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**Department of Electrical Engineering**

**College of Engineering**

**University of Salahaddin**

**Subject: Electrical Measurements**

**Course Book –*Second Year***

**Lecturer's name: Velar Hikmat, M.Sc.**

**Academic Year: *2017-2018***

**Course Book**

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| **1. Course name** | **Electrical Measurements** | |
| **2. Lecturer in charge** | **Mr.Velar Hikmat Elias** | |
| **3. Department/ College** | **Electrical Engineering** | |
| **4. Contact** | **e-mail:Velar.elias@su.edu.krd**  **Tel: (009647504712766)** | |
| **5. Time (in hours) per week** | **For example Theory: 4**  **Practical: 0** | |
| **6. Office hours** | **Office hours: Sunday 8:30 – 10:30,tuesday: 01:30-03:30** | |
| **7. Course code** | **EE209** | |
| **8. Teacher's academic profile** | **Personal Details:**  Name: Velar Hikmat Elias  Family Name: Nabaty  Date and Place of birth: 04 January 1982, Erbil-Iraq  Material Status: Married, Two Children  Home Address: Ankawa, Erbil, Kurdistan Region- Iraq    Mobile: +964(0750) 4712766  E-mail: velar.elias@su.edu.krd  **Education:**  M.Sc. In Electrical Engineering, Salahaddin University – Erbil, Iraq, 2008.  B.Sc., Electrical Engineering, Salahaddin University , Erbil-Iraq, 2003.  Baccalaureate, Ankawa Secondary School, Erbil-Kurdistan- Iraq.  Languages:  Good knowledge of spoken and written skills in English, Arabic, Kurdish, languages.  **Employment Experience:**  2013 Manager of Library of College of Engineering  2014 Member on IVSL  **Teaching Experience:**  1. Undergraduate Courses  From 2008 to 2018  1. Mechanical Engineering, Department of Electrical Engineering, College of Engineering, Salahaddin University, Erbil-Iraq  2. Communication I, Dept. of Electrical Eng. College of Engineering,  University of Salahaddin, Erbil-Iraq  3. Electrical Measurements, Dept. of Electrical Engineering College of Engineering, Salahaddin University, Erbil-Iraq  4. Analog Communication, Dept. of Physical College of Science, Salahaddin University, Erbil-Iraq  5. DSP, Dept. Of Physical, College of Science, Salahaddin University, Erbil-Iraq  6. Elective, Dept. of Electrical Engineering, College of Engineering, Salahaddin University, Erbil-Iraq  2. LAB. Supervising   1. Analog Communication Lab., Dep. Of Electrical, College of Engineering, Salahaddin University 2. Electronic Lab., Dep. Of Electrical, College of Engineering, Salahaddin University 3. C++ Lab., Dep. Of Electrical, College of Engineering, Salahaddin University   **Conferences**  Wavelet Filter Bank-based nonuniform Multi-Tone Transceiver for Digital Subscriber Line, IEEE 11th International Conference on Computer and Information Technology CIT, Cyprus, August, 2011.  **Selected Publications**   1. Performance Evaluation of DWMT Downlink Scheme over UTP-3 Cable, ELEKTRIKA, Universiti Teknologi Malaysia, vol.11, no.2, pp. 20-26, 2009 2. Modeling and Simulation of Discrete Wavelet Multi-Tone, Journal on Software Engineering, vol.2,no.3, pp. 1-5, 2008 3. Real Time Motion and Color Detection, is accepted by Journal of Zankoy Sulaimani – Part A (JZS-A), published in Vol.(17), No.(4), (2015).) | |
| **9. Keywords** | Electrical Engineering, Electrical Measurements | |
| **10. Course overview:**  The course deals with the fundamental principles of Electrical Measurements and Instrumentations. This subject is generally the second  course for all Electrical and Electronics Engineering students and is structured to cover the key aspects of the subject to meet the requirements of students studying for Electrical Engineering at the under-graduate levelThis course is a result of teaching Electrical Measurements for 3 years, providing a balance between theory and practice by explaining the topics in a very systematic and logical manner. Each chapter develops from basic concepts .Practically every major point in the lecture illustrates with suitable examples. This will help the students in understanding the basic theory and train them in solving problems systematically and confidently and makes the understanding of this subject clearer and makes it more interesting.  The subject matter is divided into chapters covering duly recognized areas of theory and study. The chapters begin with statements of pertinent definitions, principles and theorems together with illustrative examples. This is followed by sets of examples matching the theory presented and amplifying the presented theoretical concepts. The illustrative examples give students an opportunity to have a wider expose and to develop problem –solving skills. At the end of each chapter students requires performing a test (quiz). | | |
| **11. Course objective**  After successfully studying this course, students will:   1. Be able to systematically obtain the equations that characterise the performance of an electric measurements as well as designing the measurement instruments and how to use the measurement units over the standards. 2. Acknowledge the principles of operation and the main features of electric measured instruments and their applications. 3. Acquire skills in using electrical measuring devices. 4. Be aware of electrical hazards and able to implement basic actions to avoid unsafe work conditions. | | |
| **12. Student's obligation**  The student has the right and obligation to participate in the work forms of the degree programme courses in such a manner that the course objectives are attained.  Students have the right to know the competence objectives, contents, teaching methods, assessment criteria, and duration of each course.  Course-specific learning objectives and key contents are described in the degree programme curricula. The online implementation plan describes the work forms, requirements, completion order, schedule, and assessment criteria of each course. | | |
| **13. Forms of teaching**  In majority of universities all over the world, lecture is the core component of a course, supported by classes. I use the traditional way of lecturing with active lecturer standing in front of the students, delivering information relevant to the lecture content, using whiteboard with dynamic participation of students in which students cultivate new ways of thinking and doing through active discovery and discussion then, an immediate attention to the conduct of teaching has to be given, such that both students’ and teachers’ expectations are met. | | |
| **14. Assessment scheme**  Since the academic year consist of two terms students are required to perform one closed book examination at the end of the each term, plus marks obtained after each chapter, so the annual marks will be as follows:  - First term examination 15%  - Second term examination 15%  - Homework and quiz tests 10%  - Annual average marks 40%  - Final examination 60%  ‌ | | |
| **15. Student learning outcome:**  Graduates of the program are expected to demonstrate:  a) An ability to apply knowledge of mathematics, science, and engineering.  b) An ability to design and conduct experiments, as well as to analyze and interpret data.  c) An ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, manufacturability, and sustainability.  d) An ability to identify, formulate, and solve engineering problems.  e) The broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.  f) An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.  g) knowledge of mathematics through differential and integral calculus, basic sciences, computer science, and engineering sciences necessary to analyze and design complex electrical and electronic devices and software as appropriate to Electrical and Computer Engineering. | | |
| **16. Course Reading List and References‌:**   1. Electronic Measurements and Instrumentation by Bakshi 2. Electrical Measurements and Measuring Instruments by Bakjshi 3. Principle of Electrical Measurement by S. Tumanski | | |
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| **17. The topics**  EE202 Electrical Measurements-II (4 units)  Lectures: 2 hours/week, 30 weeks  Tutorials: 2 hours/week, 30 weeks   * Principles of measurements and instrumentation: Objective of measurements and philosophy of measurements, analog vs digital measurements, accuracy, precision and uncertainty, sources of measurement error. Standard cell and standard resistance. Basic characteristics of measuring instruments with a moving element. Methods of measurement, measurement systems, classification of instrument system. Characteristics of instruments and measurement system. Errors in measurement and its analysis, standard. * Instruments: analog measurement of electrical quantities – electro dynamic, thermocouple, electronic and rectifier type ammeters and voltmeters. Electro dynamic wattmeter and rectifier power measurement. Three phase wattmeter. Power in three phase system, errors remedies in wattmeter. Frequency meters, electrical resonance and Weston type of synchroscope. * Measurement of parameters: measurement of inductance , capacitance and resistance using bridge . Megger, wagners earthing device . Q meter * Magnetic measurements: Ballistic galvanometer, calibration by Hibbert’s magnetic standard , flux meter, Lloyed fisher square for measuring iron loss. Testing of ring and bar specimens. Determination of B-H curve and hysteresis loop using CRO, determination of leakage factor. * Digital measurement of electrical quantities concept of digital measurement, block diagram study of digital voltmeters, frequency meter , power meter , analyzer and harmonics analyzer. * Display methods, recorders: display methods and devices – different types of recorders – galvanometric recorders – pen driving system – magnetic recorders – digital recorders, digital storage oscilloscope (block diagram, theory and application ) * The sensors, types and roles in electrical measurements quantity * Transducers: definition – different type of transducers – criteria for selection – general characteristic - applications | |  |
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| **18. Examinations:**  Since the academic year consist of two terms, students are required to perform one closed book examination at the end of the each term, plus marks obtained after each chapter, so the annual marks will be as follows:  - First term examination 15%  - Second term examination 15%  - Homework and quiz tests 10%  - Annual average marks 40%  - Final examination 60% | | |
| **19. The Course Program:**  Week 1. The chapter starts with the brief history of the subject and smoothly covers its development touch some basic terms and definitions related to electrical engineering and measurements theory since Electrical Instrumentation is the core and fundamental subject of electrical Engineering  Week2. Introduction , Evolution of Instruments I  Mechanical  Electrical  Electronic Instruments  Advantages of Electronic Measurement, Performance Characteristics, calibration  Week3.  Definitions (Accuracy, precision, sensitivity, resolution, error)  Source of error:   * 1. Instrumental error   2. Environmental error   3. Observational error   Week4.  Example 1/ how to determine the true value and range of error  Example 2/ calculating apparent value, actual value, relative error  Example 3/ error comparison between different design connections, and different scale selection for Ex2  Week5.  Statistical Analysis: Arithmatic mean, deviation from the mean, Average deviation, standard deviation,  With Examples /  Week6.  Probability of errors , Introductions, Example,  Histogram of error probable , Example  Units: introduction ..  Week7.   * Units categories   1. Fundamental Units   2. Supplementary Units   3. Derived Units   Conversion of Units, Introductions , Examples  Week8.  Standards: introduction,   * Type of standards   1. International standards   2. Primary standards   3. Secondary standards   4. Working standards   IEEE Standards  Week9.  Analog and digital instruments, analog and digital converter, transducers, Electromechanical Instruments vs Digital measuring Instruments,  Week 10.  Active and passive instruments,  measuring instruments   1. Absolute instruments 2. Secondary instruments   Week11.  Indication instruments  Torques : deflecting torques, controlling torques (controlling by spring, controlling by gravity)  Week12.  Classification of measurement instruments, Example 1, Example 2, Example 3  Damping Toque (Air friction , Fluid friction, Eddy current)  Week 13.  Recording instruments, integrating instruments  Ammeter and Voltmeters  Week 14  Permanent magnet moving coil instruments, PMMC construction, error in PMMC, advantage and disadvantage of PMMC,  Week 15  Moving iron instruments-attraction type MI, repulsion type MI, theory of operation of moving iron  Modelling iron instruments  Week 16  Moving Iron Example1/ Example2/ Example 3  Suspension galvanometer – introduction , torque and deflection of galvanometer,  Week 17  Study state deflection of the suspension galvanometer, dynamic behaviour , working of the suspension galvanometer  Example 1/ Example 2  Week 18  Ballistic galvanometer , comparison between ballistic galvanometer and normal galvanometer  Week19  Magnet and magnetism, definitions, classification of the magnetic materials, (Ferromagnetic , paramagnetic , diamagnetic materials) , classification of the magnetic measurement , EMF, MMF  Week20  Magnetic tests – DC tests (measuring of flux/flux density using ring specimen , measuring of flux/flux density using bar specimen)  Week21  Magnetic tests – DC tests (Measurement of value of magnetizing force (H) using ring specimen and bar specimen )  Determining of BH curve - introduction  Week22.  Determination of BH curve using method of reversal  Determination of BH curve using method of step-by-step  Determine of the Hysteresis loop introduction  Week23.  Determine of the Hysteresis loop using method of reversal  Determine of the Hysteresis loop using step-by-step method  Determination of leakage factor in Dynamo-electric machinery  Week24.  AC tests – introduction  AC test   * 1. Wattmeter method..   2. AC bridge methods   3. AC potentiometer method   4. Oscillographic method   Week 25  Hibbert’s magnetic standard  DC ammeter (shunt resistors) - Example  DC voltmeter (multiplier resistor) – example  Typical multimeter circuits, - Example  Week 26  Shut type ohmmeter ,  multimeter or VOM  AC indication instruments  Rectifier type instruments  Week 27  thermo couple instruments, electro dynamometers- electrodynamometer in power measurements (single phase wattmeter , three phase wattmeter )  Instrument transformers  Week 28  Oscilloscopes,  Working of the cathode ray tube / Example  Electronic multimeter  Week 29  Digital voltmeter , Ramp type DVM, integrating type DVM, continuous balance DVM, staircase –Ramp DVM  Successive approximation DVM  Week 30  The sensors, types and roles in electrical measurements quantity  Transducers: definition – different type of transducers – criteria for selection – general characteristic - applications | | |
| **20. Peer reviewپێداچوونه‌وه‌ی هاوه‌ڵ**  This course book has to be reviewed and signed by a peer. The peer approves the contents of your course book by writing few sentences in this section.  *(A peer is person who has enough knowledge about the subject you are teaching, he/she has to be a professor, assistant professor, a lecturer or an expert in the field of your subject).*  ئه‌م کۆرسبووکه‌ ده‌بێت له‌لایه‌ن هاوه‌ڵێکی ئه‌کادیمیه‌وه‌ سه‌یر بکرێت و ناوه‌ڕۆکی بابه‌ته‌کانی کۆرسه‌که‌ په‌سه‌ند بکات و جه‌ند ووشه‌یه‌ک بنووسێت له‌سه‌ر شیاوی ناوه‌ڕۆکی کۆرسه‌که و واژووی له‌سه‌ر بکات.  هاوه‌ڵ ئه‌و که‌سه‌یه‌ که‌ زانیاری هه‌بێت له‌سه‌ر کۆرسه‌که‌ و ده‌بیت پله‌ی زانستی له‌ مامۆستا که‌متر نه‌بێت.‌‌ | | |