المؤسسة العامة للتدريب التقني والمهني
Technical and Vocational Training Corporation
Directorate General of Curricula

Training Plans for

Bachelor of Technical Colleges

Technical Electrical Engineering

Applied Power and Electrical Machines Engineering

1446 - 2024

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Program Description

The goal of the program is to provide trainees with a high-quality applications-oriented undergraduate education based on state-of-the-art technological equipment associated with Applied Electrical Engineering. This goal is achieved through several objectives such as continuing to update specific courses in the program to ensure relevance to the latest industrial changes, supporting the development of appropriate computer facilities, promoting the integration of advanced technology in all courses, and encouraging professional growth. The program is designed to satisfy the educational needs of the Saudi Council of Engineers by providing a climate that fosters self-awareness, personal growth, and a desire for lifelong learning.

Trainees completing a major in Applied Electrical Engineering receive a strong foundation in electrical circuits, analog and digital electronics, electrical power system technology, industrial electronics, and rotating machinery. Trainees have the opportunity to select additional elective courses in three semesters. Although analog electronics remain important, one of the newest and fastest growing areas is in the application of computers for simulation and control systems. The manufacturers of electrical systems and machines need electrical power engineers who are familiar with machines and machine controls, both traditional and computer-controlled. The electrical industry provides and controls the transformers, motors, generators, switchgear, and protection equipment required to power homes, businesses, and industries. Electrical power engineers design electrical systems and modifications to existing electrical systems that generate and use large amounts of electricity required for distribution networks that are economical, safe, and functional.

Graduates of the Applied Electrical Engineering major understand, design, analyze, and work effectively in industrial settings utilizing product/process control systems and electrical power systems. Graduates are working in petrochemical companies, food manufacturing, steel processing, utilities, electrical equipment, sales, manufacturing and testing, and a host of other diverse industries.

The program curriculum includes electrical and poly-phase circuits; digital circuits and systems; programmable logic controllers and motor control systems; electrical power systems and industry practices; electrical machines; power system protection, power electronics and alternate/renewable energy systems and Graduation Project. The faculty core courses provide the opportunity to improve writing skills. Mathematics and physics provide the background to help learn the electrical power course material.

The bachelor’s degree program in Applied Electrical Engineering allows a plan that will necessarily be highly structured during four semesters. The program has 73 credit hours divided into obligatory courses and elective courses.

The Theoretical and Practical Tests and Graduation Projects Determine Learning Outcomes and Trainee Levels for each program.

The training courses contain a theoretical part and a practical part. The practical part is tested as a practical test and the theoretical part is a theoretical test with different evaluation methods

The Bachelor Degree Graduate gets the sixth level in the Saudi Arabian Qualifications Framework (SAQF).

Admission Requirements: The applicant must have a diploma in Electrical Power Technology, Electrical Machines Technology or SBO Electrical Power.

Brief Description

Course Name	Advanced Electric Circuits	Course Code	ELTL 321	Credit Hours	3
Description	This course is designed to give the trainee a basic knowledge of the electric circuit's analysis in general. The trainee has to know how to analyze any electric circuit using the different methods of analysis. In addition, this course is designed to give the trainee a basic knowledge of polyphaser circuit's analysis. In addition, laboratory is an important part of the course, and it is designed to link the lecture that the trainee is taking using ORCAD PSPISE Software.				

Course Name	Electronic circuits	Course Code	ELTL 322	Credit Hours	2
Description	This course gives the trainee a basic knowledge about the Electronic devices and their applications. The trainee has to understand semiconductor diodes and Diode circuits such as rectifiers, clipping and clamping. In addition, the course gives the trainee a basic knowledge about bipolar transistors as a switch and an amplifier.				

Course Name	Electrical Machines - 1	Course Code	ELTL330	Credit Hours	2
Description	The purpose of this course is to give the trainee a basic knowledge of theory, construction, analysis, performance, and applications of dc machines. The trainee has to know the different types of dc machines; separately excited and self-excited dc machines.				

Course Name	Electric Circuits analysis	Course Code	ELTL 323	Credit Hours	3
Description	This course is designed to give the trainee a basic knowledge on electrical circuit analysis with time and frequency responses. The trainee has to know how to analyze the transient circuits either first order or second order. In addition, the course is designed to give the trainee a basic knowledge of filter circuits.				

Course Name	Digital Electronics	Course Code	ELTL 311	Credit Hours	2
Description	This course gives the trainee a basic knowledge about the number systems, logic gates and their applications, digital circuit design, arithmetic logic unit, flip-flops and their applications, registers, counters and microcontrollers.				

Course Name	Power Electronics	Course Code	ELTL 421	Credit Hours	2
Description	This course is designed to give the trainee a basic knowledge of power electronic components characteristics. This course will also provide trainee with the ability to model, analyze, and design of converters including rectifiers, inverters, DC-DC converters and AC voltage controllers.				

Course Name	Electrical Machines - 2	Course Code	ELTL 332	Credit Hours	2
Description	The purpose of this course is to give the trainee a basic knowledge of theory, construction, analysis, performance, and applications of single phase and three phase transformers, three phase synchronous machines and three phase induction machines.				

Course Name	Electric Drives	Course Code	ELTL 444	Credit Hours	3
Description	This course gives the trainee a deep understanding of various aspects of different electric drives behavior for general industrial applications. The trainee should have the ability to select, operate, and control electric machine drive.				

Course Name	Industrial Electronics	Course Code	ELTL 412	Credit Hours	2
Description	This course is designed to give the trainee a basic knowledge of electronic circuit's applications in industrial fields. These applications include the pulse waveform analysis, operational amplifier applications with real and complex impedances and specialized linear integrated circuits.				

Course Name	Electrical Power System Analysis	Course Code	ELTL 466	Credit Hours	3
Description	The purpose of this course is to give the trainee a basic knowledge of the power system representation with concerned of short, medium and long transmission line, load flow studies; Gauss-Seidel, Newton-Raphson and Fast Decupled. In addition, the trainee has to know how to calculate the fault currents for symmetrical and unsymmetrical fault.				

Course Name	Renewable Energy	Course Code	ELTL 471	Credit Hours	2
Description	The purpose of this course is to give the trainee a basic knowledge of how to design and operate renewable energy systems (RESs). This course will also provide trainee with the ability to assess the generation of these RESs and economy. The skill of installing and coordinating of different RESs configurations are also provided. It is also aimed that the trainee will be acquainted with the applications of various RES types to accommodate the load energy requirements considering the meteorological data at the installation site.				

Course Name	Power System Control & Stability	Course Code	ELTL 443	Credit Hours	2
Description	This course is concerned with the power system generation, control and stability. This gives the trainee a basic knowledge about the components of power system, control of generation, excitation systems, some abnormal condition in power system and steady state stability.				

Course Name	Power System Protection	Course Code	ELTL 462	Credit Hours	3
Description	The course presents four major topics in the area of power system protection. These topics are Attributes of Protection Systems, Protective Relays, Circuit Breakers, and Protection Schemes.				

Course Name	Automatic Control	Course Code	ELTL 442	Credit Hours	2
Description	The course includes four main topics in the field of automatic control. These topics are Control System Terminology, Linear Systems and Differential Equations, Frequency Response, and Stability.				

Course Name	Graduation Project	Course Code	ELTL 491	Credit Hours	2
Description	The purpose of the project is to make the final year trainee acquainted with the ways and means, which are adopted to carry out an investigation to solve one of the technical problems. Also, to make the trainee able to present and prepare a detailed report.				

Course Name	Electromechanical Energy Conversion	Course Code	ELTL 334	Credit Hours	2
Description	This course is designed to give the trainee a basic knowledge of the magnetic field and properties of magnetic materials. Hysteresis, eddy current losses and permanent magnets are also included in this course. This course introduces electro-mechanical energy conversion principles for single and doubly excited magnetic field system, introduction to rotating machines. M.M.F of distributed AC and DC machines windings and the torque production in alternating current and direct current machines.				

Course Name	Electromagnetic Fields	Course Code	ELTL 335	Credit Hours	2
Description	This course aims to make the trainee aware of the basic principles of static and time varying electric and magnetic fields. The course supplies the trainee with sufficient methods and rules for calculating the intensity of electric and magnetic fields as well as potential for conventional models.				

Course Name	Electrical Distribution Systems	Course Code	ELTL 361	Credit Hours	2
Description	The purpose of this course is to give the trainee a basic knowledge of DC distribution, two wire distributors, DC distributor fed at one end and DC distributor fed from both ends with equal voltages and with unequal voltages. In addition, basic knowledge of AC distribution and underground cables are given.				

Course Name	Digital Integrated Circuits	Course Code	ELTL 422	Credit Hours	2
Description	This course provides the trainee with the analytical and computer skills required for the analysis, computer simulation, design, and computer-aided physical layout of digital integrated circuits. The objectives of the course are for the trainee to learn how to model, analyze, simulate, and design digital integrated circuits for engineering applications.				

Course Name	Electrical Measurements	Course Code	ELTL 423	Credit Hours	2
Description	The aim of this course is to introduce trainees to the different physical concepts of measurements process and gives them ability to use numbers and statistics in measurement and evaluation. In addition, this course gives ability to identify, select and perform appropriate measurement in various fields.				

Course Name	Special Machines	Course Code	ELTL 437	Credit Hours	2
Description	The purpose of this course is to enable the trainee to be familiar with the construction and operation of the most popular types of small machines. The trainee has to know the importance, advantages and disadvantages utilization of special machines, definition of the type of special machine needed for each application based on the characteristics of each and treatment all the problem that may occur in practice and introduce the solution.				

Course Name	Electrical Traction	Course Code	ELTL 445	Credit Hours	2
Description	The purpose of this course is to give the trainee a basic knowledge of electric traction systems and latest trends. The trainee has to know the analysis of speed time curves, Comparison between different traction motors and the types of electrical braking system.				

Course Name	High Voltage Engineering	Course Code	ELTL 336	Credit Hours	2
Description	The aims of this course are to provide the trainee with the basic knowledge and skills of high voltage engineering. This course will also provide trainees with the high voltage phenomena concerning breakdown mechanism (in gas, liquid and solid) and high voltage generation and measurements (DC, AC and impulse types). In addition, basic knowledge of the overvoltage phenomena and overvoltage protection will be attained.				

Course Name	Economic Operation of Power System	Course Code	ELTL 463	Credit Hours	2
Description	This course is designed to give the trainee a basic knowledge how to generate, to transmit and to distribute the electrical power economically**.** The topics of this course include distribution of load between units within a plant, distribution of load between plants and the transmission-loss equation.				

توزيع الخطة التدريبية على الفصول التدريبية لمرحلة البكالوريوس بالنظام النصفي ١٤٤٦هـ

The Curriculum Framework Distributed on Semesters 2024G

6th Semester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي السادس
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	ENGL 301	English Language (1)	0	3	3	0	1	4	.	لغة انجليزية ١	٣٠١ انجل	١	
	2	MATH 301	Mathematics (1)	0	3	3	0	0	3	.	رياضيات ١	٣٠١ رياض	٢	
	3	PHYS 301	Physics	0	3	2	2	0	4	.	فيزياء	٣٠١ فيزي	٣	
	4	ELTL 321	Advanced Electric Circuits	0	3	2	2	0	4	.	الدوائر الكهربائية المتقدمة	٣٢١كهرب	٤	
	5	ELTL330	Electrical Machines - 1	0	2	1	2	0	3	.	الآت كهربائية - ١	٣٣٠كهرب	٥	
	6	ELTL 322	Electronics circuit	0	2	1	2	0	3	.	دوائر الكترونية	٣٢٢ كهرب	٦	
	7	ELTL 332	Electrical Machines - 2	0	2	1	2	0	3	.	آلات كهربائية - ٢	٣٣٢ كهرب	٧	
	8	ELTL 471	Renewable Energy	0	2	2	0	0	2	.	الطاقة المتجددة	٤٧١ كهرب	٨	
	Total Number of Units				20	15	10	1	26	المجموع				

7th Semester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي السابع
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	ENGL302	English Language (2)	ENGL 301	3	3	0	1	4	٣٠١ انجل	لغة انجليزية ٢	٣٠٢ انجل	١	
	2	MATH 302	Mathematics (2)	MATH 301	3	3	0	0	3	٣٠١ رياض	رياضيات ٢	٣٠٢ رياض	٢	
	3	STAT 303	Statistics and Probability	0	3	3	0	0	3	.	الإحصاء والاحتمالات	٣٠٣ احصا	٣	
	4	ELTL 323	Electric Circuits analysis	ELTL 321	3	3	0	0	3	٣٢١ كهرب	تحليل الدوائر الكهربائية	٣٢٣كهرب	٤	
	5	ELTL421	Power Electronics	ELTL 322	2	1	2	0	3	٣٢٢ كهرب	الكترونيات القوى	٤٢١كهرب	٥	
	6	ELTL 311	Digital Electronics	ELTL 322	2	1	2	0	3	٣٢٢كهرب	الكترونيات رقمية	٣١١ كهرب	٦	
	7	ELTL 361	Electrical Distribution Systems	0	2	2	0	0	2	.	نظم التوزيع الكهربائي	٣٦١ كهرب	٧	
	8	ELTL 442	Automatic Control	ELTL 321	2	1	2	0	3	٣٢١كهرب	التحكم الآلي	٤٤٢ كهرب	٨	
	Total Number of Units				20	17	6	1	24	المجموع				

8th Semester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي الثامن
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	GNRL 404	Quality Tools and Applications	0	3	3	0	0	3	٠	أدوات الجودة و تطبيقاتها	٤٠٤عامة	١	
	2	GNRL 402	Engineering Project Management	0	3	3	0	0	3	٠	إدارة المشاريع الهندسية	٤٠٢عامة	٢	
	3	ELTL466	Electrical Power System Analysis	0	3	2	2	0	4	٠	تحليل نظم القوى	٤٦٦كهرب	٣	
	4	ELTL 412	Industrial Electronics	ELTL 322	2	1	2	0	3	٣٢٢كهرب	الكترونيات صناعية	٤١٢ كهرب	٤	
	5	ELTL 444	Electric Drives	ELTL330 ELTL332 ELTL421	3	2	2	0	4	٣٣٠ كهرب ٣٣٢ كهرب ٤٢١ كهرب	تسيير كهربائي	٤٤٤ كهرب	٥	
	6	ELTL***	Elective Course - 1	0	2	2	0	0	2	٠	مقرر اختياري - ١	***كهرب	٦	
	Total Number of Units				**16**	**13**	**6**	**0**	**19**	**المجموع**				

CTH: Contact Hours T: Tutorial Practical :P L: Lecture CRH: Credit Hours

س.أ : ساعات اتصال أسبوعي تم : تمارين، عم : عملي/ ورش، مح : محاضرة، معتمدة، و.م : وحدات

9th Semester	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	الفصل التدريبي التاسع
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	GNRL405	Engineering Economy	0	2	2	0	0	2	٠	إقتصاد هندسي	٤٠٥ عامة	١	
	2	ELTL437	Special Machines	ELTL 332	2	2	0	0	2	٣٣٢ كهرب	آلات كهربائية خاصة	٤٣٧ كهرب	٢	
	3	ELTL 462	Power System Protection	ELTL466	3	2	2	0	4	٤٦٦كهرب	حماية نظم القوى الكهربائية	٤٦٢ كهرب	٣	
	4	ELTL 443	Power System Control & Stability	ELTL 466	2	2	0	0	2	٤٦٦كهرب	التحكم في نظم القوي الكهربائية	٤٤٣كهرب	٤	
	5	ELTL463	Economic Operation of Power System	ELTL466	2	2	0	0	2	٤٦٦كهرب	التشغيل الاقتصادي لنظم القوى	٤٦٣ كهرب	٥	
	6	ELTL***	Elective Course - 2	0	2	1	2	0	3	٠	مقرر اختياري - ٢	***كهرب	٦	
	7	ELTL***	Elective Course - 3	0	2	2	0	0	2	٠	مقرر اختياري - ٣	***كهرب	٧	
	8	ELTL 491	Graduation Project	0	2	1	2	0	3	٠	مشروع التخرج	٤٩١ كهرب	٨	
	Total Number of Units				**17**	**14**	**6**	**0**	**20**	**المجموع**				

Total Number of Semesters Units	CRH	L	P	T	CTH	المجموع الكلي لوحدات البرنامج
	و.م	مح	عم	تم	س.أ	
	73	59	28	2	89	

Total Contact Hours × 16	Co-operative Training	المجموع الكلي لوحدات التدريب	التدريب التعاوني	ساعات الإتصال الكلية × ١٦
1424	0	1424	٠	١٤٢٤

Elective Courses

Elective Courses -1	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	المقررات الإختيارية -١
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	ELTL334	Electromechanical Energy Conversion	0	2	2	0	0	2	٠	التحويل الكهروميكانيكي للطاقة	٣٣٤كهرب	١	
	2	ELTL335	Electromagnetic Fields	0	2	2	0	0	2	٠	المجالات الكهرومغناطيسية	٣٣٥كهرب	٢	

Elective Courses -2	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	المقررات الإختيارية -٢
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	ELTL422	Digital Integrated Circuits	0	2	1	2	0	3	٠	الدوائر المتكاملة الرقمية	٤٢٢كهرب	١	
	2	ELTL423	Electrical Measurements	0	2	1	2	0	3	٠	القياسات الكهربائية	٤٢٣كهرب	٢	

Elective Courses -3	No.	Course Code	Course Name	Prereq	No. of Units					المتطلب	اسم المقرر	رمز المقرر	م	المقررات الإختيارية -٣
					و.م	مح	عم	تم	س.أ					
					CRH	L	P	T	CTH					
	1	ELTL 445	Electrical Traction	ELTL 332	2	2	0	0	2	٣٣٢ كهرب	الجر الكهربائي	٤٤٥كهرب	١	
	2	ELTL 336	High Voltage Engineering	ELTL466	2	2	0	0	2	٤٦٦كهرب	هندسة الضغط العالي	٣٣٦كهرب	٢	
	CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours									س.أ : ساعات اتصال أسبوعي تم : تمارين، ورش، /عم : عملي مح : محاضرة، و.م : وحدات معتمدة،				

Courses Detail Description

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Advanced Electric Circuits	Course Code	ELTL 321
Prerequisites	-	Credit Hours CRH	3 CTH 4
		L 2 P 2 T 0	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description :
This course is designed to give the trainee a basic knowledge of the electric circuit's analysis in general. The trainee has to know how to analyze any electric circuit using the different methods of analysis. In addition, this course is designed to give the trainee a basic knowledge of polyphaser circuit's analysis. In addition, laboratory is an important part of the course, and it is designed to link the lecture that the trainee is taking using ORCAD PSPISE Software.

Topics:
- Methods of analysis of DC circuits.
- Methods of analysis of AC circuits.
- The Sinusoidal Steady-State Analysis.
- Polyphaser Circuits.

Experiments: If applicable, it will support the course topics.
References : Bolested Electrical circuit analysis, Theraja "Electrical Technology"

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Review of DC and AC Circuits:** Ohm' law, Kirchhoff's law, Analysis of a single-loop circuit, The single-node-pair circuit, resistance and source combination, Voltage and Current division, Star-Delta reduction.	9
2	**Methods of analysis of Electrical circuits:** Current branch method, Mesh method and Nodal method.	8
3	**Network Theorem:** Superposition, Thevenin's and Norton theorems.	5
4	**The Sinusoidal Steady-State Analysis:** Instantaneous power, Average power, Effective values of current and voltage, Apparent power, Power factor and Complex power, Reactive power compensation, Phasor diagrams.	5
5	**Polyphaser Circuits** Introduction to three phase circuits, three phase sources, Star connected sources (three/four-wire system), Delta connected sources, Relationship between phase and line quantities for different connections, Three phase loads, Voltage and Current relationships for the different source-load connections, Three phase power.	5
Textbook	• Bolested "Introductory circuit analysis"	

	• Theraja "Applied Electrical Engineering"

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	• Introduction to OrCAD Capture	2
2. 3. 4. 5. 6. 7. 8. 9. 10.	• Introduction to component database • How to place the parts in the design • Connecting the parts with wire, bus, net alias and power symbol in the design • How to modify the properties of the parts (Property Editor) • How to edit the physical appearance of the parts (Part Editor) • How to create a new library • How to create a new part • How to work in Multi sheet projects • How to make connectivity between schematic pages	4
11.	• Bias Point analysis (To display DC bias values) • Superposition Theorem • Mesh analysis and Pspice • Nodal Analysis • Thevenin's Theorem • Norton's Theorem	6
12.	• DC Sweep analysis (Design response variation with respect to DC parameters)	4
13.	• Parametric analysis (Design response variation with respect to Design element parameters)	4
14.	• AC Sweep analysis (Design response variation with respect to Frequency)	4
15.	• Transient analysis (Time domain Response)	4
16.	• Single Window, Single window with multiple Y-axis, Split window and Multi window representation	4
Textbook:	• OrCAD PSpice for Windows Volume 1: DC and AC Circuits (3rd Edition) 3rd Edition. • OrCAD PSpice for Windows Volume II: Devices, Circuits, and Operational Amplifiers (3rd Edition) 3rd Edition	

Textbooks	• Bolested, "Introductory circuit analysis" • Theraja , "Electrical Technology" • OrCAD PSpice for Windows Volume 1: DC and AC Circuits (3rd Edition) 3rd Edition. • OrCAD PSpice for Windows Volume II: Devices, Circuits, and Operational Amplifiers (3rd Edition) 3rd Edition

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering						
Course Name	Industrial Electronics	Course Code	ELTL 412						
Prerequisites	ELTL 322	Credit Hours CRH	2		CTH	3			
			L	1	P	2	T	0	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

This course is designed to give the student a basic knowledge of the Operational amplifier applications, and Specialized linear ICs.

Topics :

- Operational Amplifier Applications with Real Impedances.
- Op.-Amp. Applications with Complex Impedances.
- Specialized Linear Ices.

References :

- Deuton J.D." Operational Amplifiers and Linear Integrated Circuits", McGraw-Hill
- Ronald J. Tocci, "Fundamentals of Pulse and Digital Circuits", Charles E. Mill Publishing Co. (A bell & Howell Company).

Details of Theoretical Contents		
No.	**Contents**	**Hours**
1.	**Pulse Waveform Analysis:** Switching circuits, Ideal pulse signals, Ideal switching devices, Time-varying currents & voltages, Types of pulse distribution, Time-rising, Time-duration and Time falling of a pulse, Harmonics content of periodic waveforms, Effect of oscillation on pulse , Effect of linear networks on pulse waveforms, Non- periodic pulses.	4
2.	**Operational Amplifier Applications with Real Impedances:** Basic Op-Amp characteristics, Op-Amp equivalent circuit , The Comparator, The voltage follower, Non-Inverting Amplifier, The inverting Amplifier, Summing Amplifier, Practical summing, Amp. Consideration, Averages, Voltage-to-current and current-to-voltage correction, closed loop frequency bandwidth, cascade Op.Amp.	4
3.	**Op. Amp. Applications with Complex Impedances:** The differentiator, The integrator, Non-linear Op-Amp circuits, The logarithmic Amplifier, Precision half/full - wave rectifier, Active filters, Active LP AND 4P Filters, Band-pass filters, Band-stop filters.	4
4.	**Specialized Linear Ices:** Pulse generating circuits, UJT, Oscillator-spite wave form, The 555IC Timer as a voltage- controlled oscillator, The zero- crossing detector, The comparator with	4

	Hysteresis, analog switches, Track-and-Hold circuits, Operational transduction Amplifiers.	
Textbook:	• Deuton J.D." Operational Amplifiers and Linear Integrated Circuits", McGraw-Hill • Ronald J. Tocci, "Fundamentals of Pulse and Digital Circuits", Charles E. Mill Publishing Co. (A bell & Howell Company).	

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	AF Amplifier in Emitter Circuits	3
2.	2- Stages Amplifier	3
3.	A Stable Multivibrator	3
4.	Monostable Multivibrator with (FET)	3
5.	Differential Amplifier	4
6.	Operational Amplifier (Inv- Non inv)	4
7.	Subtractor Op-Amp	4
8.	Adder OP-Amp	4
9.	Voltage Follower OP- Amp	4
Textbook:	• Deuton J.D." Operational Amplifiers and Linear Integrated Circuits", McGraw-Hill	

Textbooks	• Deuton J.D." Operational Amplifiers and Linear Integrated Circuits", McGraw-Hill • Ronald J. Tocci, "Fundamentals of Pulse and Digital Circuits", Charles E. Mill Publishing Co. (A bell & Howell Company). • Thomas L. Floyd "Electronic Devices" Person International Edition.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Electrical Machines -2	Course Code	ELTL 332
Prerequisites	-	Credit Hours CRH	2 CTH 3
			L 1 P 2 T 0

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

The purpose of this course is to give the student a basic knowledge of theory, construction, analysis, performance, and applications of transformers, synchronous, induction machines and . the most popular types of small machines.

Topics :

- Transformers.
- Induction Machines.
- Synchronous Machines.

References :

- Fitzgerald, A.E., Kingsely, and Kusko, A., "Electric Machinery", McGraw-Hill 5th edition.
- Hindmarsh, J., "Electrical Machines and Their Application", Pergaman 3rd edition.
- A. HUGHES, Electric Motors and Drives Fundamentals, Types and Applications. Heinemann Newnes, London, 1990.
- V. Subrahmanyam, Electric Drives: Concepts and Applications; McGraw-Hill, New York, 1990.

Details of Theoretical Contents		
No.	**Contents**	**Hours**
1.	**Transformers:** Constructional Features of Transformers, Steady-state equivalent circuit, Open and Short circuit tests, Losses and Efficiency, Per-Unit values. Three-phase transformers, Auto-transformer, Parallel operation, Voltage regulation and Kapp diagram.	6
2.	**Induction Machines:** Constructional Features of Poly-phase Induction Machines, Steady-state equivalent circuit of three-phase Induction Machine, Equivalent circuit from Open and Short circuit tests, Three-phase Induction Motor performance, Power flow diagram, torque /speed characteristics, Starting current, Speed control of a Three-phase Induction Motor.	6
3.	**Synchronous Machines:** Constructional Features of Synchronous Machines, Equivalent circuit of Synchronous Machines, Phasor diagrams, Open and Short-circuit Characteristics, Power–Angle and other performance characteristics, V- Curves, Effects of Saliency: Two-Reactance Theory of Salient-pole Synchronous Machines.	4
Textbook:	• Fitzgerald, A.E., Kingsely, and Kusko, A., "Electric Machinery", McGraw-Hill 5th edition.	

	• Hindmarsh, J., "Electrical Machines and Their Application", Pergaman 3rd edition.

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	Single phase transformer: Determination of equivalent circuit parameters, Power measurement, improvement of power factor and efficiency	2
2.	Determination of phase shift between primary and secondary line voltage for 3-phase transformers and determination of the phase group.	2
3.	Different connections of a 3-phase transformer and voltage distribution on the windings.	2
4.	Three phase induction motor: Determination of equivalent circuit parameters, Power measurement, improvement of power factor	2
5.	Electric braking of 3-phase induction motors.	4
6.	Voltage regulation of an alternator: Synchronous impedance, Ampere-turn, and Zero-power factor methods.	4
7.	Slip test for measuring Xd and Xq of salient-pole synchronous machines.	4
8.	Synchronization process with an infinite Bus-Bar and control of power and power factor.	4
9.	V- Curves of a synchronous motor.	4
10.	Retardation test for evaluating moment of inertia.	4
Textbook:	Hindmarsh, J., "Electrical Machines and Their Application", Pergaman 3rd edition.	

Textbooks	• Fitzgerald, A.E., Kingsely, and Kusko, A., "Electric Machinery", McGraw-Hill 5th edition. • Hindmarsh, J., "Electrical Machines and Their Application", Pergaman 3rd edition.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Power System Control & Stability	Course Code	ELTL 443
Prerequisites	ELTL466	Credit Hours CRH	2 CTH 2 (L 2, P 0, T 2)

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

This course is concerned with the power system generation, control and stability. This gives the student a basic knowledge about the components of power system, control of generation, excitation systems, some abnormal condition in power system and steady state stability.

Topics :

This includes the following:

- Components of Power System.
- Control of Generation.
- Excitation Systems.\
- Some Abnormal Condition in Power System.
- Steady State Stability.

References :

- Stevenson, W.: Elements of Power System Analysis.
- P.M.Andrson and A.A.Fouad, “Power System Control and Stability”.
- Allen J. Wood, Bruce F. Wellenberg, ”Power Generation Operation & Control”, John Wiely& Sons, NY 1999, Third Edition.

Details of Theoretical Contents		
No.	**Contents**	**Hours**
1.	**Control of generation:** Generator model, Load model, Prime-mover model, Governor model, Tie-line model, Generation control: Supplementary control action, Tie-line control, Generation allocation, Automatic generation control.	12
2.	**Excitation systems:** Self and separately excited exciter, Quick response excitation system, Modern trend in excitation systems, Regular function and development, Voltage regulator capacity.	6
3.	**Steady state stability:** Significance of steady state stability, Power limit of transmission system, Two-machine system with negligible losses, Power angle characteristics and steady state stability limit of cylindrical rotor machines, Power angle and steady state stability limit of salient pole synchronous machines, Two-machine system with losses, Effect of inertia and governor operation, Steady state stability with automatic voltage regulators, Impact of short circuit ratio on stability, Swing equation for a synchronous machine, Step by step procedure for the solution of the	14

	swing equation, Equal area criterion, Application of equal area criterion under fault conditions, Determination of critical clearing angle.	
Textbook:	• Stevenson, W.: Elements of Power System Analysis. • P.M.Andrson and A.A.Fouad, “Power System Control and Stability”. • Allen J. Wood, Bruce F. Wellenberg, ”Power Generation Operation & Control”, John Wiely& Sons, NY 1999, Third Edition.	

Textbooks	• Stevenson, W.: Elements of Power System Analysis. • P.M.Andrson and A.A.Fouad, “Power System Control and Stability”. • Allen J. Wood, Bruce F. Wellenberg, ”Power Generation Operation & Control”, John Wiely& Sons, NY 1999, Third Edition. • N. Jenkins., B.M. Weedy., B.J. Cory., J.B. Ekanayake. and G. Strbac., ″Electric Power Systems″,Fifth Edition, 2012, John Wiley & Sons Ltd.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering						
Course Name	Power System Protection	Course Code	ELTL 462						
Prerequisites	ELTL466	Credit Hours CRH	3	CTH	4				
			L	2	P	2	T	0	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

The course presents four major topics in the area of power system protection. This includes Attributes of Protection Systems, Protective Relays, Circuit Breakers, and Protection Schemes.

Topics :

- Attributes of Protection Systems.
- Protective Relays.
- Circuit Breakers.
- Protection Schemes.

References :

- Freeman, J.: Electric Power Systems Engineering.
- Stevenson, W.: Elements of Power System Analysis.
- Stanley H. Horowitz and Arun G. Phadke. : ″Power System Relaying″. John Wiley & Sons

Details of Theoretical Contents		
No.	**Contents**	**Hours**
1.	**Attributes of Protection Systems:** Types of faults, Consequences of Faults, Components of protection systems, Transducers, Relays, Circuit Breakers, Zones of protection, Primary and backup protection.	8
2.	**Protective Relays:** Different types of protective relays, Electromechanical relay, Magnetic relays, Static relays, Impedance relay. Applications of relays: Magnitude relays, Ratio relays, Directional relays, Differential relays, Pilot relays.	8
3.	**Circuit Breakers:** Calculation of circuit breaker rapture capacity, Basic construction of circuit breakers, Breaking mechanism, Different types of circuit breakers: Air blast circuit breaker, Water flow breakers, SF6 breakers, Oil circuit breaker, Maintenance of circuit breakers, Switch gear co-ordination.	8
4.	**Protection Schemes:** Merz-Price protection of transformers, Earth-fault protection, Earth-leakage protection, Surge protection, Current limiting reactors, Bus bar arrangements, Protection of sub transmission, Protection of generators, Protection of rectifiers, Introduction to digital protection schemes.	8
Textbook:	• Freeman, J.: Electric Power Systems Engineering.	

	• Stevenson, W.: Elements of Power System Analysis.

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	Operation of protection devices (fuses and relays)	4
2.	protection of transmission lines using static relays	4
3.	Static protection by earth fault relays	4
4.	Over current protection	4
5.	Protection of generation unit	4
6.	Differential protection	4
7.	Directional protection	4
8.	Unbalanced protection	4
Textbook:	• Freeman, J.: Electric Power Systems Engineering.	

Textbooks	• Freeman, J.: Electric Power Systems Engineering. • Stevenson, W.: Elements of Power System Analysis. • Stanley H. Horowitz and Arun G. Phadke. : ″Power System Relaying″. John Wiley & Sons

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Renewable Energy	Course Code	ELTL 471
Prerequisites	-	Credit Hours CRH	2 CTH 2
			L 2 P 0 T 0

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

This course is concerned with the sustainable energy and include the methods of generation electrical energy from renewable energy sources.

Topics :

- Principles of renewable energy
- Hydro-power
- Photovoltaic generation
- Power from the wind
- Geothermal energy
- Biomass and biofuels
- Wave power and tidal power
- Energy systems, storage and transmission
- Stand-Alone and Grid-Connected Systems

References :

- M. Godoy Simoes,Felix A. Farret: Renewable Energy Systems: Design and Analysis with Induction Generators. Top of Form
- John Twidell and Tony Weir : Renewable Energy Resources .
- Mukund R. Patel : Wind and Solar Power Systems Design, Analysis, and Operation .

Details of Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1.	**Principles of renewable energy** Analyzing the full range of renewable energy supplies available for modern economies. Such renewables are recognized as vital inputs for sustainability and so encouraging their growth is significant.	4
2.	**Hydro-power** Assessing the resource for small installations, Hydroelectric systems and types of hydraulic turbines.	4
3.	**Photovoltaic generation** The silicon p–n junction , PV Cell, Module and Array , Equivalent Electrical Circuit , Open-Circuit Voltage and Short-Circuit Current , I-V and P-V Curves , Array Design , Peak-Power Operation and System Components .	4
4.	**Power from the wind** Characteristics of the wind, Turbine types, Power extraction by a turbine and Electricity generation.	4
5.	**Geothermal energy**	4

	Dry rock and hot aquifer analysis , Harnessing Geothermal Resources and environmental aspects .	
6.	**Biomass and biofuels** Biofuel classification and Biomass production for energy farming .	4
7.	**Wave power and tidal power** Wave motion , Wave energy and power , The cause of tides , Tidal current/stream power , and Tidal range power .	4
8.	**Energy systems, storage and transmission** The importance of energy storage and distribution **,** Electrical storage: batteries and accumulators **.**	2
9.	**Stand-Alone and Grid-Connected Systems** PV and wind Stand-Alone , Hybrid Systems , Synchronizing with the Grid , Operating Limit and Grid Stability Issues .	2
Textbook:	• M. Godoy Simões,Felix A. Farret: Renewable Energy Systems: Design and Analysis with Induction Generators. Top of Form • John Twidell and Tony Weir : Renewable Energy Resources . • Mukund R. Patel : Wind and Solar Power Systems Design, Analysis, and Operation .	

Textbooks	• M. Godoy Simões,Felix A. Farret: Renewable Energy Systems: Design and Analysis with Induction Generators. Top of Form • John Twidell and Tony Weir : Renewable Energy Resources . • Mukund R. Patel : Wind and Solar Power Systems Design, Analysis, and Operation .

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Automatic Control	Course Code	ELTL 442
Prerequisites	ELTL 321	Credit Hours CRH	2 CTH 3

L	1	P	2	T	0

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

The course includes four main topics in the field of automatic control: Control System Terminology, Linear Systems and Differential Equations, Frequency Response, and Stability

Topics :

- Control System Terminology.
- Linear Systems and Differential Equations.
- Frequency Response.
- Stability.

Experiments: if applicable it will support the course topics.

References :

- M. Ogata " Modern Control Engineering " Last edition Prentice Hall
- B C Nakra Theory and Applications of Automatic Controls
- Robert E. King Computational Intelligence in Control Engineering
- Pao C. Chau Process Control: A First Course with MATLAB

Details of Theoretical Contents		
No.	**Contents**	**Hours**
1.	**Control System Terminology:** Block diagram fundamentals, Transfer functions, Closed-loop control, Open-loop control (Feedback systems), Block-diagram algebra, Servomechanisms, Regulators.	2
2.	**Linear Systems and Differential Equations:** Equation of physical systems, Ordinary differential equations, Linearity, Superposition, Causality, Solution of linear constant coefficient ordinary differential equations (1st order and 2nd order),	4
3.	**Frequency Response:** The Laplace transform and its inverse, Properties of Laplace transform, Application of Laplace transform to the solution of linear constant coefficient ordinary deferential equations, Frequency response function, Bode magnitude and phase plots, Straight line approximation, Plant identification.	5
4.	**Stability:** Definitions of stability, The root locus method, The Hurwitz-Routh stability criterion, The Nyquist criterion, Performance and Robustness, The design of control system (proportional control, lag-compensator, lead-compensator). PID Controller.	5
Textbook:	• M. Ogata " Modern Control Engineering " Last edition Prentice Hall	

	• B C Nakra Theory and Applications of Automatic Controls • Robert E. King Computational Intelligence in Control Engineering • Pao C. Chau Process Control: A First Course with MATLAB

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	**Familiarization:** Analog unit check , Display the test waveforms, Display the speed of response of the motor.	2
2.	**Motor, Tachogenerator & Brake Characteristics:** Steady-state characteristics, S.S.C- Brake load, Transient Response of motor, Motor time constant.	2
3.	**Feedback Polarity & The Influence of Gain:** Feedback Polarity, Input & Output Rotation Directions step Response.	2
4.	**Velocity Feedback :** Simple Velocity Feedback.	2
5.	**Unstable Systems:** Additional time constant, Unstable systems.	2
6.	**Speed Control Systems:** Closed-loop Speed Control Systems.	2
7.	**Introduction to 3-Term Control**: Derivative Measurement, Op. Amp. Integrator, 3- Term Controller Test.	2
8.	**Application of 3-Term Control:** Proportional + Derivative (P+D) Control, Elimination of following error elimination of disturbance, Response to output loading.	2
9.	**Single Amplifier Control Circuits: (P+D control & P+I Control)**: Importance of resistor in Amplifier Feedback, Single Amp. Amp. 3-Term control.	4
10.	**Transient Velocity Feedback and Derivative Feed**	4
11.	**Transfer Functions and Closed-loop:**	4

	(Frequency Response of Time Constant, Freq. Response of Integrator, Closed-loop System Experimental, and Oscillation.	
12.	**Application of Frequency Response Methods**: Time constant, Motor Transfer, Proportional & Derivative Control, Integral Control, Velocity (Tacho-generator) Control.	4
Textbook:	M. Ogata " Modern Control Engineering " Last edition Prentice Hall	

Textbooks	• M. Ogata " Modern Control Engineering " Last edition Prentice Hall • B C Nakra Theory and Applications of Automatic Controls • Robert E. King Computational Intelligence in Control Engineering • Pao C. Chau Process Control: A First Course with MATLAB

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Digital Electronics	Course Code	ELTL 311
Prerequisites	ELTL 322	Credit Hours CRH	2 CTH 3 (L 1, P 2, T 0)

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

This course gives the student a basic knowledge about the number systems, logic gates and their applications, digital circuit design, arithmetic logic unit, and microcontrollers.

Topics :

- Number Systems:
- Logic Gates and Their Applications.
- Digital Circuit Design and Simplification.
- Arithmetic Logic Unit.
- Flip-Flops and Their Applications.
- Registers and Counters.
- Memories.
- The Analogy Interface.
- Microcontrollers

References :

- Walter A.T., “Integrated Digital Electronics”, Prentice-Hall, Inc.
- Albert P.M.,” Digital Computer Electronics”, an Introduction to Microprocessors”, McGraw-Hill, Inc.
- Charles A.H., “Electronic Circuits Digital & Analog”, John Wiley & Sons, Inc.

Details of Theoretical Contents		
No.	**Contents**	**Hours**
1.	**Number Systems**: Binary, Decimal, Hexadecimal, BCD (binary-coded decimal) numbers and Grey code.	2
2.	**Logic Gates and Their Applications**: OR, AND, NOT, NOR, NAND, XOR and XNOR gates, Truth tables, Boolean algebra, Controlled inverters, Odd-parity generator, Word comparator.	2
3.	**Digital Circuit Design and Simplification:** Boolean relations, Sum of products method, Algebraic simplification, Karnaugh map simplification, and Don’t care conditions.	2
4.	**Arithmetic Logic Unit:** Binary addition and subtraction, Half-and-full adders, 2’s complement adder- sub-tractor.	2

5.	**Flip-Flops and Their Applications:** RS-latches, level clocked D-latches, edge-triggered, D flip-flops, edge-triggered, JK flip-flops, and JK master-slave flip-flops.	2
6.	**Registers and Counters:** Buffer and shift registers, ripple, synchronous and ring counters, three-state registers, bus-organized computers.	2
7.	**Memories:** ROMs, PROMs and EPROMs, RAMs, a small TTL memory, Hexadecimal.	2
8.	**The Analogy Interface:** Op.Amp. basics, D/A Converters, A/D Converters.	1
9.	**The Microcontrollers:** Introduction to the Microcontroller , Inside the Microcontroller and Microcontroller Architecture	1
Textbook:	• Walter A.T., " Integrated Digital Electronics", Prentice-Hall, Inc. • Albert P.M. ," Digital Computer Electronics", An Introduction to Microprocessors", McGraw-Hill, Inc. • Charles A.H., "Electronic Circuits Digital & Analog", John Wiley & Sons, Inc.	

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	Logic Gates (AND - OR - NOT)	2
2.	Logic Gates (XOR - XNOR)	2
3.	Logic Gates Applications	2
4.	Half Adder -Full Adder	2
5.	Half Sub-tractor - Full Sub-tractor	2
6.	S.R Flip Flop	2
7.	J.K FLIP flop	2
8.	Master- Slave Flip Flop	2
9.	D Flip Flop	2
10.	T Flip Flop	2

11.	Shift Registers (SISO - SIPO)	2
12.	Counters Circuits	2
13.	Up Counter - Down Counter	2
14.	Counters of (4 - 5) Factor	2
15.	Sequential Counters Circuits	2
16.	Analog Interface	2
Textbook:	• Walter A.T., " Integrated Digital Electronics", Prentice-Hall, Inc.	

Textbooks	• Walter A.T., " Integrated Digital Electronics", Prentice-Hall, Inc. • Albert P.M. ," Digital Computer Electronics", An Introduction to Microprocessors", McGraw-Hill, Inc. • Charles A.H., "Electronic Circuits Digital & Analog", John Wiley & Sons, Inc.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Electric Drives	Course Code	ELTL 444
Prerequisites	ELTL 330 ELTL 332 ELTL 421	Credit Hours CRH	3 CTH 4 L 2 P 2 T 0

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

This course gives the student a deep understanding of various aspects of different electric drives behavior for general industrial applications. A graduated student should have the ability to select, operate, and control electric machine drive.

Topics :

The course covers the following topics:

- Basic Concepts.
- DC Motor Drives.
- AC Motor Drives.
- Traction Drives.

References :

- G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 1995.
- A. Hughes, "Electric Motors and Drives Fundamentals, Types and Applications, HeinemanNewnes, London, 1990.
- Yasuhiko Dote, "Brushless Servomotors Fundamentals and Applications", Clarendon Press, Oxford, 1990.
- M. E. El-Hawary, "Principles of Electric Machines with Power Electronic Applications", Prentice-Hall, 1986.

Details of Theoretical Contents		
No	**Contents**	**Hours**
1.	**Basic Concepts:** Definition, Types, Electric drive topology, Motor -load dynamics and stability, Typical load torque's, Multiquadrant operation, Performance indices of modern electric drives, Choice of electric drives, Status of DC and AC drives.	6
2.	**DC Motor Drives:** Types: Separately excited, Shunt, Series, Compound, Universal, Permanent magnet, DC servo, and Torque motors. Performance, Starting, Braking and Transient for each type of these motors. Methods of speed control: Armature voltage control, Controlled rectifier fed DC drives, and Chopper controlled DC drives.	10
3.	**AC Motor Drives:** - Three-phase induction motors: Analysis and performance, Starting, Braking, Transient analysis, and Speed control. - Single-phase induction motors: Starting methods and Types, Braking, Speed control.	10

	- Synchronous motor drives: Types, starting, pull-in, braking, and Synchronous motor variable speed drives: Brushless dc motors, Stepper motors, and Switched reluctance motor drives.	
4.	**Traction Drives:** Types, Nature of traction load, Braking, Rating and energy consumption.	6
Textbook:	• G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 1995. • A. Hughes, "Electric Motors and Drives Fundamentals, Types and Applications, HeinemanNewnes, London, 1990.	

Details of Practical Contents		
No	**Contents**	**Hours**
1.	Speed control of separately excited DC motor using single phase semi converter	4
2.	Speed control of separately excited DC motor using single phase full converter	4
3.	Inverse drive of separately excited DC motor using single phase dual converter	4
4.	Speed control of separately excited DC motor using three phase half wave converter	4
5.	Speed control of separately excited DC motor using three phase semi converter	4
6.	Speed control of separately excited DC motor using three phase full converter	4
7.	Speed control of squirrel cage induction motor by inverters	3
8.	Speed control of wound rotor induction motor by slip power recovery	3
9.	Speed control of DC motor using chopper circuits	2
Textbook:	• G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 1995.	

Textbooks	• G. K. Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 1995. • A. Hughes, "Electric Motors and Drives Fundamentals, Types and Applications, HeinemanNewnes, London, 1990.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Electrical Power System Analysis	Course Code	ELTL 466
Prerequisites	-	Credit Hours CRH	3 CTH 4 (L 2, P 2, T 0)

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

The purpose of this course is to give the student a basic knowledge of the power system representation, calculation of the different kinds of faults and load flow studies.

Topics :

The course contains four main topics:

- Power Systems Representation.
- Load Flow Studies.
- Fault Calculations.

References :

- K.A.Gangadhar "Analysis and Stability of Electric Power Systems", Khanna Pub. Delhi.
- A.Andrson and A.Fouad "Power System .ControlandStability"، McGrowHill
- Gross. , "Power System Analysis", John Wiley and Sons.
- Stevenson, W.: Elements of Power System Analysis, McGraw Hill 1982.

Details of Theoretical Contents		
No	**Contents**	**Hours**
1.	**Power Systems Representation**: General layout of the power system, System components, One-line diagram, Impedance diagram, Per-unit quantities, Change of per-unit base.	11
2.	**Load Flow Studies**: Power flow in a short transmission line, Phasor diagram, Power flow equations, Gauss-Siedal diagram, Bus voltage specification, Voltage regulation, Transmission efficiency.	11
3.	**Fault Calculations**: Types of faults, Symmetrical faults, Unsymmetrical faults, Symmetrical components, Sequence power, Sequence impedance's and networks.	10
Textbook:	• D P Kothari, l J Nagrath : Modern Power System Analysis. • John J. Grainger, Wuliam D. Stevenson : Power System Analysis .	

Details of Practical Contents		
No	**Contents**	**Hours**
1.	Study of high voltage transmission lines under the following conditions of, No-load, Inductive load and Symmetrical short-circuit.	8
2.	Determination of the sequence impedance is for a synchronous generating unit.	6
3.	Study of the behavior of a synchronous generating unit under different variable loading conditions.	6
4.	Control active and reactive power components of a generating unit connected to an infinite bus bar.	6
5.	Power factor improvement using synchronous condenser.	6
Textbook:	• D P Kothari, l J Nagrath : Modern Power System Analysis.	

Textbooks	• D P Kothari, l J Nagrath : Modern Power System Analysis. • John J. Grainger, Wuliam D. Stevenson : Power System Analysis .

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Electronic circuits	Course Code	ELTL 322
Prerequisites	-	Credit Hours CRH	2 CTH 3 (L 1, P 2, T 0)

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

This course gives the student a basic knowledge about the Electronic devices and their applications

Topics :

- Introduction to semiconductors.
- Diodes Applications and special purpose Diodes: Zener Diode, LED etc
- Bipolar Junction Transistors:.
- Transistor Bias Circuit
- Bipolar Junction Transistor Amplifiers and power amplifiers
- Field Effect transistors:
- Thyristors and GTO
- Voltage Regulators
- Active Filters

References :

- Thomas L. Floyd "Electronic Devices" Person International Edition

Details of Theoretical Contents		
No	**Contents**	**Hours**
1.	**Introduction to semiconductors.** Circuit and SPICE Elements .	2
2.	**Diodes Applications and special purpose Diodes** The Ideal Diode **,** Diode Terminal Characteristics , Graphical Analysis , Equivalent-Circuit Analysis , Rectifier Applications , Clipping and Clamping Operations and The Zener Diode	3
3.	**Bipolar Junction Transistors** BJT Construction and Symbols **,** Common-Base Terminal Characteristics , Common-Emitter Terminal Characteristics , Current Relationships , Bias and DC Load Lines . Measures of Amplifier Goodness **,** CE Amplifier Analysis , CB Amplifier Analysis and CC Amplifier Analysis .	3
4.	**Field Effect transistors** JFET Construction and Symbols **,** JFET Terminal Characteristics , JFET Bias Line and Load Line and Graphical Analysis for the JFET . MOSFET Construction and Symbols **,** MOSFET Terminal Characteristics , MOSFET Bias Line and Load Line and Graphical Analysis for the MOSFET .	3

5.	**Thyristors and GTO** The Silicon-Controlled Rectifier (SCR) **,** SCR Applications , The Diac and Triac and The Silicon-Controlled Switch (SCS) .	3
6.	**Voltage Regulators** Basic Linear Series Regulators **,** Basic Linear Shunt Regulators , Basic Switching Regulators and Integrated Circuit Voltage Regulators .	2
Textbook:	• Thomas L. Floyd "Electronic Devices" Person International Edition • Sedra Smith "Microelectronic Circuits"	

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	Introduction to Semiconductors	4
2.	SI Diode Characteristics – FBJ - SI Diode Characteristics – RBJ	4
3.	Half wave Rectifier	4
4.	Full wave Rectifier	4
5.	Clipping Circuits- Clamping Circuits	4
6.	Current and Voltage Characteristics of BJT	2
7.	Bipolar Junction Transistors (Bias circuits, DC load lines, application as amplifier)	4
8.	Field Effect Transistors (Bias circuits, Characteristics, Load line, Applications)	4
9.	Thyristors (Characteristics, Applications)	2
Textbook:	• Thomas L. Floyd "Electronic Devices" Person International Edition	

Textbooks	• Thomas L. Floyd "Electronic Devices" Person International Edition • Sedra Smith "Microelectronic Circuits"

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Electric Circuits Analysis	Course Code	ELTL 323
Prerequisites	ELTL 321	Credit Hours CRH	3 CTH 3
			L 3 P 0 T 0

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course description :

This course is designed to give the student a basic knowledge on Applied Electrical Engineering

Topics :

- Transient Circuits
- Analysis Circuits Via Energy
- Filters analysis.
- Signal Analysis.
- Two-Port Network

References :

- Bolested Electrical circuit analysis, Theraja "Electrical Technology"

Details of Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1.	**Transient Circuits** First order circuits; free RC circuit, free RL circuit, step response RC circuit and step response RL circuit. Second order circuits; free RLC series circuit, free RLC parallel circuit, step response RLC series circuit and step response RLC parallel circuit.	10
2.	**Analysis Circuits Via Energy** DC analysis method, AC analysis method and power factor correction methods.	9
3.	**Filters analysis.** Filter Response Characteristics, Passive Low-Pass Filters, Passive High-Pass Filters, Passive Band-Pass Filters and Passive Band-Stop Filters. Active Low-Pass Filters, Active High-Pass Filters, Active Band-Pass Filters and Active Band-Stop Filters.	10
4.	**Signal Analysis.** Fourier transform and some properties, Convolution and circuit response in the time domain, The system function and response in the frequency domain, Harmonics.	10
5.	**Two-Port Network** Equation of One-Port network, Matrix of Two-Port network, Admittance parameters, Impedance parameters, Hybrid parameters, Transmission parameters, Symmetrical and Reciprocal Circuits Relationship between different matrix parameters, Some equivalent networks, Amplitude transfer function and phase-angle transfer function.	9

Textbook:	• C. K. Alexander and M. N. O. Sadiku : "Fundamentals of Electric Circuits" • Bolested : "Introductory circuit analysis" • Theraja : "Electrical Technology"

Textbooks	• C. K. Alexander and M. N. O. Sadiku : "Fundamentals of Electric Circuits" • Bolested : "Introductory circuit analysis" • Theraja : "Electrical Technology"

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Graduation Project	Course Code	ELTL 491
Prerequisites	-	Credit Hours CRH	2 CTH 3
			L 1 P 2 T 0

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Objectives:

The purpose of this course is to make the final year student aquatinted with the ways and means, which are adopted to carry out an investigation to solve one of the technical problems. Also, to make the student able to present and prepare a detailed report.

Topics :

Each student must undertake a project in one of the main topics listed there under. The relevant projects are offered as options. Details of the projects available will be handed out to the students at the last semester. Some of these projects will involve the use of laboratory or computer or both. It is recommended that the student should choose the project option that most relevant to the courses he undertakes. It is also expected that he will carry out a literature survey on the topic of this project. The main topics are given below as:

1. Electrical Machines
2. Power System Technology
3. Control of Electrical Machines
4. Automatic Control
5. Special Machines
6. System Protection
7. Renewable Energy.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Electrical Machine - 1	Course Code	ELTL 330
Prerequisites	-	Credit Hours CRH	2 CTH 3
		L 1 P 2 T 0	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description :
The purpose of this course is to give the trainee a basic knowledge of theory, construction, analysis, performance, and applications of dc machines. The trainee has to know the different types of dc machines; separately excited and self-excited dc machines.

Topics :
- Principles of DC machines
- DC Generators
- DC Motors

Experiments: If applicable, it will support the course topics.

References: Stephen J. Chapman "Electric Machinery Fundamentals", McGraw-Hill, 2012.

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Principles of DC machines** Voltage is induced in a rotating loop, equation for induced voltage, lap winding, wave winding and construction of dc machine.	6
2	**DC Generators** Types of dc generators, equivalent circuit of a de generator, derive the voltage-current characteristics of separately excited, shunt, series, and compounded dc generators.	10
3	**DC Motors** Types of dc motors, equivalent circuit of a de motor, derive the torque-speed characteristics of separately excited, shunt, series, and compounded de motors, methods of starting dc motors.	10
Textbook	Stephen J. Chapman "Electric Machinery Fundamentals", McGraw-Hill, 2012.	

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	No load test for separately excited generator	4
2.	Load characteristics curve of separately excited generator	4
3.	Load characteristics curve of shunt excited generator	4
4.	Load characteristics curve of compound excited generator	4
5.	Speed – Torque characteristics curve of separately excited motor	4
6.	Speed – Torque characteristics curve of shunt excited motor	4
7.	Speed – Torque characteristics curve of series excited motor	2
8.	Speed – Torque characteristics curve of compound excited motor	2
9.	Speed control of separately excited motor	2
10.	Electric braking of DC motors.	2
Textbook:	• Stephen J. Chapman "Electric Machinery Fundamentals", McGraw-Hill, 2012.	

Textbooks	• Stephen J. Chapman "Electric Machinery Fundamentals", McGraw-Hill, 2012.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Power Electronics	Course Code	ELTL 421
Prerequisites	ELTL 322	Credit Hours CRH	2 CTH 3

L	1	P	2	T	0

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description :

This course is designed to give the trainee a basic knowledge of power electronic components characteristics. This course will also provide trainee with the ability to model, analyze, and design of converters including rectifiers, inverters, DC-DC converters and AC voltage controllers.

Topics :

- Fundamentals of power electronics devices
- DC-DC Converters
- Pulse Width Modulation Inverters
- Controlled Rectifiers
- AC Voltage Controllers

Experiments: If applicable, it will support the course topics.

References: M.H. Rashid, "Power Electronics circuits, devices and applications", Pearson, Fourth Edition, 2013.

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Fundamentals of power electronics devices** Power semiconductors devices, Comparison of Power Semiconductor Devices, control characteristics of power devices, characteristics and specifications of switches and types of power electronic circuits.	2
2	**DC-DC Converters** Principle of step-down operation, Principle of step-up operation, Converter classification, Switching Mode Regulators and comparison of regulators.	4
3	**Pulse Width Modulation Inverters** Principle of operation, Single phase bridge inverters, three phase inverters, Voltage control of single phase and three phase inverters, Advanced modulation techniques and harmonics reduction.	4
4	**Diode Rectifiers** Principle of phase-controlled converter operation, single phase full converters, single phase dual converters, Principle of three phase half wave converters, Principle of three phase full wave converters and three phase dual wave converters.	4

5	**AC Voltage Controllers** Principle of On-Off control, Principle of phase control, single phase bidirectional controllers and Ac voltage controllers with PWM.	**2**
Textbook	• M.H. Rashid, " Power Electronics circuits, devices and applications", Pearson, Fourth Edition, 2013. • T.M. Mohan, "Power Electronics. Converters applications and design", John Wiley, 2003.	

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	Diode and Thyristor characteristics	4
2.	Single phase half wave rectifier	4
3.	Single phase full wave rectifier	2
4.	Three phase rectifier	2
5.	Firing circuit of thyristor	2
6.	Half wave controlled rectifier	2
7.	Full wave controlled rectifier	2
8.	Three phase half wave controlled rectifier	2
9.	Three phase full wave controlled rectifier	2
10.	Control of phase angle for Ac voltage control.	2
11.	Step down DC Chopper	2
12.	Step up DC Chopper	2
13.	Single Phase Bridge Inverter	2
14.	Three Phase Bridge Inverter	2
Textbook:	• M.H. Rashid, " Power Electronics circuits, devices and applications", Pearson, Fourth Edition, 2013.	

Textbooks	• M.H. Rashid, " Power Electronics circuits, devices and applications", Pearson, Fourth Edition, 2013. • T.M. Mohan, "Power Electronics. Converters applications and design", John Wiley, 2003.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Electromechanical Energy Conversion	Course Code	ELTL 334
Prerequisites	-	Credit Hours CRH	2 CTH 2 (L 2 P 0 T 0)

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description:
This course is designed to give the trainee a basic knowledge of the magnetic field and properties of magnetic materials. Hysteresis, eddy current losses and permanent magnets are also included in this course. This course introduces electro-mechanical energy conversion principles for single and doubly excited magnetic field system, introduction to rotating machines. M.M.F of distributed AC and DC machines windings and the torque production in alternating current and direct current machines.

Topics :
- The Magnetic Circuit.
- Electromechanical Energy Conversion of single and doubly excited systems.
- Rotating electric machines

References : Fitzgerald, A.E., "Electric Machinery", Mc Graw-Hill 5 rd edition.

Detailed of Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1.	**The Magnetic Circuit:** Magnetic circuit computation, Ampere-turns, Flux, Reluctance, Calculation of inductance, Flux linkage, Field Energy, motional voltages, field energy, reluctance and electromagnetic torque's.	8
2.	**Electromechanical Energy Conversion:** -Energy balance -Singly excited magnetic field systems, induced voltage and Electric input, Field energy, Mechanical force and energy in a linear system, Mechanical force and energy in saturable systems, Co-energy and its mathematical representation. -Multi excited magnetic field systems, transformer**.**	16
3.	**Rotating electric machines:** - DC generators and motors, Synchronous generators and motors, Induction motors and Electromechanical system models.	8

Textbook	
	• B. Adkins and R.G. Harley, "The General Theory of Alternating Current Machines", abd Hall, London, 1975. • Fitzgerald, A.E., "Electric Machinery", Mc Graw-Hill 5 rd edition.

Textbooks	• B. Adkins and R.G. Harley, "The General Theory of Alternating Current Machines", abd Hall, London, 1975. • Fitzgerald, A.E., "Electric Machinery", Mc Graw-Hill 5 rd edition. • Theraja, A.E., "Electrical Technology", Rajendra Ravindra Printers, New Delhi,2005.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering						
Course Name	Electromagnetic Fields	Course Code	ELTL 335						
Prerequisites	-	Credit Hours CRH	2		CTH	2			
			L	2	P	0	T	0	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description:

This course aims to make the trainee aware of the basic principles of static and time varying electric and magnetic fields. The course supplies the trainee with sufficient methods and rules for calculating the intensity of electric and magnetic fields as well as potential for conventional models.

Topics:

- Theory of the Electromagnetic Field
- Quantities of the Electromagnetic Field
- The Laws of the Electromagnetic Field
- The Energy of the Electromagnetic Field

References: Andrei Nicolaide, "General Theory of the Electromagnetic Field**",** Transilvania University Press, Braşov, 2012**.**

Detailed of Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1.	**Theory of the Electromagnetic Field** Field and Substance, Lines of Field, Physical Quantities, Manners of Studying the Theory of the Electromagnetic Field, General Considerations on the Structure of Conductors and Dielectrics, Electric Field Strength and The Electric Current.	8
2.	**Quantities of the Electromagnetic Field** The Expressions of the Force and Electric Field Strength and Electromagnetic Potentials.	8
3.	**The Laws of the Electromagnetic Field** The Law of Electric Flux, The Relation between the Electric Displacement, Electric Field Strength and Electric Polarization, The Law of Magnetic Flux, The Law of Electromagnetic Induction for Media at Rest, The Law of Magnetic Circuit and Derivation of the Fundamental Equations of the Electromagnetic Field Theory in the General Case. Maxwell Equations.	8
4.	**The Energy of the Electromagnetic Field** The Expression of the Energy of the Electromagnetic Field Poynting Vector, Theorem of Irreversible Transformation of Electromagnetic and The Theorem of Electromagnetic Momentum.	8

Textbook	• Andrei Nicolaide, " General Theory of the Electromagnetic Field**",** Transilvania University Press, Braşov, 2012**.** • Bo Thidé, "Electromagnetic Field Theory**",** Uppsala, sweden,2004.

Textbooks	• Andrei Nicolaide, " General Theory of the Electromagnetic Field**",** Transilvania University Press, Braşov, 2012**.** • Bo Thidé, "Electromagnetic Field Theory**",** Uppsala, sweden,2004. • Theraja, A.E., “Electrical Technology”, Rajendra Ravindra Printers, New Delhi,2005.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering						
Course Name	Electrical Distribution Systems	Course Code	ELTL 361						
Prerequisites	-	Credit Hours CRH	2		CTH	2			
			L	2	P	0	T	0	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description:

The purpose of this course is to give the trainee a basic knowledge of DC distribution, two wire distributors, DC distributor fed at one end and DC distributor fed from both ends with equal voltages and with unequal voltages. In addition, basic knowledge of AC distribution and underground cables are given. The course covers all aspects of distribution engineering from basic system planning and concepts through distribution system reliability.

Topics:

- Load Characteristics
- Application of Distribution Transformers
- Design Considerations of Primary Systems
- Design Considerations of Secondary Systems
- Voltage Drop and Power Loss Calculations
- Distribution System Voltage Regulation
- Distribution System Reliability

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1	**Load Characteristics** Basic Definitions, The Relationship Between the Load and Loss Factors, Maximum Diversified Demand, Load Forecasting and Load Management.	3
2	**Application of Distribution Transformers** Types of Distribution Transformers, Regulation, Transformer Efficiency, Terminal or Lead Markings, Transformer Polarity and Distribution Transformer Loading Guide.	3
3	**Design Considerations of Primary Systems** Radial-Type Primary Feeder, Loop-Type Primary Feeder, Primary Network, Primary-Feeder Voltage Levels, Primary-Feeder Loading, Tie Lines, Distribution Feeder Exit: Rectangular-Type Development, Radial-Type Development, Radial Feeders with Uniformly Distributed Load, Radial Feeders with Nonuniformly Distributed Load, Application of the A,B,C,D General Circuit Constants to Radial Feeders and The Design of Radial Primary Distribution Systems.	4

4	**Design Considerations of Secondary Systems** Design Considerations of Secondary Systems, Secondary Voltage Levels, The Present Design Practice, Secondary Banking, The Secondary Networks, Spot Networks, Economic Design of Secondary systems and Unbalanced Load and Voltages.	4
5	**Voltage Drop and Power Loss Calculations** Three-Phase Balanced Primary Lines, Nonthree-Phase Primary Lines, Four-Wire Multigrounded Common Neutral Distribution System and Percent Power (or Copper) Loss	6
6	**Distribution System Voltage Regulation** Basic Definitions, Quality of Service and Voltage Standards, Voltage Control, Feeder Voltage Regulators, Line-Drop Compensation, Distribution Capacitor Automation and Voltage Fluctuations.	6
7	**Distribution System Reliability** Basic Definitions, National Electric Reliability Council, Appropriate Levels of Distribution Reliability, Basic Reliability Concepts and Mathematics, Series Systems, Parallel Systems and Series and Parallel Combinations.	6
Textbook	• Turan Gonen, "Electric Power Distribution System Engineering" Second Edition, CRC Press, 2007.	

Textbooks	• Turan Gonen, "Electric Power Distribution System Engineering" Second Edition, CRC Press, 2007.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Digital Integrated Circuits	Course Code	ELTL 422
Prerequisites	-	Credit Hours CRH	2 CTH 3
		L 1 P 2 T 0	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description :

This course provides the trainee the most extensive coverage of digital integrated circuit principles available in a single source. This include transistor-transistor logic (TTL, STTL, and ASTTL), emitter-coupled logic (ECL), NMOS logic, CMOS logic. In addition to the basic inverter circuits, complete details of other logic circuits are presented. The logic circuits include NAND, AND, NOR, OR, XOR and XNOR. The objectives of the course are for the trainee to learn how to model, analyze, simulate, and design digital integrated circuits for engineering applications.

Topics :

- The manufacturing processes
- Design methodology of devices
- Design methodology of wire
- The CMOS inverter
- Designing combinational logic gates in CMOS

Detailed of Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1.	**The manufacturing processes** Manufacturing CMOS Integrated Circuits, Packaging Integrated Circuits and Trends in Process Technology	8
2.	**Design methodology of devices** Design methodology of diodes, MOSFET, A Word on Process Variations and Technology Scaling.	8
3.	**Design methodology of wire** Interconnect Parameters — Capacitance, Resistance, and Inductance Electrical Wire Models and SPICE Wire Models	8
4.	**The CMOS inverter** The CMOS inverter, Performance of CMOS Inverter, Power, Energy, and Energy-Delay and Technology Scaling and its Impact on the Inverter Metrics.	8

Textbook	Rabaey, Jan, AnanthaChandrakasan, and Bora Nikolic. "Digital Integrated Circuits: A Design Perspective". 2nd ed. Prentice Hall, 2002.

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	Introduction to Orcad Capture (Time and Frequency Domain)	4
2.	Resistor-Transistor Logic	4
3.	Diode Resistor Logic example using Orcad Capture	4
4.	Resistor-Transistor Logic examples using Orcad Capture	4
5.	Diode-Transistor Logic examples using Orcad Capture	2
6.	Transistor-Transistor Logic	2
7.	SchottkyTransistor-Transistor Logic	4
8.	Basic-Emitter-Coupled Logic	2
9.	Temperature Emitter-Coupled Logic	4
10.	NMOS and CMOS Digital Circuits	2
Textbook:	• OrCAD PSpice for Windows Volume II: Devices, Circuits, and Operational Amplifiers 3rd Edition. • OrCAD PSpice for Windows Volume III: Digital and Data Communications 3rd Edition.	

Textbooks	• Digital Integrated Circuits by Thomas A. DeMassa and Zack Ciccone • OrCAD PSpice for Windows Volume II: Devices, Circuits, and Operational Amplifiers 3rd Edition. • OrCAD PSpice for Windows Volume III: Digital and Data Communications 3rd Edition.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering						
Course Name	Electrical Measurements	Course Code	ELTL 423						
Prerequisites	-	Credit Hours CRH	2		CTH	3			
			L	1	P	2	T	0	

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description :

The aim of this course is to introduce trainees to the different physical concepts of measurements process and gives them ability to use numbers and statistics in measurement and evaluation. Also, this course gives ability to identify, select and perform appropriate measurement in various fields.

Topics :

- Concept of Measurement Systems
- Analog Meter
- Instrument Transformer
- AC Bridges
- Power Measurement
- Sensors and Transducers

References: P.Purkait, B.Biswas, S.Das, "Electrical and Electronics Measurements and Instrumentation", McGraw Hill Education (India) Private Limited, 2013.

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1.	**Concept of Measurement Systems** Fundamental and derived units, standards and their classifications, methods of measurement, measurement system and its elements, classification of instruments and definitions of some static characteristics.	2
2.	**Analog Meter** Classification of analog instruments, principle of operation, operating torques, constructional details, permanent magnet moving coil instrument, extension of range of pmmc instruments, moving-iron instruments and electrodynamometer-type instruments.	4
3.	**Instrument Transformer** Advantages of instrument transformers, current transformers, theory of current transformers, errors introduced by current transformers, potential transformers, errors introduced by potential transformers and operational characteristics of potential transformers.	2
4.	**AC Bridges** Sources and detectors in ac bridges, general balance equation for four-arm bridge, measurement of self-inductance, measurement of capacitance, measurement of frequency and wagner earthing device.	2

5.	**Power Measurement** Power measurement in dc circuits, power measurement in ac circuits, electrodynamometer-type wattmeter, induction-type wattmeter and power measurement in polyphaser systems.	2
6.	**Sensors and Transducers** Electrical transducers, linear variable differential transformer, strain gauges, electromagnetic flow meter, temperature transducers and pressure measurement.	2

Textbook	• P.Purkait, B.Biswas, S.Das, "Electrical and Electronics Measurements and Instrumentation", McGraw Hill Education (India) Private Limited, 2013. • John Bird, “Electrical and Electronic Principles and Technology”, British Library • Cataloguing in Publication Data, Second Editions, 2003.

Details of Practical Contents		
No.	**Contents**	**Hours**
1.	Series- Parallel resistance connections and Kirchhoff's Law.	4
2.	Measurement of Galvanometer internal resistance.	4
3.	Use of Galvanometer in measurements.	4
4.	Use of Digital measuring instruments.	4
5.	Measurements using Oscilloscope.	4
6.	Measurements using Wheatstone bridge and Maxwell Bridge.	4
7.	Electrical Power measurements.	2
8.	Measurements using current and voltage transformers.	2
9.	Electrical Energy measurements.	4

Textbook:	• John Bird, “Electrical and Electronic Principles and Technology”, British Library • Cataloguing in Publication Data, Second Editions, 2003.

Textbooks	• P.Purkait, B.Biswas, S.Das, "Electrical and Electronics Measurements and Instrumentation", McGraw Hill Education (India) Private Limited, 2013. • John Bird, “Electrical and Electronic Principles and Technology”, British Library • Cataloguing in Publication Data, Second Editions, 2003. • John Bird, “Electrical and Electronic Principles and Technology”, British Library • Cataloguing in Publication Data, Second Editions, 2003.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Special Machines	Course Code	ELTL 437
Prerequisites	ELTL 332	Credit Hours CRH	2 CTH 2
			L 2 P 0 T 0

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description:
The purpose of this course is to enable the trainee to be familiar with the construction and operation of the most popular types of small machines. The trainee has to know the importance, advantages and disadvantages utilization of special machines, definition of the type of special machine needed for each application based on the characteristics of each and treatment all the problem which may occur in practice and introduce the solution.

Topics :

- Single Phase Induction Motors.
- Reluctance and Repulsion Motors.
- Permanent Magnet Machines.
- Stepper Motors.
- Synchronous and Control Transformers.
- Servomotors.
- Tacho-generators.

Experiments: If applicable, it will support the course topics.
References: E.G. Janardanan, "Special Electrical Machines", PHI learning Private Limited, 2014.

Detailed of Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1.	**Single Phase Induction Motors:** Revolving field theory of single-phase induction motors, Construction, operation, and characteristics of different types of single-phase induction motors, Equivalent circuit, power and efficiency of single-phase induction motor.	4
2.	**Reluctance and Repulsion Motors:** Construction and configuration, Theory of operation, Voltage equations, Phasor diagram, Steady state, Starting and synchronizing performances, Applications.	4
3.	**Permanent Magnet Machines:** PM materials and their characteristics, Rotor construction and configurations, Theory of operation, Advantages and disadvantages, Steady state, Starting, pull-in and Synchronization performances, Applications.	4
4.	**Universal Motor**	4

	Construction of Universal motor, Working of universal motor, Speed/load characteristics and Applications of universal motor.	
5.	**Stepper Motors:** Types, Basic configurations of single and multi-stack variable-reluctance and Permanent magnet stepper motors, Equations and operating characteristics, Applications.	4
6.	**Synchros and Control Transformers:** Construction of different component of synchros, Theory of operation, Application as data and torque transmitters.	4
7.	**Servomotors:** Equivalent circuit and static characteristics of DC and AC servo motors, Static characteristic curve, Selection, Applications.	4
8.	**Tacho-generators:** Types, Construction, Working principles, Characteristic curve, Source of errors, Reducing errors, Applications.	4
Textbook	• A. hughes, Electric Motors and Drives Fundamentals, Types and Applications. Heinemann Newnes, London, 1990. • V. Subrahmanyam, Electric Drives: Concepts and Applications; Mc Graw-Hill, New York, 1990. • E.G. Janardanan, " Special Electrical Machines", PHI-Janardanan,2014.	

Textbooks	• A. hughes, Electric Motors and Drives Fundamentals, Types and Applications. Heinemann Newnes, London, 1990. • V. Subrahmanyam, Electric Drives: Concepts and Applications; Mc Graw-Hill, New York, 1990. • E.G. Janardanan, " Special Electrical Machines", PHI-Janardanan,2014.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Electrical Traction	Course Code	ELTL 445
Prerequisites	ELTL 332	Credit Hours CRH	2 CTH 2

L	2	P	0	T	0

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description :
The purpose of this course is to give the trainee a basic knowledge of electric traction systems and latest trends. The trainee has to know the analysis of speed time curves, Comparison between different traction motors and the types of electrical braking system.

Topics :
- Introduction to Electric Traction
- Power systems of electric traction
- Torque-speed relationship
- Systems of speed and braking control
- Hybrid and electric vehicles

References: AC Motor control and Electric Vehicle Applications, Editorial CRC. Kwang Hee Nam. 2010.

Detailed of Theoretical and Practical Contents		
No.	**Contents**	**Hours**
1.	**Introduction to Electric Traction.** • Traction definition and types. • Motion theory. • Electric traction evolution. • Electric traction systems.	6
2.	**Power systems of electric traction.** • Introduction to power systems of electric traction. • DC systems. • AC systems. • Three-phase AC systems.	6
3.	**Torque-speed relationship.** • Comparison between different rotary machines used in traction. • Tractive effort and engine power. • Traction motors. General aspects. • DC motors. • AC induction motors. • Synchronous and Brushless motors.	6
4.	**Systems of speed and braking control.** • Introduction. • Dynamic of the motor–load combination. Stability. • Speed drives. • Speed control of DC motors.	7

	• Speed control of AC induction motors. • Speed control of Brushless motors. • Braking control. • Speed sensors.	
5.	**Hybrid and electric vehicles.** • Introduction to hybrid and electric vehicles. • Hybrid vehicles. • Electric vehicles. • Motor selection. • Power storage system in electric vehicles	7
Textbook	• Electric Motors and Drives. Fundamentals, Types and Applications. Edit. Elsevier Newnes. Austin Hughes. 2006. • AC Motor control and Electric Vehicle Applications, Editorial CRC. Kwang Hee Nam. 2010.	

Textbooks	• Electric Motors and Drives. Fundamentals, Types and Applications. Edit. Elsevier Newnes. Austin Hughes. 2006. • AC Motor control and Electric Vehicle Applications, Editorial CRC. Kwang Hee Nam. 2010. • Theraja, "Electrical Technology", Rajendra Ravindra Printers, New Delhi,2005.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	High Voltage Engineering	Course Code	ELTL 336
Prerequisites	ELTL 466	Credit Hours CRH	2 CTH 2
			L 2 P 0 T 0

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description :

The aims of this course are to provide the trainee with the basic knowledge and skills of high voltage engineering. This course will also provide trainees with the high voltage phenomena concerning breakdown mechanism (in gas, liquid and solid) and high voltage generation and measurements (DC, AC and impulse types). Also, basic knowledge of the overvoltage phenomena and overvoltage protection will be attained.

Topics :

- The breakdown mechanisms in gases, liquid and solid insulators.
- Identify high voltage generation and measurements (DC, AC and impulse voltages).
- Demonstrate overvoltage Phenomenon and Insulation Coordination in Electric Power Systems.

References : -M.S. Naidu, “High Voltage Engineering”, 3rd edition, McGraw-Hill, New Delhi, 2004.

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1.	**The breakdown mechanisms in gases, liquid and solid insulators.** Collision and Ionization Processes, Townsend's Current Growth Equation, Breakdown in Electronegative Gases, time Lags for Breakdown, streamer theory of breakdown in gases, Paschen's Law, Breakdown in non-Uniform fields and corona discharges, post-breakdown phenomena and applications, practical Considerations in using gases for insulation purposes, vacuum insulation.	11
2.	**Identify high voltage generation and measurements** Generation of High DC and AC Voltages, Generation of High AC voltages and impulse currents and voltages, tripping and control of impulse generators, Measurement of High DC, AC and impulse Voltages, Measurement of High DC, AC and Impulse voltages, Measurement of High DC, AC and Impulse Currents.	11
3.	**Demonstrate overvoltage Phenomenon** National causes for overvoltage, Lightning Phenomenon, Overvoltage due to switching surges, system faults and other abnormal conditions.	10

Textbook	• M.S. Naidu, "High Voltage Engineering", 3rd edition, McGraw-Hill, New Delhi, 2004. • E. Kuffel, W.S. Zaengl and J. Kuffel, "High Voltage Engineering, Fundamental", 2nd edition, Butterworth-Heinemann, 2000. • Hugh M. Ryan, "High Voltage Engineering and Testing", 2nd edition, 2001.

Textbooks	• M.S. Naidu, "High Voltage Engineering", 3rd edition, McGraw-Hill, New Delhi, 2004. • E. Kuffel, W.S. Zaengl and J. Kuffel, "High Voltage Engineering, Fundamental", 2nd edition, Butterworth-Heinemann, 2000. • Hugh M. Ryan, "High Voltage Engineering and Testing", 2nd edition, 2001.

Department	Applied Electrical Engineering	Major	Applied Power and Electrical Machines Engineering
Course Name	Economic Operation of Power System	Course Code	ELTL 463
Prerequisites	ELTL 466	Credit Hours CRH	2 CTH 2 (L 2 P 0 T 0)

CRH: Credit Hours L: Lecture P: Practical T: Tutorial CTH: Contact Hours

Course Description :

This course is designed to give the trainee a basic knowledge how to generate, to transmit and to distribute the electrical power economically**.** The topics of this course include distribution of load between units within a plant, distribution of load between plants and the transmission-loss equation.

Topics :

- Power Generation Economics.
- Power Transmission Economics.
- Power Distribution Economics.

References: Stevenson, W.: Elements of Power System Analysis, McGraw Hill 1982.

Detailed of Theoretical Contents		
No.	**Contents**	**Hours**
1.	**Power Generation Economics:** Introduction to power system economics, Station performance and operating characteristics, Distribution of loads in a generating plant, Incremental rate theory, Optimal division of loads between two machines, optimal scheduling of generation in a multi-machine system.	11
2.	**Power Transmission Economics:** Transmission losses as a function of plant generation, Systematic development of transmission loss formula, Loss formula coefficients, Co-ordination for optimum economy distribution of loads with and without consideration of transmission losses, penalty factor.	11
3.	**Power Distribution Economics:** Daily demand characteristics for residential, industrial and commercial areas, load factors, load management, loss factors, Fuel cost adjustment, Power factor correction, Calculation of the size and cost of shunt capacitors, Economic justification for capacitors.	10
Textbook	• Stevenson, W.: Elements of Power System Analysis, McGraw Hill 1982. • Gonen, T.: Electric Power Distribution System Engineering.	

Textbooks	• Stevenson, W.: Elements of Power System Analysis, McGraw Hill 1982. • Gonen, T.: Electric Power Distribution System Engineering.

Appendix Laboratory Equipment, Workshops and Laboratories

No.	Laboratory name / workshop	Capacity of training	Number of trainers	Training courses benefiting from the laboratory / workshop / lab
1.	Circuits Lab.	12	1	1. Advanced Electric Circuits 2. Electrical Power System Analysis 3. Digital Integrated Circuits
2.	Electronic Circuits Lab.	12	1	1. Electronic Circuits 2. Industrial Electronics
3.	Digital Electronics Lab.	12	1	Digital Electronics
4.	DC Machines Lab.	12	1	Electrical Machines-1
5.	AC Machines Lab.	12	1	Electrical Machines-2
6.	Power Electronics Lab.	12	1	Power Electronics
7.	Electric Drives Lab.	12	1	Electric Drives
8.	Protection Lab.	12	1	Power System Protection
9.	Automatic Control Lab.	12	1	Automatic Control
10.	Measurements Lab.	12	1	Electrical Measurements

List of Detailed Equipment for Each Laboratory, Workshop or Lab

Circuits Laboratory		
No.	**Product's Name**	**Quantity**
1.	Personal Computer	20
2.	Pspice package software	1
3.	ETAP package software	1

Electronic Circuits Laboratory

No.	Product's Name	Quantity
1.	Function generator	12
2.	Measurement devices; voltmeter, ammeter and wattmeter	36
3.	Electronic components, diode and transistor	60
4.	Resistances, coils and capacitors	144
5.	Switches	48
6.	Oscilloscope	12
7.	Plug-in Board	12
8.	COM3LAB unit	12
9.	Personal Computer	12

Digital Electronics Laboratory

No.	Product's Name	Quantity
1.	Logic Training Board	2
2.	Digital to Analog Converter (D To A)	2
3.	Analog to Digital Converter (A To D)	2
4.	8-Bit Multiplying Digital to Analog Converter	2
5.	BCD to Seven Segment Display	2
6.	Arithmetic Logic Unit A. L. U. Chip (74181)	2
7.	4- Bit Binary Full Adder and Subtractor	2
8.	Various Types of Flip - Flops	2
9.	Digital Network Multiplexer	2

DC Machines Laboratory

No.	Product's Name	Quantity
1.	DC series motor, 220 V, 300 W	6
2.	DC compound motor, 220 V, 300 W	6
3.	Field regulator motor	6
4.	Field regulator generator	6
5.	Magnetic braking	6
6.	Digital control unit	6
7.	Digital multimeter	6
8.	Firing and control unit	6
9.	IGBT control unit	6

AC Machines Laboratory		
No.	**Product's Name**	**Quantity**
1.	Single phase induction motor, 220 V, 300 W	6

2.	Three phase squirrel cage induction motor,220/380 V, 300 W	6
3.	Three phase slip ring induction motor,220/380 V, 300 W	6
4.	Three phase synchronous machine,220/380 V, 300 W	6
5.	Field regulator motor	6
6.	Field regulator generator	6
7.	Magnetic braking	6
8.	Digital control unit	6
9.	Three-phase transformer	6
10.	Single phase transformer	6
11.	Resistance, Inductive and capacitive loads	6
12.	Circuit Breaker	6
13.	Reverse Direction Switch	6
14.	Delta – Star Switch	6
15.	Digital multimeter	6
16.	Wattmeter	6
17.	Firing and control unit	6
18.	IGBT control unit	6

Power Electronics Laboratory		
No.	**Product's Name**	**Quantity**
1.	Function generator	12

2.	Integrated Thirstier	12
3.	Step-up Chopper 30V/2A	1
4.	Step Down Chopper 220V/5A	1
5.	Triac Module with protection 10A/500V	1
6.	Three-phase Control half & Full Converter	1
7.	Three-phase half & Fully Control Power Circuit	1
8.	Three Phase Inverter Stack for PWM Inverter, Semikron	1
9.	Single Phase Fully Control Bridge Converter with RL Load	1
10.	Gate Firing Circuit trainer	1
11.	Submicron Make Inverter	1
12.	BC Jone Chopper	1
13.	Oscilloscope	12
14.	Plug-in Board	12
15.	Measurement devices; voltmeter, ammeter and wattmeter	36
16.	Electronic components, diode and transistor	60
17.	Resistances, coils and capacitors	144

Electric Drives Laboratory		
No.	**Product's Name**	**Quantity**
1.	Three-phase induction motor	12

2.	DC multifunction machine	12
3.	Reference variable generator	12
4.	Synchroscope	12
5.	AC/DC stabilizer	12
6.	Selenium rectifier 25V/10A	12
7.	Machine test system	12
8.	Control unit six pulse digital	12
9.	Control unit two pulse	12
10.	Tacho-generator	12
11.	Trigger point limiter	12
12.	Thyristor 1000V/12A	24
13.	IGBT 1000V/10A	24
14.	Triac 1000V/11A	24

Protection Laboratory		
No.	**Product's Name**	**Quantity**
1.	Protection bag; 230 V, 60 Hz	12

2.	Voltage source 380V	12
3.	Three-phase Wattmeter	6
4.	Double voltmeter	2
5.	Voltmeter 600 V	4
6.	Synchroscope	2
7.	Control unit	2
8.	Three-phase transformer	8
9.	Three-phase circuit breaker	16
10.	Protection relays	14

Automatic Control Laboratory		
No.	**Product's Name**	**Quantity**
1.	Main control device	12

2.	Oscilloscope	12
3.	Control applications	4
4.	Control panel	4
5.	Fault diagnosis panel	4
6.	Amplifier unit	4
7.	COM3LAB unit	12
8.	Personal Computer	12

Measurements Laboratory		
No.	**Product's Name**	**Quantity**
1.	Oscilloscope, two channels	12

2.	Variable dc/ac source	12
3.	Three-phase source 220/380 V	12
4.	Function generator	12
5.	Measurement devices; voltmeter, ammeter and wattmeter	36
6.	Electronic components, diode and transistor	60
7.	Resistances, coils and capacitors	144
8.	Switches	48

References

Textbooks	**1.**	Bolested, "Introductory circuit analysis", 9Th edition, Prentice Hall, 2003.
	2.	Theraja, "Applied Electrical Engineering", Rajendra Ravindra Printers, New Delhi,2005.
	3.	Deuton J.D." Operational Amplifiers and Linear Integrated Circuits", McGraw-Hill
	4.	Ronald J. Tocci, "Fundamentals of Pulse and Digital Circuits", Charles E. Mill Publishing Co. (A bell & Howell Company).
	5.	Fitzgerald, A.E., Kingsely, and Kusko, A., "Electric Machinery", McGraw-Hill 5th edition.

	6.	Hindmarsh, J., “Electrical Machines and Their Application”, Pergaman 3rd edition.
	7.	A. HUGHES, Electric Motors and Drives Fundamentals, Types and Applications. Heinemann Newnes, London, 1990.
	8.	V. Subrahmanyam, Electric Drives: Concepts and Applications; McGraw-Hill, New York, 1990.
	9.	Stevenson, W.: Elements of Power System Analysis.
	10.	P.M.Andrson and A.A.Fouad, “Power System Control and Stability”.
	11.	Allen J. Wood, Bruce F. Wellenberg,” Power Generation Operation & Control”, John Wiely& Sons, NY 1999, Third Edition.
	12.	M. Godoy Simões,Felix A. Farret: Renewable Energy Systems: Design and Analysis with Induction Generators. Top of FormBottom of Form
	13.	John Twidell and Tony Weir : Renewable Energy Resources .
	14.	Mukund R. Patel : Wind and Solar Power Systems Design, Analysis, and Operation .
	15.	M. Ogata " Modern Control Engineering " Last edition Prentice Hall
	16.	B C Nakra Theory and Applications of Automatic Controls
	17.	Robert E. King Computational Intelligence in Control Engineering
	18.	Pao C. Chau Process Control: A First Course with MATLAB
	19.	Walter A.T., “Integrated Digital Electronics”, Prentice-Hall, Inc.
	20.	Albert P.M. ,” Digital Computer Electronics”, An Introduction to Microprocessors”, McGraw-Hill, Inc.
	21.	Charles A.H., “Electronic Circuits Digital & Analog”, John Wiley & Sons,Inc.
	22.	G. K. Dubey, “Fundamentals of Electrical Drives”, Narosa Publishing House, 1995.
	23.	A. Hughes, “Electric Motors and Drives Fundamentals, Types and Applications, HeinemanNewnes, London, 1990.
	24.	Yasuhiko Dote, “Brushless Servomotors Fundamentals and Applications”, Clarendon Press, Oxford, 1990.
	25.	M. E. El-Hawary, “Principles of Electric Machines with Power Electronic Applications”, Prentice-Hall, 1986.
	26.	K.A.Gangadhar “Analysis and Stability of Electric Power Systems”, Khanna Pub. Delhi.
	27.	A.Andrson and A.Fouad “Power System Control and Stability", McGraw-Hill.
	28.	C. K. Alexander and M. N. O. Sadiku : "Fundamentals of Electric Circuits", McGraw-Hill, 2013.
	29.	Stephen J. Chapman "Electric Machinery Fundamentals", McGraw-Hill, 2012.
	30.	M.H. Rashid, " Power Electronics circuits, devices and applications", Pearson, Fourth Edition, 2013.

	31.	T.M. Mohan, "Power Electronics. Converters applications and design", John Wiley, 2003.
	32.	Andrei Nicolaide, " General Theory of the Electromagnetic Field", Transilvania University Press, Braşov, 2012.
	33.	Bo Thidé, "Electromagnetic Field Theory", Uppsala, sweden,2004.
	34.	Turan Gonen, "Electric Power Distribution System Engineering" Second Edition, CRC Press,2007.
	35.	Rabaey, Jan, Anantha Chandrakasan, and Bora Nikolic. "Digital Integrated Circuits: A Design Perspective". 2nd ed. Prentice Hall, 2002.
	36.	P.Purkait, B.Biswas, S.Das, "Electrical and Electronics Measurements and Instrumentation", McGraw Hill Education (India) Private Limited, 2013.
	37.	John Bird, "Electrical and Electronic Principles and Technology", British Library
	38.	E.G. Janardanan, " Special Electrical Machines", PHI learning Private Limited,2014.
	39.	Electric Motors and Drives. Fundamentals, Types and Applications. Edit. Elsevier Newnes. Austin Hughes. 2006.
	40.	AC Motor control and Electric Vehicle Applications, Editorial CRC. Kwang Hee Nam. 2010.
	41.	M.S. Naidu, "High Voltage Engineering", 3rd edition, McGraw-Hill, New Delhi, 2004.
	42.	E. Kuffel, W.S. Zaengl and J. Kuffel, "High Voltage Engineering, Fundamental", 2nd edition, Butterworth-Heinemann, 2000.
	43.	Hugh M. Ryan, "High Voltage Engineering and Testing", 2nd edition, 2001.
	44.	Rabaey, Jan, AnanthaChandrakasan, and Bora Nikolic. "Digital Integrated Circuits: A Design Perspective". 2nd ed. Prentice Hall, 2002.