Department of Physics

College of Science

University of Salahaddin

Subject: Electrical Measurements and measuring Instruments(I)

Course Book – (2nd Class)

Lecturer's name: Khidir Hamedamin Husain

Academic Year: 2023/2024

Course Book

1. Course name	**Electrical Measurements and measuring Instruments**
2. Lecturer in charge	**Khidir Hamedamin Husain**
3. Department/ College	**Physics / Science**
4. Contact	**e-mail: khdr.husen@su.edu.krd**
4. Time (in hours) per week	**Theory: 3** **Practical: 2**
6. Office hours	**4**
6. Course code	**SPh201**
7. Teacher's academic profile	My Academic studies starts with the acceptance in the B.Sc. program in 2006 as an undergraduate student in Physics department and extended as I finished the following education degrees **Education:** B.Sc, 2008 — Physics- College of Science M.Sc.2013 — Radiation Science **Academic titles attained:** Academic title: Assistant Lecturer — Date of attainment: 2/3/2014 I starts my Academic role as a staff member giving lectures in my specialization through theoretical and practical modules to the students in undergraduate stages, **Main Teaching Areas:** * Radiation Dosimetry * Electrical Measurements * Nuclear Physics Lab. * Laser Lab. * Electrical Measurements Lab.
8. Keywords	**Electrical Measurements, System of Units, Errors, Oscilloscope, AC and DC Circuits, PMMC, Diodes.**

10. Course overview:

The course will start with a brief description of Units and Systems , Errors And Measurements , Measuring Instruments (Oscilloscope , Ammeters , Voltmeters , Ohmmeters , Wattmeter's . Their Constructions and Physical Principles Of Working . Instruments Scale Calibrations , Bridges , AC

Circuits , Transient behaviour Of DC Circuits , Circuit Theories (Kirchhoff's laws , Thevenin , Norton, Super Position, Millman, Node) and circuit Analysis . Semiconductors (P – N) Semiconductor Junctions (Diodes) Laws , Types of Diodes , Circuit Applications.

11. Course objective:

the course subject of the electrical measurements and instrumentation has topics providing theoretical principles for electrical measurements circuits .

Errors in measured current , voltages , power , resistance, self – inductance and capacitance.

Errors of circuits , errors of instruments ,and their scale calibration , DC , AC , bridge circuits for measuring difference circuit elements . Circuit theories for simplifying complex electric to simple equivalent one , with the aims of reducing errors of the measured circuit quantities .

Instrument types and their basic theories , instrument converting , scale extension . theories of semiconductor (p – n)junctions (diodes), construction ; characteristics and its practical circuit applications . Electrical instrumentation is a useful and important empirical subject has many wide application in electrical engineering and electronic applications it is marketable force subject .

12. Student's obligation

The class attendance on time is the first obligation of the student. During the semester one or two compulsory written exams will be done beside three or more pop quizzes inside the lectures. As well solving exercises and given problems is the student duties.

13. Forms of teaching

All the lecture outlines are prepared and will be a subject of open discussion inside the lectures. In the beginning of each lecture a brief summary of the previous lecture will be remembered and the headlines of the forward lecture is identified and determined. The materials given in the lecture is always accompanied by the illustrations and detail derivations with the aid of white board and available animations; beside this for every physical phenomenon there will be scientific and live discussion which assists the student to understand the subjects. The lectures will be given mainly in the English language. Throughout the lectures as well as at the end of each chapter there will be

home work problems given to the students as a review and assessments.

14. Assessment scheme

The qualified assessment of the student level in general was based on the written examinations in class room . Maximum passing level is 100 marks, and minimum of 40 marks . 40 marks 0n first and second seasons examines and 60 marks on the final examine ,their sum is the final marks. Some cases 10 marks for quizzes.

15. Student learning outcome:

The students who has succeed with good level of marks must have attained more about the course book. Then he will be marketable worker either in electrical engineering or electronic circuits and instrumentations. circuit theories of diode and their applications will make him able to work as a good technician in electronics, Electrical engineering, connecting electricity circuits, and secondary school teacher of physics.

16. Course Reading List and References:

1- ***Electrical measurements and measuring instruments . By A.K. Sawheny 2006 .***

2- ***E.W. Golding and E.C. Widdis . Electrical measurements . 1862 .***

3- ***J .B . Gupta . Electrical measurements and measuring instruments .1866 .***

4- ***Analysis of Electrical circuits and networks By : Jaydeep Chakravorty . 2008 .***

5- ***Electrical engineering By : Nitin Saxena . 2008 .***

6- ***Electrical measurements and instrumentation By : A.U. Bakshi ,A.V. Bakshi 2014***

7- ***Electronic devices and circuit theory . By Robert L. Boylastad 11th ed. 2011.***

8- ***Electronic Instrumentation and Measurements. By David A.Bell 2nd Edition 2004***

17. The Topics:	**Lecturer's name**
1. Units 1.1 Fundamental and derived units 1.2 system of units 1.3 International system of units	ex: (6 hrs) ex: 14/10/2014 weeks (1 + 2)
1.4 Measurements and errors 1.4.1 Error types 1.4.2 Accuracy and precision	ex: (6 hrs) weeks (3 + 4)

2. Cathode Ray Oscilloscope 2.1 Construction 2.1.1 Electron beam source 2.1.2 acceleration part 2.1.3 deflection part 2.1.4 fluorescence screen	ex: (6 hrs) weeks (5 + 6)
2.2 Derivation the law of (CRT) sensitivity and scale deflection factor 2.3 usage of the oscilloscope 2.3.1 A.C, D.C, voltage measurements 2.3.2 frequency measurements 2.3.3 phase angle measurement 2.3.4 wave combinations (lissajous figures) .	ex: (6 hrs) weeks (7+ 8)
3. Electromechanical Instruments 3.1 PMMC is permanent magnet moving coil 3.1.1 PMMC as D.C Voltmeters 3.1.2 PMMC as D.C Ammeters 3.1.3 PMMC as Watt meters 3.1.4 PMMC as Ohmmeters	Ali Hassan Ahmed ex: (6 hrs) weeks (9 + 10)
3.2 Dynamometer type moving coil instrument with pointer 3.2.1 As D.C , A.C ammeters ,voltmeters and watt- meters 3.2.2 Derivation of their working laws	ex: (3 hrs) weeks (11)
4. Semiconductor devices 4.1 Theories of Semiconductor (P – N) junction 4.2 Diode formation 4.3 Energy band diagram 4.4 derivation of junction potential barrier and junction (I – V) equations 4.6 Studies of the P –N junction (diode) (I – V) characteristics curves 4.6. Diode circuit applications 4.6.1 Rectifiers circuits 4.6.2 Clipping circuits 4.6.3 Clamping circuits 4.6.4 Voltage doubling circuits	ex: (6 hrs) weeks (12 + 14)
14. Examinations: ***Q1.*** An 720 Ω resistor with an accuracy of $\pm 10\%$ carries a current of 10 mA. The current was measured by an analog ammeter on a 24 mA range with an accuracy of $\pm 2\%$ of full scale. Determine the accuracy in the Power in the resistor. (10marks)	

$$P = I^2R$$
$$P = (10\text{ mA})^2 \times 820\ \Omega$$
$$= 82\text{ mW}$$

$$error\ in\ R = \pm 10\%$$

$$error\ in\ I = \pm 2\%\text{ of }25\text{ mA}$$
$$= \pm 0.5\text{ mA}$$
$$= \frac{\pm 0.5\text{ mA}}{10\text{ mA}} \times 100\%$$
$$= \pm 5\%$$

$$\%\ error\ in\ I^2 = 2(\pm 5\%)$$
$$= \pm 10\%$$

$$\%\ error\ in\ P = (\%\text{ error in } I^2) + (\%\text{ error in } R)$$
$$= \pm(10\% + 10\%)$$
$$= \pm 20\%$$

Q2. Design a multirange ammeter by using direct method to give the following ranges 10mA, 100mA, 1A, 10A, and 100A. If d'Arsonval meter have internal resistance of 10Ω and full scale current of 1mA. (10marks)

Sol:

Rm=10Ω Im=1mA

$$Rsh_{*} = \frac{\mathrm{Im}\,Rm}{Ir_{*} - \mathrm{Im}}$$

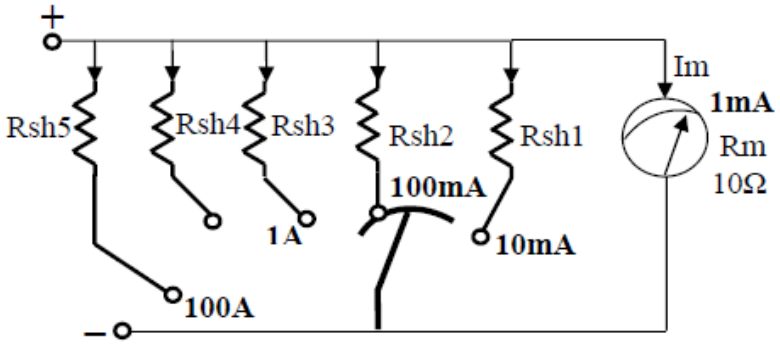
$$Rsh1 = \frac{1\times10^{-3}\cdot10}{(10-1)\times10^{-3}} = 1.11\Omega$$

$$Rsh2 = \frac{1\times10^{-3}\cdot10}{(100-10)\times10^{-3}} = 0.101\Omega$$

$$Rsh3 = \frac{1\times10^{-3}\cdot10}{1-10\times10^{-3}} = 0.0101\Omega$$

$$Rsh4 = \frac{1\times10^{-3}\cdot10}{10-1\times10^{-3}} = 0.0011\Omega$$

$$Rsh5 = \frac{1\times10^{-3}\cdot10}{100-1\times10^{-3}} = 0.00011\Omega$$



Q3. An electrically deflected CRT has a final anode voltage of 2000 V and parallel deflecting plates 1.4 cm long and 4 mm apart. If the screen is 40 cm from the centre of deflecting plates, find :
(10 marks)

(a) beam speed,
(b) the deflection sensitivity of the tube
(c) the deflection factor of the tube.

Solution Velocity of the beam

$$v_{ox} = \sqrt{2eE_a/m} = \sqrt{\frac{2\times 1.6\times 10^{-19}\times 2000}{9.1\times 10^{-31}}} = 26.5\times 10^6 \text{ m/s}$$

Deflection sensitivity,

$$S = \frac{Ll_d}{2dE_a} = \frac{0.5\times 1.5\times 10^{-2}}{2\times 5\times 10^{-3}\times 2000} = 0.375 \text{ mm/V}$$

$$\text{Deflection factor, } G = \frac{1}{S} = \frac{1}{0.375} = 2.66 \text{ V/mm}$$

Q4. The impedance of the basic a.c bridge are given as follows:
Z1= 100 ∠70° (inductive impedance) Z2 = 240Ω Z3 = 400 ∠ 30° (inductive impedance Z4 = unknown
(10 marks)

Sol:

$\boxed{Z_4 = \frac{Z_2 Z_3}{Z_1}}$ $Z_4 = \frac{250\times 400}{100} = 1k\Omega$ $\boxed{\theta_4 = \theta_2 + \theta_3 - \theta_1}$ $\theta_4 = 0 + 30 - 80 = -50^\circ$

$Z_4 = 1000\angle -50^\circ$ (capacitive impedance)

Example (2):

For the following bridge find Zx?

The balance equation $Z_1 Z_4 = Z_2 Z_3$

$Z_1 = R = 450\Omega$

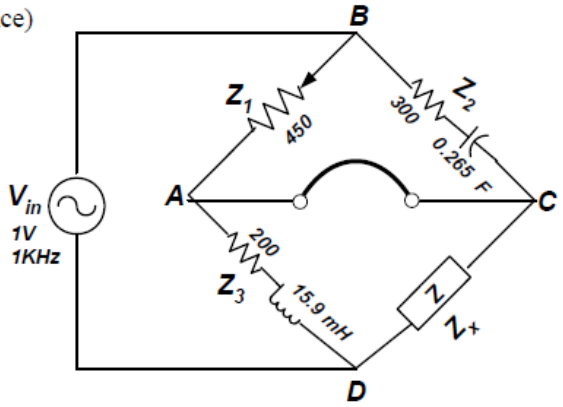
$Z_2 = R + \frac{1}{j\omega C} = R - \frac{j}{\omega C}$

$Z_2 = 300 - j600$

$Z_3 = R + j\omega L$

$Z_3 = 200 + j100$

$Z_4 = Z_x = unknown$



$Z_4 = \frac{Z_2 Z_3}{Z_1}$ $Z_4 = \frac{(300 - j600)(200 + j100)}{450} = 266.6 - j200$

$R = 266.6\Omega$ $C = \frac{1}{2\pi F \times 200} = 0.79\mu F$

18. Extra notes: Here the lecturer shall write any note or comment that is not covered in this template and he/she wishes to enrich the course book with his/her valuable remarks.	Lecturer's name ex: (3-4 hrs) ex: 14/10/2014
19. Peer review **پێداچوونەوەی هاوەڵ** 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).* ئەم کۆرسبووکە دەبێت لەلایەن هاوەڵێکی ئەکادیمیەوە سەیر بکرێت و ناوەڕۆکی بابەتەکانی کۆرسەکە پەسەند بکات و جەند ووشەیەک بنووسێت لەسەر شیاوی ناوەڕۆکی کۆرسەکە و واژووی لەسەر بکات. هاوەڵ ئەو کەسەیە کە زانیاری هەبێت لەسەر کۆرسەکە و دەبیت پلەی زانستی لە مامۆستا کەمتر نەبێت.	