General Information

|  |  |
| --- | --- |
| Name of Course | Foundations of Electrical Signals of Hardware *(Introduction to Electric Circuits for Hardware)* |
| Course Code | PMRMINB135HA |
| Semester | 2016/2017 1. (Autumn) |
| Number of Credits | 4 |
| Allotment of Hours per Week | 2 lectures and 2 practical lessons per week |
| Evaluation | Signature with grade |
| Prerequisites | - |
| Instructors | Dr. István Gyurcsek, Email: [gyurcsek.istvan@mik.pte.hu](mailto:gyurcsek.istvan@mik.pte.hu)  Office: 7624 Pécs Boszorkány u. 2. Room: B232, Office phone extension: 23852 |

Introduction and learning outcomes

Electric circuit theory and electromagnetic theory are the fundamental principles upon, which many branches of engineering are built. Therefore, the basic electric circuit theory is not only the one of the most important course for students learning information technology, electrical engineering but always an excellent starting point for the beginnings in all kind of engineering education.

Circuit theory is also valuable for students specializing in other branches of the physical sciences because circuits are good model for the study of energy systems in general, and because the applied mathematics, physics, and topology involved.

In different branches of engineering, we are often interested in communicating or transferring energy from one point to another. To do this an interconnection of electrical devices is required. The interconnection is referred as an electric circuit and each component of the circuit is known as an element.

This course is the short collection of the fundamental principles is given helping to understand the basics of practical electricity i.e. the basics of electric circuits.

General Course Description and Main Content

This subject covers the fundamental principles of the electricity that is required to the study of students attending the B.Sc. program. It aims to increase students’ knowledge and expertise and determine whether they satisfy the requirements of the course.

The subject of the course includes the followings.

* Basic overview of electromagnetic fields. We discuss the most important properties and behavior of the electricity, electric fields and magnetic fields.
* Behavior of the fundamental circuit elements like voltage sources, current sources, resistors, capacitors, inductors. Theorems of electrical circuits through Ohm’s Law, Kirchhoff’s Laws. Calculations with series and parallel resistors, voltage division, current division, and rules of serial and parallel connections of capacitors, inductors.
* Electric Circuits Analysis covering the basics of Loop Analysis, Nodal Analysis, Superposition Theorem, Thevenin’s Theorem, Norton’s Theorem and Source Transformation and the theorem of Maximum Power Transfer.
* Sinusoids and Phasors with the phasor relationship for main circuit elements like resistors, inductors, capacitors. Circuit analysis with Kirchhoff’s Laws in the frequency domain. Analyzing the Power ‘behavior’ in alternating current (AC) environment with respect to the practical importance of the Power Factor and Power Factor Correction.
* Three-phase circuits. Analysis of the WYE and DELTA connections, calculation of three-phase power.
* Two-port network analysis. Hybrid and transmission type parameters, and their behavior. Relationship between these parameters.
* Theoretical overview and practical methods for system transfer function analysis. Examples with Niquist and Bode plots.

Methodology

The course is based on the lectures and practices giving examples and calculation exercises to help understanding the subject of the study.

Schedule

The semester is divided into five principle periods and attendant exercises. The rough outline of the schedule is as the followings:

**Week 1-2: Overview of Electromagnetic Field (INT, EMF1, EMF2)**

* Electric field: Electric charge, Charge models, Description of electric field as vector field, Gauss’s law of electrostatics, Coulomb’s law, Voltage and electric potential, Work performed in static electric fields, Equipotential surfaces, Capacitance and capacitors, Energy density of the electric field, Stationary electric field, Power density of the stationary electric field, Equation of continuity
* Magnetic field: Magnetic permeability, Static magnetic field, Stationary magnetic field, Description of the magnetic vector field, Energy of the magnetic field, Forces in magnetic fields, Interaction of matter with magnetic fields, The hysteresis loop, Flux linkage and the self and mutual inductance, Electric and magnetic fields varying in time, Electromagnetic waves

**Week 3-5: Electric Circuit Analysis (DEF, THO, ANL)**

* Circuit concepts and definitions: Electric current, voltage, Power and energy, Passive and active Circuit elements, Resistor (Ohm’s Law), Capacitor, Inductor, Voltage and current sources
* DC Circuits’ analysis 1: Kirchhoff’s laws, Series and parallel resistors, voltage and current divisions, Series and parallel capacitors and inductors, Wye-delta transformation
* DC Circuits’ analysis 2: Loop and nodal analysis, Problem of the linearity, Superposition theorem, Source transformation, Thevenin’s and Norton’s theorem, Maximum power transfer theorem

**Week 6-8: Alternating Current (PHA, SPQ, ACC)**

* Sinusoidal varying excitations 1: Sinusoids and phasor relationship for circuit element; Resistor, Inductor, Capacitor, Impedance and admittance, Kirchhoff's laws in the frequency domain, Mean or average values
* Sinusoidal varying excitations 2: Power in AC circuits - Complex power, Power factor
* AC Circuits’ analysis: Pure, serial and parallel RLC circuits, serial and parallel resonant circuits, analysis of free resonance.

**Week 9-12: Alternating Current (PER, THR)**

* General periodic excitations: Circuits with general periodic excitations; Fourier series, Fourier analysis, Alternative forms of Fourier series, Circuit application, Average power and RMS values
* Three-phase circuits: Three-phase WYE and DELTA connections, Three-phase power, Unbalanced three-phase circuits, Power in case of unbalanced load

**Week 13-15: Two-port networks (TWO, TFA, BOD)**

* Parameters of two-ports; impedance-, admittance-, hybrid-, inverse hybrid-, transmission-, inverse transmission parameters. Properties of two-port networks; Reciprocity and symmetry, Wave impedance, Relationship between parameters
* Overview of the transfer function analysis. Two-port network analysis with Nyquist and Bode plots.

Attendance

Attending is required all classes and will impact the grade. Unexcused absences will adversely affect tge grade and in case of absence from more than 30% of the total number of lessons will be grounds for failing the class. To be in the class at the beginning time and stay until the scheduled end of the lesson is required. Tardiness of more than 20 minutes will be counted as an absence. In the case of an illness or family emergency the student must present a valid excuse, such as a doctor’s note.

The highest possible grade on the late performance (in two weeks) is ‘2’.

Required Performance, Evaluating, Grading

The requirement is two approved classroom studies, scheduled during the semester and the written examination scheduled for the exam terminus. The grade of the examination will be based on the following guidelines:

5. Outstanding work. Execution of work is thoroughly complete and demonstrates a superior level of achievement overall with a clear attention to details. The student is able to synthesize the course material with new concepts and ideas in a thoughtful manner and is able to express those ideas in clear way.

4. High quality work. Student work demonstrates a high level of knowledge with consistency. The student demonstrates a level of thoughtfulness in addressing concepts and ideas. Work demonstrates excellence but less consistency than a ‘5’ student.

3. Satisfactory work. Student work addresses all of the task and assignment objectives with few minor or major problems.

2. Less than satisfactory work. Work is incomplete in significant ways and lacks attention to details.

1. Unsatisfactory work. Work exhibits several major and minor problems with basic conceptual premise, lacking both intention and resolution. Results are severely lacking and are weak in clarity and completeness.

Grading Scale:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Numeric Grade | 5 | 4 | 3 | 2 | 1 |
| Evaluation interval | 90-100% | 76-89% | 63-75 % | 51-62 % | 0-50 % |

Students with Special Needs

Students with disability and needs to request special accommodations, please notify the Deans Office. Proper documentation of disability will be required. All attempts to provide an equal learning environment for all will be made.

Recommended Reading and Reference Materials

* Dr. Gyurcsek István – Dr. Elmer György; Theories in Electric Circuits – An overview, Faculty of Engineering and Information Technology, University of Pécs, 2015
* http://vili.pmmf.hu/~gyurcsek (Introduction to Electric Circuits for Hardware)