course:

The course aims to inform the trainees of the components of different types of distribution systems such as; distributors, and feeders. It also presents the operation of the ring main units, the lighting system technology and earthing of the distribution system and equipment.

Behavioral Objectives:

The trainees should be able to:

1. Name and describe the components of distribution systems.
2. Describe the deferent types of distributors and feeders.
3. Describe the different types of ring main unit.
4. Identify the types and characteristics of electrical loads.
5. Calculate the voltage and current for DC & AC distributors.
6. Explain the reactive power and its compensation.
7. Describe the technologies of lighting installations.
8. Describe the technologies used in earthing the electrical distribution systems and equipment.

Contents:

- **Components and types of distribution systems**
- **Secondary distribution substations (Ring Main Units RMU)**
- **Electric loads**
- **Power consumptions tariff**
- **Electric feeders and distributors**
- **Power factor improvements**
- **Electric lighting**
- **Earthing of distribution systems**

Detailed Contents		
Hours	**Contents**	**Related Tasks**
4	**1-Components and types of distribution systems:** • Components of power system • Distribution systems: - Primary distribution - Secondary distribution	B10, B11, B12, E2, E13, G4, H2, H3, H6, G2
6	**2-Secondary distribution substations (RMU):** • Components • Distribution transformers: - Types according to fixing - Types according to cooling • Connecting switches: - Types - Uses - operation	B10, B11, B12, E2, E13, G4, H2, H3, H6, G2
4	**3- Electric loads:** • Types of loads • Load tables	B10, B11, B12, E2, E13, G4, H2, H3, H6, G2
4	**4- Power consumption tariff:** • Flat tariff • Two sides tariff • Ascending tariff • Ascending tariff according to power factor	B10, B11, B12, E2, E13, G4, H2, H3, H6, G2

Detailed Contents		
Hours	**Contents**	**Related Tasks**
5	**5- Electric feeders and distributers:** • DC distribution feeders: - Distributors fed at one end - Distributors fed at both ends • .AC distribution feeders: - Single-phase double wires feeders	B10, B11, B12, E2, E13, G4, H2, H3, H6, G2
5	**6- Power factor improvements (reactive power compensation):** • Power factor • Power factor improvements • Capacitors • Table method	B10, B11, B12, E2, E13, G4, H2, H3, H6, G2
5	**7- Electric lighting:** • Definitions, symbols, and units • Interior light distribution • Determination of the required number and type of lamps • Lighting tables	B10, B11, B12, E2, E13, G4, H2, H3, H6, G2
6	**8- Earthing in distribution systems:** • Earthing of distribution system • Earthing of equipments • Earthing conductors • Protection conductors	

References	• نقل وتوزيع وحماية القدرة الكهربائية. محمد عدنان سراج وزارة التعليم – سوريا- 1996 • The Electrical Power Engineering Handbook, Leo L. Grigsby, Marcel Dekker, New York, 1994. • Power Distribution Planning Reference Book, H. Lee Willis, ABB Inc., North Carolina, 2004. • Electrical Power Distribution and Transmission, L. M. Faulkenberry and W. Coffer, Prentice-Hall, 1996. • التمديدات الكهربائية وحمايتها. محمد عالية. المؤسسة العربية للدراسات والنشر.

<table>
<tr><td>Department</td><td>Electrical Technology</td><td>Specialization</td><td colspan="5">Electrical Power</td></tr>
<tr><td>Course Name</td><td>Programmable Control Technology</td><td>Course Code</td><td colspan="5">ELT 205</td></tr>
<tr><td>Prerequisites</td><td colspan="7">Electrical Circuits II</td></tr>
<tr><td colspan="3" rowspan="4">Course Description:
This course presents applied and experimental study for logic circuits and the programmable logic controller. It also enables the student to draw the control circuits and programs the PLC using the program required for industrial applications. It also trains the trainees to test and maintain control circuits.</td><td colspan="2">Trimester</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td colspan="2">Credit Hours</td><td></td><td></td><td></td><td>3</td></tr>
<tr><td rowspan="3">Contact Hours (h/w)</td><td>L</td><td></td><td></td><td></td><td>2</td></tr>
<tr><td>P</td><td></td><td></td><td></td><td>2</td></tr>
<tr><td>T</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">General objective of the course:
This course aims to teach the trainees the construction of the PLC, the fundamentals of its operation. It also presents the application of the PLC in different industrial areas.</td></tr>
<tr><td colspan="8">Behavioral Objectives:
The trainees should be able to:
1. Understand the control circuits used in industrial applications.
2. Recognize the construction of the PLC and its fundamentals.
3. Understand the different programming methods.
4. Simulate an industrial process with a simple PLC program.
5. Inspect the control circuits, PLC, locate any faults and repair them.</td></tr>
<tr><td colspan="8">Contents:
- System of numbers
- Logic circuits
- PLC construction and fundamentals of its operation
- PLC programming (LAD – STL – CSF)
- Basic functions (Timers – Counters – Flip-flop – Shift Registers – Comparators)
- Laboratory applications
- Control circuit testing</td></tr>
</table>

Detailed Contents (Theoretical)		
Hours	**Contents**	**Related Tasks**
2	**1- System of numbers:** • Decimal system • Binary system	Basic Knowledge E1, I2, E3, B1
4	**2- Logic circuits:** • Logic gates (AND, OR, NOT, NAND, and NOR) • Logic expressions and its representation using logic gates • Representing control circuits using logic expressions and logic gates	Basic Knowledge E1, I2, E3, B1
4	**3- PLC construction and fundamentals of its operation:** • PLC construction • Advantages of using the PLC in industry	Basic Knowledge E1, I2, E3, B1
4	**4- PLC Programming (LAD – STL – CSF):** • Ladder (LAD) • Control System Flowchart (CSF) • Statement List (STL)	Basic Knowledge E1, I2, E3, B1
4	**5- Basic Functions:** • Latch function • Set/Reset function • Timers • Counters	Basic Knowledge E1, I2, E3, B1
4	**6- Laboratory applications:** • Operating the three-phase Induction Motor (IM) from two different locations • Fast and slow reversing the direction for three phase IM • Starting slip ring IM using starting resistances • Starting delta connected IM using star/delta switch	Basic Knowledge E1, I2, E3, B1
4	**7- Inspection of operation and control circuits:** • Maintenance of PLC controlled systems • Fault finding • Clearing the faults	Basic Knowledge E1, I2, E3, B1, F1, F2, F3, F4, F5, F6, F7, F8

Detailed Contents (Practical)		
Hours	**Contents**	**Related Tasks**
4	• Special applications for PLC programming fundamentals	Basic Knowledge E1, I2, E3, B1, F1, F2, F3, F4, F5, F6, F7, F8
2	• Speed control of IM and direction reversing	
4	• Staring IM using star/delta switch with possibility of reversing the direction of rotation	Basic Knowledge E1, I2, E3, B1, F1, F2, F3, F4, F5, F6, F7, F8
2	• Operating the three phase IM with two speeds (Dalender)	
2	• Speed control of wound rotor IM using starting resistances	Basic Knowledge E1, I2, E3, B1, F1, F2, F3, F4, F5, F6, F7, F8
2	• Temperature control	
2	• Traffic signal application	Basic Knowledge E1, I2, E3, B1, F1, F2, F3, F4, F5, F6, F7, F8
2	• Stepper motor application	
2	• Washing machine application	Basic Knowledge E1, I2, E3, B1, F1, F2, F3, F4, F5, F6, F7, F8
2	• Left application	
2	• Maintenance and system diagnosis	Basic Knowledge E1, I2, E3, B1, F1, F2, F3, F4, F5, F6, F7, F8

References	
	• Programmable Logic Controllers, J. W. Wabb and R. A. Reis, 1994 • Programmable Logic Controllers, C. Simpson, 1993 • Programmable Logic Controller and their Engineering Applications, A. Crispin, 1990 • The PLC workbook, Clement Jewery, 1993 • أجهزة تحكم قابلة للبرمجة للمهندس عيد شحاذة هلالة – سلسلة الرضا للمعلومات

Department	Electrical Technology	Specialization	Electrical Power
Course Name	Electrical Networks	Course Code	ELT 262
Prerequisites	Electrical Circuits II		

Course Description:

The course describes the components of power system networks, overhead transmission lines, under ground cables, and symmetrical short circuit calculations. It also includes the study of the effect of some phenomena on the transmission line.

Trimester					5
Credit Hours					3
Contact Hours (h/w)	L				3
	P				
	T				

General objective of the course:

The course aims to introduce the trainees to power system networks and the components such as overhead transmission lines and cables. It enables the trainees to calculate the sag in transmission lines. It also enables the trainees to perform symmetrical short circuit calculations. In addition, it describes lightning and protection against it.

Behavioral Objectives:

The trainees should be able to:

1. Name and describe the components of power system networks.
2. Name the material used in cable, towers, and overhead lines manufacturing.
3. Determine the sag between two towers and the factors affecting it.
4. Distinguish between the different types of cables.
5. Use the available tables to choose the required cables.
6. Find the faults in cables.
7. Describe the reasons of symmetrical short circuits.
8. Calculate symmetrical short circuit currents.
9. Describe the effect of a three-phase short circuit and its duration in the power system.
10. Explain corona discharge and the factors affecting it.
11. Explain lightning strikes (surges) and protection methods.

Contents:

- **Overhead lines**
- **Insulators in power networks**
- **Underground cables**
- **Short circuits**
- **Phenomena affect the overhead transmission lines**

Detailed Contents		
Hours	**Contents**	**Related Tasks**
12	**1- Overhead lines:** • Types of overhead transmission lines: - Short transmission lines - Medium transmission lines - Long transmission lines - Calculation of the sending voltage for short and medium lines • Transmission lines installations: - Electrical conductors - Conductors in overheat transmission lines - Towers - Sag calculation between two identical towers and factors affects it	Basic Knowledge B13, C3, D1, D2, D3, D4, D7, F2, F3, F4, I1
9	**2-Insulators in power system networks:** • Types of insulators: - Gaseous insulators - Liquid insulators - Solid insulators • Overhead lines insulators: - Introduction and bases - Materials used in manufacturing overhead lines - Types - Voltage distribution on the insulator string and string efficiency	Basic Knowledge B13, C3, D1, D2, D3, D4, D7, F2, F3, F4, I1
12	**3- Underground cables:** • Types of cables and parameters calculation • Power loss and determination of ampere-capacity using tables • Cooling of underground cables • Number of cables in ducts • Voltage drop • Faults in underground cables: a Types of faults b Reasons for faults **c** Locating the faults	Basic Knowledge B13, C3, D1, D2, D3, D4, D7, F2, F3, F4, I1

Detailed Contents		
Hours	**Contents**	**Related Tasks**
3	**4- Short circuits:** • Sources of short circuit • Per unit system • Types of short circuits: a Symmetrical short circuit fault. • Symmetrical short circuit current calculation • Effect of short circuit and its duration time in the power network	Basic Knowledge B13, C3, D1, D2, D3, D4, D7, F2, F3, F4, I1
3	**5- Phenomena affecting transmission lines:** • Skin effect • Corona • Lightning and lightning protection	Basic Knowledge B13, C3, D1, D2, D3, D4, D7, F2, F3, F4, I1

References	• Electric Power Systems, Syed A. Nasar and F. C. Trutt, Taylor and Fracis, 2001. • Electrical Power Cable Engineering, 2nd Edition, William A. Thue, Taylor and Fracis, 2003. • Electric Power Systems, J.A. Harrison, McGraw Hill, 1996 • Power System Analysis, C.A. Gross, J. Wiley & Sons Ltd, 1997 • Elements of power system analysis, W. D. Stevenson, McGrew Hill International Edition.

<table>
<tr><td>Department</td><td>Electrical Technology</td><td>Specialization</td><td colspan="5">Electrical Power</td></tr>
<tr><td>Course Name</td><td>Power Electronics</td><td>Course Code</td><td colspan="5">ELT 208</td></tr>
<tr><td>Prerequisites</td><td colspan="6">Electrical Circuits II</td></tr>
<tr><td colspan="3" rowspan="5">Course Description:
This course introduces the trainees to power electronics' elements and circuits. These circuits include power converters as a means to control the voltage and frequency. It also uses the power electronic circuits to control the performance of electrical machines.</td><td colspan="2">Trimester</td><td>1</td><td>2</td><td>3</td><td>4</td></tr>
<tr><td colspan="2">Credit Hours</td><td></td><td></td><td></td><td>4</td></tr>
<tr><td rowspan="3">Contact Hours (h/w)</td><td>L</td><td></td><td></td><td></td><td>3</td></tr>
<tr><td>P</td><td></td><td></td><td></td><td>2</td></tr>
<tr><td>T</td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">General objective of the course:
This course aims to familiarize the trainees with the characteristics of power electronic elements and their uses in different power converters; such as controlled rectifiers, AC voltage controllers, and inverters. It also aims to teach the students the uses of power converter power applications.</td></tr>
<tr><td colspan="7">Behavioral Objectives:
The trainees should be able to:
1. Understand the characteristics and uses of power electronic elements.
2. Describe the operation and uses of uncontrolled and controlled rectifiers.
3. Describe the operation and uses of AC voltage controllers.
4. Describe the operation and uses of inverters.
5. Name the uses of power converters in the field of the electrical power.</td></tr>
<tr><td colspan="7">Contents:
- Semiconductor devices
- Rectifier circuits
- AC Voltage controller circuits
- Inverters circuits
- Applications</td></tr>
</table>

Detailed Contents (Theoretical)		
Hours	**Contents**	**Related Tasks**
9	**1- Semi-conductor devices:** • Power diode • Thyristors • Firing and protection circuits • Power transistors • Characteristic curves of power electronic elements	Basic Knowledge B1, E9, E10, F2
9	**2- Rectifier circuits:** • Types of rectifier circuits • Single phase rectifiers (uncontrolled/controlled) with resistive and inductive loads • Controlling the voltage by changing the firing angle • Three phase rectifier circuits (uncontrolled/controlled) • Uses of rectifier circuits in battery charging.	Basic Knowledge B1, E9, E10, F2
6	**3- AC Voltage controllers:** • Theory of operation of phase angle control • Uses of AC voltage controller in lighting and temperature control • AC voltage controller circuits (single and three phase) • Reactive power control using AC voltage controller	Basic Knowledge B1, E9, E10, F2
9	**4- Power inverters:** • Theory of operation • Voltage and frequency control • Single phase inverter circuits • Three phase inverter circuits • Uses of power inverters in UPS and emergency lighting • Methods of improving inverter's output waveform	Basic Knowledge B1, E9, E10, F2
6	**5- Applications:** • DC transmission • Static exciter	Basic Knowledge B1, E9, E10, F2

Detailed Contents (Practical)		
Hours	**Contents**	**Related Tasks**
6	**1- Semiconductor devices:** • Data sheet reading for power electronic elements • Characteristic curves for diodes • Characteristic curves for SCR	Basic Knowledge B1, E9, E10, F2
6	**2- Uncontrolled rectifier circuits:** • Single phase rectifier with resistive loads • Three phase rectifier with resistive loads • Smoothing the output voltage using capacitors	Basic Knowledge B1, E9, E10, F2
10	**3- Controlled rectifier circuits:** • Firing circuits • Single phase rectifier with resistive and inductive loads • Three phase rectifier with resistive and inductive loads	Basic Knowledge B1, E9, E10, F2
4	**4- AC Voltage controllers:** • Controlling the output voltage by changing the phase angle	Basic Knowledge B1, E9, E10, F2

References	
	• An Introduction to Power Electronics, B. M. Bird, K. G. King, D. A. G. Pedder, John Wiley & sons, 1993 • Modern Power Electronics, B. K. Rose, IEEE Press Publication , 1992 • Power Electronics: Circuits, Devices and applications, M. H. Rashid, Prentice Hall, 1994ISBN:81-203-0869-7 • Power Electronic: Converters, Applications, and Design Ned Mohan, T. M. undeland, W. T. Robbins, Jon Wiley & sons, 1994

Department	Electrical Technology	Specialization	Electrical Power
Course Name	Special places installation & Protection W/S	Course Code	ELT 289
Prerequisites	Industrial Installation W/S		

Course Description:

This practical course focuses on safety and protection measures, putting into operation and documentation electrical installation of special operating places. It also includes the operation of emergency units.

Trimester		1	2	3	4
Credit Hours					3
Contact Hours (h/w)	L				
	P				6
	T				

General objective of the course:

The course aims to teach the trainees safety measures. It also helps them to plan installation for special operating places; such as agricultural, fire endangered, highly explosive sites and rooms being used for medical purposes. In addition, it helps the trainees to operate and maintain the emergency unit.

Behavioral Objectives:

The trainees should be able to:

1. Explain and apply protective measures and safety regulations according to the standards.
2. States the rules and requirements for the installation of electrical systems in special places.
3. Determine the safety precautions.
4. Estimate the power requirement.
5. Choose proper cables and wires needed.
6. Read the necessary technical drawings, wiring diagrams and installation plans.
7. Calculate the cost estimate for the installation of the system.
8. Estimate the required working time.
9. Carry out and document a function test under operating conditions.
10. Install, operate and maintain an emergency unit.
11. State and apply the protective measures for electrical hazards.

Contents (Practical):

- Rules and regulations for workshops and special places
- Special site installations
- Emergency units
- Protective measures and safety regulations

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
12	**1- Rules and regulations for workshops and special sites:** • Rules and requirements for the following places: - Damp and wet - Agriculture - Fire hazardous - Explosion hazardous - Medical rooms	Basic Knowledge B1, B2, B3, B4, B5, B6, B8, B9, B10, B12, B13, B14, C1, C2, C3, C4, C5, C6, G2, H2, H3, I1, I3
30	**2- Special site installations:** • Reading technical drawing and wiring diagram • Determination of work sequences and estimation of the time required • Various costs estimation • Carrying out the installation • Carrying out and documenting a function test under operating condition • Judging existent installation according to the following criteria: a Protective precautions b Execution c Aptitude of applied material and appliances • Exercises: a Door intercom b Security camera c Photo cells sensors d Smoke and fire detectors e Agriculture installation f Medical room g Fountains and swimming pools	Basic Knowledge B1, B2, B3, B4, B5, B6, B8, B9, B10, B12, B13, B14, C1, C2, C3, C4, C5, C6, G2, H2, H3, I1, I3
12	**3- Emergency units:** • Types of emergency units • Power calculation of emergency units • Installation of emergency units • Maintenance of emergency units	Basic Knowledge B1, B2, B3, B4, B5, B6, B8, B9, B10, B12, B13, B14, C1, C2, C3, C4, C5, C6, G2, H2, H3, I1, I3

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
24	**4- Protective measures and safety regulations:** • Testing the effectiveness of safety measures in case of direct and indirect contact: a Safety measures in case of touching a life conductor b Safety measures in case of indirect contact of electrical current • Protection using isolating transformer: a Earthing protection b Ground fault circuit interrupters	Basic Knowledge B1, B2, B3, B4, B5, B6, B8, B9, B10, B12, B13, B14, C1, C2, C3, C4, C5, C6, G2, H2, H3, I1, I3

References	• Top 2 and 4: Electrical Power Engineering Proficiency Course, Deutsche Gesellschaft Fur Technische Zusammenarbeit (GTZ)

Department	Electrical Technology	Specialization	Electrical Power
Course Name	Maintenance of Power Systems	Course Code	ELT 263
Prerequisites	Electrical Distribution Technology		

Course Description:

The course concerns the maintenance of power system components; such as generators, RMU, transmission lines and its insulators. It also helps the trainees with the skills needed to perform routine maintenance for power system components.

Trimester					5
Credit Hours					3
Contact Hours (h/w)	L				3
	P				
	T				

General objective of the course:

The course aims to introduce the trainees to maintenance of power system components. It provides the trainees with the skills needed to perform the routine maintenance for power system components.

Behavioral Objectives:

The trainees should be able to:

1. Understand the objectives of the maintenance of power system components.
2. Describe the methods of maintenance of substations.
3. Describe the methods of maintenance of bus-bars and circuit breakers.
4. Describe the methods of maintenance of transmission lines and their insulators.
5. Describe the methods of maintenance of alternators.

Contents:

- Importance of maintenance
- Maintenance of substations (RMU)
- Maintenance of overhead transmission lines and its insulators
- Maintenance of underground cables
- Maintenance of alternators

Detailed Contents		
Hours	**Contents**	**Related Tasks**
4	**1- Importance of maintenance:** • Why we perform maintenance? • Maintenance planning • Review of electrical power distribution • Maintenance considerations and requirements	C7, C8,C9, D5, D6, D7, D8, D9, D10, D11, E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, H4, H5, I1, I2, I3
18	**2- Maintenance of substations:** • Substation isolation • Using warning signs • Transformer maintenance • Circuit breaker maintenance • Maintenance of instruments and protection transformer • Maintenance of protection devices • Maintenance of batteries and DC current circuits • Bus-bar maintenance • Insulators maintenance • Inspection of alarm system • Inspection of earthing circuits and boxes • Putting a substation back into service	C7, C8,C9, D5, D6, D7, D8, D9, D10, D11, E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, H4, H5, I1, I2, I3
9	**3- Maintenance of overhead transmission lines and its insulators:** • Maintenance of energized transmission line • Maintenance of de-energized transmission line • Maintenance of transmission lines insulators	C7, C8,C9, D5, D6, D7, D8, D9, D10, D11, E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, H4, H5, I1, I2, I3
4	**4- Maintenance of underground cables**	C7, C8,C9, D5, D6, D7, D8, D9, D10, D11, E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, H4, H5, I1, I2, I3

Detailed Contents		
Hours	**Contents**	**Related Tasks**
4	**5- Maintenance of alternators**	C7, C8,C9, D5, D6, D7, D8, D9, D10, D11, E1, E2, E3, E4, E5, E6, E7, E8, E9, E10, E11, E12, E13, H4, H5, I1, I2, I3

References	• Testing, Commissioning, Operation & Maintenance of Electrical Equiment, S. Rao, Khanna Publishers, Delhi, 2002. • Power system commissioning and Maintenance Practice, K. Harker, IEEE, 1998. • Power Station Maintenance, Professional Engineering Publishers, Wiley Publisher, 2000. • Electrical Power System Technology, S.W. Fardo and D.R. Patrick, Butterworth-Heinemann, 1997 • Standard Handbook for Electrical Engineers, Mc Graw Hill

Department	**Electrical Technology**	**Specialization**	**Electrical Power**
Course Name	**Automatic Control Technology**	**Course Code**	**ELT 207**
Prerequisites	**Electric Circuits-II**		

Course Description:

The course covers terminology, concepts, and principles of automatic control technology. It gives practical examples and explains the basic definitions of automatic control systems with the aid of the block diagram. Emphasis is on the applications of well-established methods, with the aid of examples and computer programs to determine the constants of these controllers.

Trimester		1	2	3	4
Credit Hours					3
Contact Hours (h/w)	**L**				2
	P				2
	T				

General objective of the course:

The aim of the course is to teach the trainees the fundamentals of automatic control technology that enables them to understand the control systems used in industry. This course enables the trainees to apply some simple control systems using ready-made packages, using a computer for this purpose.

Behavioral Objectives:

The trainees should be able to:

1. Distinguish between open loop and control loop systems.
2. Sketch the block diagram and perform simple block diagram simplifications.
3. Understand the importance of automatic control in different fields.
4. Understand the methods of representing the basic control system.
5. Distinguish between analogue and digital controllers.
6. Describe process control and process controllers.
7. Describe the physical elements of each part of the control system.
8. Explain the role of each element in the system.
9. Explains the main control methods.

Contents (Theoretical and Practical):

- **Fundamentals of automatic control**
- **Types and characteristics of industrial control systems**
- **Closed loop control systems**
- **Laboratory experiments**

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
8	**1. Fundamentals of automatic control:** • Importance of automatic control (practical examples) • Applications of automatic control in different fields • Process representation using block diagram or power flow graph • Basic definitions of control system (input, output, error, and reference) • Open loop and closed loop system: Concepts, advantages, and disadvantages • Simplification of block diagram	Basic knowledge F5, F6
10	**2. Types and characteristics of industrial control systems:** • Definition of analogue and digital control • Definition of process control • Servomechanism • Basic components of industrial systems • Final Control elements: A. Control valves B. Electric motors • Sensors and transducers • Controllers • Measurements in control technology: A. Position, displacement, velocity, acceleration. B. Force, temperature, flow rate, pressure, and level.	Basic knowledge F5, F6
8	**3. Closed loop control system:** • Define the closed loop desired characteristics of the controlled system • Explain the role of each elements of P, PI, and PID controllers in closed loop system settings • Use of SIMULINK to illustrate the concepts introduced above	Basic knowledge F5, F6

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
2	**1. Introduction to equipment and devices**	Basic knowledge F5, F6
8	**2. Analysis of open loop industrial system response:** • Step response analysis of thermal system • Step response analysis of DC motor • Step response analysis of level control system	Basic knowledge F5, F6
16	**3. Analysis of closed loop industrial system response:** • Closed loop control of thermal system: A. Influence of proportional controller gain on the steady state error and settling time B. Zero steady state error using PI controller • Closed loop control of a DC motor system: A. Influence of proportional controller gain on the steady state error and settling time B. Zero steady state error using PI controller C. Effect of adding d type element to the PI controller • Closed loop control of thermal system: A. Influence of proportional controller gain on the steady state error and settling time B. Zero steady state error using PI controller	Basic knowledge F5, F6

References	• Modern Control Engineering, K. Ogatta, Prentice Hall, 1994 • Modern Control System, R. C. Dorf, Eddison Wesley, 1990 • Control System Design, C. T. Chen, Saunders College Publishing, 1993 • Feedback Control System, John Van De Vegta, Prentice Hall, 1990 • Automatic Control Systems, B. Kuo, Prentice Hall

Department	**Electrical Technology**	**Specialization**	**Electrical Power**
Course Name	**Generation & Main Substations**	**Course Code**	**ELT 264**
Prerequisites	**Electric Circuits-II**		

Course Description:

The course introduces the trainees to energy resources, conventional power plants, main substations, and electric loads. It also introduces the trainees to the operation and maintenance of power plants and main substations.

Trimester					5
Credit Hours					3
Contact Hours (h/w)	**L**				3
	P				0
	T				

General objective of the course:

The course aims to familiarize the trainees with energy resources, power plants, types of electrical loads and their factors. It also equips the trainees with the skills necessary to operate and maintain power plants and substations.

Behavioral Objectives:

The trainees should be able to:

1. Name and describe different energy resources.
2. Identify the components of different types of power plants.
3. Mention the advantages and disadvantages of each type of power plants.
4. Choose the proper site for a power plant.
5. Represent different electrical loads.
6. Name the types of substations.
7. Identify the components of a power substation.

Contents (Theoretical and Practical):

- **Electrical energy sources**
- **Conventional power plants**
- **Electrical loads**
- **Energy tariffs**
- **Overhead lines**
- **Laboratory experiments**

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
3	**1- Electrical energy resources:** • Conventional resources (coal, oil, natural gas, hydraulic, nuclear) • Renewable resources (solar, windmills, sea waves, and geothermal)	Basic knowledge
15	**2- Conventional power plants:** • Steam power stations • Gas power stations • Diesel power stations • Environmental consideration for each type. • Power plant site selection. • Comparison between different types of power plants	Basic knowledge E12, E13, E14, F2, F3, F4, G2, G3, G4, G5, G6, G7, I3
9	**3. - Electrical loads:** • Types of loads: a Domestic, commercial, industrial, b Street lighting and transportation. • Different load factors: a Load factor. b Demand factor c Diversity factor • power plants' factors: **a** Plant capacity factor b Reserve factor c Utilization factor	Basic knowledge E12, E13, E14, F2, F3, F4, G2, G3, G4, G5, G6, G7, I3

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
12	**4. – Transformer Substations:** • Types of substations : a Step up substation, b Step down substation • Substation components • Substation layout • Power transformers and cooling methods • Bus scheme: - Types - Advantages and disadvantages of each type • Circuit breakers, disconnecting and earthing switches • Protection and measuring instruments • Alarm system • Batteries • Substation earthing • Control instruments • Introduction to gas insulated substation	Basic knowledge E12, E13, E14, F2, F3, F4, G2, G3, G4, G5, G6, G7, I3

References	• **نقل وتوزيع وحماية القدرة الكهربائية. محمد عدنان سراج . وزارة التعليم العالي – سوريا - 1996** • Guide to Electrical Power Generation, 3rd Edition, Anthony J. Pansini and K. D. Smalling, Taylor and Francis, 2005. • Wind and Solar Power Systems: Design, Analysis and Operation, 2nd Edition, Mukund R. Patel, Taylor and Francis, 2005 • Electric Power Generation, R.K. Garg, Khama Publishers, Delhi

Department	Electrical Technology	Specialization	Electrical Power
Course Name	Power Systems Protection	Course Code	ELT 265
Prerequisites	Electric Transmission Network		

Course Description:

The course introduces the trainees to the methods of protection of the different components in power systems; such as alternators, transformers, bus bars, transmission lines, and motors. It also describes the different protection devices used for this purpose.

Trimester					5
Credit Hours					4
Contact Hours (h/w)	L				3
	P				2
	T				

General objective of the course:

The course aims to teach the trainees the protection methods used in power systems, especially those used to protect electrical installations and electrical machines. It also introduces the trainees to circuit breakers and protective relays.

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Behavioral Objectives:

The trainees should be able to:

1. Define the terms used in the field of protection.
2. Explain the basics of protection.
3. Describe the construction and function of fuses, circuit breakers, and relays.
4. Describe the methods of protection of electrical installation.
5. Describe the methods of protection of transformers, generators, and motors.

Contents (Theoretical and Practical):

- **Basics of protection**
- **Protective devices**
- **Protection of electrical installation**
- **Transformer protection**
- **Generator protection**
- **Motor protection**
- **Laboratory experiments**

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
2	**1- Basics of protection:** • Importance of protection • Definition of terms	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6
15	**2- Protective devices:** • Fuses: a Two element fuses b tubular fuses • Circuit breakers: a Low voltage circuit breaker b Air circuit breaker c Oil circuit breaker d SF6 circuit breaker e Vacuum circuit breaker • Protective relays: a Types of relays according to construction: 1. Electromagnetic relays 2. Static relays b Types of relays according to function: 1. Over current relays 2. Distance relays 3. directional relays	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6
6	**3- Protection of electrical installations:** • Protection device selection • Protection of feeders • Protection of electrical equipment • Protection of distribution panels	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6

Detailed Theoretical Contents		
Hours	**Contents**	**Related Tasks**
6	**4- Transformer protection:** • Differential protection • Over load protection • Bocholz relay	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6
5	**5- Generator protection:** • Differential protection • Overload protection • Protection against winding short circuit • Protection against field winding faults	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6
5	**6- Motor protection:** • Motor feeding and control circuit protection. • Locked rotor protection • Phase unbalance and single phasing protection • Earth fault protection • Overload protection	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
2	**1- Use of different protective devices to protect electrical equipment**	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6
2	**2- Protection of transmission line using static relay**	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6
6	**3- Over current protection:** • Symmetrical three-phase short circuit. • Line to line fault • Single line to ground fault • Overload protection	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6
2	**4- Differential protection**	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6
14	**5-Generator protection:** • Field winding to earth fault protection • Stator winding to earth fault protection • Single line to ground fault protection (unbalance) • Over current protection using the C. T's and three relays • Differential protection • Reverse power protection	A1, B1, B9, B10, C2, C3, C4, C5, C6, E1, E2, E3, 34, E5, E6

References	• Power System Protection, IEEE Electricity Training Association, 1997. • Power System Protection, Paul M. Anderson, Wiley-IEEE Press, 1998. • Application Guide For Industrial Generator Protection, GEC Company, 1995 • Transformer Protection Application Guide, Basler Electric Company, 1996 • Application Guide Lines for Protection of Industrial Three Phase Motor, GEC Company, 1995.

Department	Electrical Technology	Specialization	Electrical Power
Course Name	Power Systems lab.	Course Code	ELT 266
Prerequisites	Electric Transmission Network		

Course Description:

The course aims to provide the trainees with the skills needed to obtain the characteristics of the synchronous generators under different operating conditions and to control the active and reactive power of generators. It also includes the study of the characteristics of different transmission lines.

Trimester						5
Credit Hours						2
Contact Hours (h/w)	L					
	P					4
	T					

General objective of the course:

The course aims to help the trainees to obtain experimentally and understand the characteristics of power system components (generators, and transmission lines).

Behavioral Objectives:

The trainees should be able to:

1. Control the terminal voltage of the synchronous generator.
2. Control the frequency of the generated voltage.
3. Control the active and reactive power.
4. Connect the synchronous generator to the power system network.
5. Describe the characteristics of the transmission line under different operating conditions.
6. Connect two transmission lines in parallel.

Contents (Practical):

- **Introduction to the laboratory**
- **Characteristics of synchronous generators**
- **High voltage transmission lines**

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
4	**1- Introduction to the lab and safety measures**	
22	**2- Characteristics of synchronous generator:** • No load test • Short circuit test • Load test (different loads) • Connecting the synchronous generator to the network (synchronization) • Active and reactive power control	B10, E2, E3, E13, G4
24	**3- High voltage transmission lines:** • Transmission line at no load • Transmission line with resistive load • Transmission line with inductive load • Transmission line with capacitive load • Connecting two lines in parallel • Connecting two lines in series	B10, E2, E3, E13, G4

المراجع	• نقل وتوزيع وحماية القدرة الكهربائية. محمد عدنان سراج .وزارة التعليم العالي – سوريا - 1996 • The Electrical Power Engineering Handbook, Leo L. Grigsby, Marcel Dekker, New York, 1994. • Power Distribution Planning Reference Book, H. Lee Willis, ABB Inc., North Carolina, 2004. • Electrical Power Distribution and Transmission, L.M. Faulkenberry and W. Coffer, Prentice-Hall, 1996 التمديدات الكهربائية وحمايتها . محمد عالية . المؤسسة العربية للدراسات و النشر

Department	**Electrical Technology**	**Specialization**	**Electrical Power**
Course Name	**Electrical Programmable Control W/S**	**Course Code**	**ELT 288**
Prerequisites	**Programmable Control Technology**		

Course Description:

This practical course familiarizes the students with the practical aspects of standards, circuits, materials, equipment, technologies and systems used for the planning and execution of PLC control systems. It also presents the programming methods of lighting systems and remote controls that operate by sensors. In addition, it trains them to maintain control circuits.

Trimester						5
Credit Hours						4
Contact Hours (h/w)	**L**					
	P					8
	T					

General objective of the course:

The course aims to familiarize the trainees with the different components used for PLC control systems. It also enables them to develop the required control circuits and install the required programs. In addition, trainees gain experience in how to perform the maintenance of control circuits.

Behavioral Objectives:

The trainees should be able to:

1. Find faults in control circuits.
2. Clear faults in control circuits.
3. Describe the methods of programming the PLC.
4. Develop the PLC programs needed to control electric motors.
5. Reads technical drawings and documents.
6. Describe the devices used for electrical lighting control.
7. State the programming methods used for electrical lighting.
8. Program controller (free programming) with the specialized program software.
9. Plan the necessary working steps and estimate the required working time.
10. Carry out and document a function test under operating conditions.

Contents (Practical):

- **Conventional and PLC control circuits**
- **Building automation systems**
- **Fault finding in control circuits**

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
56	**1- Conventional and PLC control circuits:** • Reading and drawing the technical drawing and documents • Determining the required material and components. Estimating the required working time • Executing the required control circuit • Comparing PLC control to conventional method • Exercises: a Control of three-phase motor using conventional control circuits (contactors) b Control of three phase motor using PLC c Operation and reversing the direction of rotation of three phase motors using contactors d Operation and reversing the direction of rotation of three phase motors using PLC e Operation and reversing the direction of rotation of three phase motors with Y/Δ switch using contactors f Operation and reversing the direction of rotation of three phase motors with Y/Δ switch using PLC g Operation and reversing the direction of rotation of a two speed three phase motors (YY/Δ) using ontactors h Operation and reversing the direction of rotation of a two speed three phase motors (YY/Δ) using PLC	Basic Knowledge, B2, B3, B4, B5, B6

Detailed Practical Contents		
Hours	**Contents**	**Related Tasks**
32	**2- Building automation systems:** • Standardize terms, abbreviations, specification and symbols of bus operated building control and automation techniques • EIB technology, structure of the network • Familiarization with EIB software • EIB software for different types of witches (single, double, etc) • EIB software for remote control using sensors • EIB software for timers • Applications: a Light control with single pole switch b Light and curtain control with double pole switch c Light control with quad pole switch d Light control using sensors (photo and thermal sensors)	Basic Knowledge, B2, B3, B4, B5, B6
16	**3- Fault finding in control circuits**	Basic Knowledge, B2, B3, B4, B5, B6, F1, F2, F3, F4, F5, F6, F7, F8

References	**Top 2 and 4: Electric Power Engineering Proficiency Course,** Deutsche Gesellschaft Fur Technische Zusammenarbeit (GTZ)