Sana'a University
Faculty of Engineering
Electrical Engineering Department
B.Sc. of Computer and Control Engineering

38. Course Specification of Electrical Measurements and Instrumentations

I. Course Identification and General Information:

1.	Course Title:	Electrical Measurements and Instrumentations				
2.	Course Code &Number:	PME223				
3.	Credit hours:	C.H				Total
		Th.	Tu.	Pr	Tr.	
		2	-	2	-	3
4.	Study level/ semester at which this course is offered:	Third level / 2nd Semester				
5.	Pre –requisite (if any):	Electrical Circuits, Electronics				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered:	All Electrical Engineering				
8.	Language of teaching the course:	English & Arabic				
9.	Location of teaching the course:	Faculty of Engineering, Sana'a University				
10.	Prepared By:	Asst. Prof. Dr. Al-Eriany Abdulkafi				
11.	Date of Approval	2020				

II. Course Description:

This course provides students with basic knowledge and understanding necessary for performing specific measurement tasks. The course exposes students with international system of units, main definitions and terms related to measurement and measuring instruments, different types of error that appear in results of measurement and how they are expressed in results of measurement. This course gives students a good knowledge of several types of measuring instruments and some important types of sensors or detectors that are used to find non-electrical quantities. Finally, the course equipps students with sufficient knowledge and

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ability to choose suitable measuring instrument and suitable method of measurement including simulation software and tools.

III. Course Intended learning outcomes (CILOs) of the course		**Referenced PILOs**
a1	Demonstrate performing specific measurement tasks related to electrical and electronic circuits and systems.	A1
a2	Apply knowledge of mathematics and basic sciences in metrology of measurements to provide results with an acceptable degree of accuracy.	A2
b1	Select the suitable methods of measurement and suitable types of instruments for measuring different electrical and non-electrical quantities.	B1
b2	Analyze the modern methods and tools of measurement in the field of industry.	B3
c1	Conduct laboratory experiments safely to verify theoretical concepts related to electrical and electronics components and devices.	C3
c2	Employ the international standards and technical specifications and software tools to measurement and measuring instruments.	C2
d1	Assess personal commitment to electronics engineering tasks and effectively manage time and resources.	D3
d2	Function effectively in different working environments as an individual, and as a member of team.	D1

(A) Alignment Course Intended Learning Outcomes of Knowledge and Understanding to Teaching Strategies and Assessment Strategies:		
Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
a1- Provide students with basic knowledge necessary for performing specific measurement	- Lectures - Seminar	- Quizzes - Testes - Written Exams

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	tasks related to electrical and electronic circuits and systems.	- Laboratory & Reports - Interactive class discussion	- Homework - Project with Simulation
a2- and	Understand the basic knowledge understanding of choosing suitable methods of measurement and suitable types of instruments for measuring different electrical and non-electrical quantities.	- Lectures - Seminar - Laboratory & Reports - Interactive class discussion	- Quizzes - Testes - Written Exams - Homework - Project with Simulation

(B) Alignment Course Intended Learning Outcomes of Intellectual Skills to Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
b1- Apply knowledge of mathematics and basic sciences in metrology of measurements to provide results with an acceptable degree of accuracy.	- Lectures - Seminar - Laboratory & Reports - Interactive class discussion	- Quizzes - Testes - Written Exams - Homework - Project with Simulation
b2- Apply the modern methods and tools of measurement in the field of industry.	- Lectures - Seminar - Laboratory & Reports - Interactive class discussion	- Quizzes - Testes - Written Exams - Homework - Project with Simulation

©Alignment Course Intended Learning Outcomes of Professional and Practical Skills to Teaching Strategies and Assessment Strategies:

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Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
c1- Conduct laboratory experiments safely to verify theoretical concepts related to electrical and electronics components and devices.	- Lectures - Seminar - Laboratory & Reports - Interactive class discussion	- Quizzes - Testes - Written Exams - Homework - Project with Simulation
c2- Employ the international standards and technical specifications and software tools to measurement and measuring instruments.	- Lectures - Seminar - Laboratory & Reports - Interactive class discussion	- Quizzes - Testes - Written Exams - Homework - Project with Simulation

(D) Alignment Course Intended Learning Outcomes of Transferable Skillsto Teaching Strategies and Assessment Strategies:

Course Intended Learning Outcomes	Teaching strategies	Assessment Strategies
d1- Assess personal commitment to and effectively manage time and resources.	- Lectures - Laboratory & Reports - Seminar - Interactive class discussion	- Quizzes - Testes - Written Exams - Homework - Project with Simulation
d2- Function effectively in different working environments as an individual, and as a member of team**.**	- Lectures - Laboratory & Reports. - Seminar. - Interactive class discussion.	- Quizzes - Testes - Written Exams - Homework - Project with Simulation

IV. Course Content:

A – Theoretical Aspect:

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Order	Units/Topics List	Learning Outcomes	Sub Topics List	Number of Weeks	Contact hours
1.	International system of units and Basic terms	a1, a2, b1, b2, c1, c2, d1, d2	▪ Metric system of units. ▪ Accuracy, precision, sensitivity and resolution of measurement.	1	2
2.	Errors of measurements	a1, a2, b1, b2, c1, c2, d1, d2	▪ Systematic errors. ▪ Random errors. ▪ Gross errors	1	2
3.	Methods of measurements	a1, a2, b1, b2, c1, c2, d1, d2	▪ Direct methods of measurements. ▪ Indirect methods of measurements. ▪ Comparison methods of measurements	1	2
4.	Errors of measuring instruments	a1, a2, b1, b2, c1, c2, d1, d2	▪ Analog measuring instruments – Accuracy Class (A.C.). ▪ Digital measuring instrument errors.	1	2
5.	Analog measuring instrument, (PMMC) meters	a1, a2, b1, b2, c1, c2, d1, d2	▪ PMMC meters, - construction, principle of operation. ▪ Deflection, restoring and damping torques.	1	2
6.	PMMC - Ammeters	a1, a2, b1, b2, c1, c2, d1, d2	▪ Basic Single- Range ammeter. ▪ Multi-Range ammeter.	1	2
7.	PMMC - Voltmeter	a1, a2, b1, b2, c1, c2, d1, d2	▪ Basic Single- Range voltmeter. ▪ Multi-range voltmeter. ▪ Loading effect of voltmeter.	1	2

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8.	Electro-dynamic wattmeter	a1, a2, b1, b2, c1, c2, d1, d2	▪ Electro-dynamic and ferro-dynamic materials. ▪ Basic wattmeter circuit. ▪ Active power and power factor.	1	2
9.	DC balanced bridges and AC balanced bridges	a1, a2, b1, b2, c1, c2, d1, d2	▪ DC Balanced Resistive Wheatstone Bridge. ▪ Schering Balanced (ac) Bridge. ▪ Maxwell-Wien (ac) Balanced Bridge.	1	2
10.	Transducers and measurement of non-electrical quantities	a1, a2, b1, b2, c1, c2, d1, d2	▪ Classification and physical Effects. ▪ Dynamic parameters and their correction.	1	2
11.	Resistance Changing transducer	a1, a2, b1, b2, c1, c2, d1, d2	▪ Potentiometers. ▪ Resistive Transducer Detectors (RTDs).	1	2
12.	Thermistors	a1, a2, b1, b2, c1, c2, d1, d2	▪ Measuring Circuits with Thermistors. ▪ Strain Gauges. ▪ Temperature Effects.	1	2
13.	Capacitive Transducers and Inductive Transducers	a1, a2, b1, b2, c1, c2, d1, d2	▪ Capacitive Transducers. ▪ Inductive Transducers. ▪ Thermocouple Transducers	1	2
14.	Digital Optical Transducers	a1, a2, b1, b2, c1, c2, d1, d2	▪ Incremental Sensors. ▪ Digital Encoders.	1	2
Number of Weeks /and Units Per Semester				**14**	**28**

B - Practical Aspect:

Order	Tasks/ Experiments	Number of Weeks	Contact hours	Learning Outcomes

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1.	An Experiment to be familiarize with Measuring Instruments and Tools and How to present a report.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
2.	Errors of Measurements and Systematic & random errors.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
3.	Single-Range & Multi-Range Ammeter.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
4.	Single-Range & Multi-Range Voltmeter and Loading Effect of Voltmeter.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
5.	Electro-dynamic Wattmeter and Active Power.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
6.	DC resistive Balanced Wheatstone Bridge.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
7.	Schering AC Capacitive Wheatstone Bridge and Maxwell-Wien Inductive Balanced Bridge.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
8.	Resistive Transducers and Potentiometers.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
9.	Thermocouple Transducers.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
10.	Capacitive Transducers.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
11.	Inductive Transducers.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
12.	Optical Transducers.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
13.	Simulated Test.	1	2	a1, a2, b1, b2, c1, c2, d1, d2
14.	Review	1	2	a1, a2, b1, b2, c1, c2

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Number of Weeks /and Units Per Semester	**14**	**28**	

V. Teaching strategies of the course:

- Active Lectures
- Discussions.
- Laboratory hands-on work.
- Seminar
- Projects and Report Presentations.

VI. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Errors of Measurements. Methods of measurements.	a1, a2, b1, b2, c1, c2, d1, d2	1st &2ed	3
2.	Analog Measuring Instrument. Digital Measuring Instruments.	a1, a2, b1, b2, c1, c2, d1, d2	3ed & 6th	3
3.	Balanced DC & AC Bridges.	a1, a2, b1, b2, c1, c2, d1, d2	7th & 9th	3
4.	Resistive Transducers.	a1, a2, b1, b2, c1, c2, d1, d2	10thto11th	3
5.	Capacitive & Inductive Transducers.	a1, a2, b1, b2, c1, c2, d1, d2	12th to 14th	3
	Total			**15**

VII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment	Aligned Course Learning Outcomes
1.	Assignments& Homework	2nd to 15th	15	10%	a1, a2, b1, b2, c1, c2, d1, d2

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2.	Lab work and experiments reports	4th to 13th	15	10%	a1, a2, b1, b2, c1, c2, d1, d2
3.	Midterm Exam	7th	30	20%	a1, a2, b1, b2, c1, c2, d1
4.	Final Exam (Practical)	15th	15	10%	a1, a2, b1, b2, c1, c2, d1
5.	Final Exam	16th	75	50%	a1, a2, b1, b2, c1, c2, d1
	Sum		**150**	**100%**	

VIII. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. HS Kalsi Electronic Instrument Mc Graw Hill 2nd Edition.
2. Curtis D. Johnson, Process Control Technology, Pearson international Edition 8th Edition
3. U. A. Bakshi, A. V. Bakshi, Measurement & Instrumentation, technical Publication.

2- Essential References.

1. Electrical Measurement and Instrumentation, M. Sedlacek. Vladimir Haasz, Czech Technical University of Prague, Czech Republic, 1996.-

3- Electronic Materials and Web Sites *etc*.

1. Faculty Electronic Library.

IX. Course Policies:

1. **Class Attendance:**

- The students should have more than 75% of attendance according to rules and regulations of the faculty.

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2.	**Tardy:** - The students should respect the timing of attending the lectures. They should attend within 15 minutes from starting of the lecture.
3.	**Exam Attendance/Punctuality:** - The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final exam.
4.	**Assignments & Projects:** - The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.
5.	**Cheating:** - If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquiries.
6.	**Plagiarism:** - If one student attends the exam on another behalf; he will be dismissed from the faculty according to the policy, rules and regulations of the university.
7.	**Other policies:** - All the teaching materials should be kept out the examination hall and mobile phones are not allowed. - Mutual respect should be maintained between the student and his teacher and also among students. Failing in keeping this respect is subject to the policy, rules and regulations of the university.

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Reviewed By	**Vice Dean for Academic Affairs and Post Graduate Studies: Asst. Prof. Dr. Tarek A. Barakat** **President of Quality Assurance Unit: Assoc. Prof. Dr. Mohammed Algorafi** **Name of Reviewer from the Department: Asst. Prof. Dr.Mohammed Al-Suraby**
	Deputy Rector for Academic Affairs Asst. Prof. Dr. Ibrahim AlMutaa **Assoc. Prof. Dr. Ahmed Mujahed** **Asst. Prof. Dr. Munasar Alsubri**

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38. Template for Course Plan of Electrical Measurements & Instrumentation

I. Information about Faculty Member Responsible for the Course:							
Name of Faculty Member	Dr. Al-Eriany Abdulkafi	**Office Hours**					
Location & Telephone No.	771623637	**SAT**	**SUN**	**MON**	**TUE**	**WED**	**THU**
E-mail	akafi_abdul@yahoo.com						

II. Course Identification and General Information:						
1.	Course Title:	Electrical Measurements and Instrumentations				
2.	Course Number & Code:	PME223				
3.	Credit hours:	C.H				Total
		Th.	Tu.	Pr.	Tr.	
		2	-	2	-	3
4.	Study level/year at which this course is offered:	Third Level / First Semester				
5.	Pre –requisite (if any):	Electrical Circuits, Electronics				
6.	Co –requisite (if any):	None.				
7.	Program (s) in which the course is offered	Electrical Eng. Dept				
8.	Language of teaching the course:	English & Arabic				
9.	System of Study:	Regular study				
10.	Mode of delivery:	Lectures				
11.	Location of teaching the course:	Faculty of Engineering, Sana'a University				

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III. Course Description:

This course provides students with basic knowledge and understanding necessary for performing specific measurement tasks. The course exposes students with international system of units, main definitions and terms related to measurement and measuring instruments, different types of error that appear in results of measurement and how they are expressed in results of measurement. This course gives students a good knowledge to several types of measuring instruments and some important types of sensors or detectors that are used to find non-electrical quantities. Finally, the course equipps students with sufficient knowledge and ability to choose suitable measuring instrument and suitable method of measurement including simulation software and tools.

IV. Intended learning outcomes (ILOs) of the course:

- Brief summary of the knowledge or skill the course is intended to develop**:**

1. Demonstrate performing specific measurement tasks related to electrical and electronic circuits and systems.
2. Apply knowledge of mathematics and basic sciences in metrology of measurements to provide results with an acceptable degree of accuracy.
3. Select the suitable methods of measurement and suitable types of instruments for measuring different electrical and non-electrical quantities.
4. Analyze the modern methods and tools of measurement in the field of industry.
5. Conduct laboratory experiments safely to verify theoretical concepts related to electrical and electronics components and devices.
6. Employ the international standards and technical specifications and software tools to measurement and measuring instruments .
7. Assess personal commitment to electronics engineering tasks and effectively manage time and resources.
8. Function effectively in different working environments as an individual, and as a member of team.

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V. Course Content:

A – Theoretical Aspect:

Order	Units/Topics List	Sub Topics List	Number of Weeks	Contact hours
1.	International system of units and Basic terms	▪ Metric system of units. ▪ Accuracy, precision, sensitivity and resolution of measurement.	1st	2
2.	Errors of measurements	▪ Systematic errors. ▪ Random errors. ▪ Gross errors	2nd	2
3.	Methods of measurements	▪ Direct methods of measurements. ▪ Indirect methods of measurements. ▪ Comparison methods of measurements	3rd	2
4.	Errors of measuring instruments	▪ Analog measuring instruments – Accuracy Class (A.C.). ▪ Digital measuring instrument errors.	4th	2
5.	Analog measuring instrument, (PMMC) meters	▪ PMMC meters, - construction, principle of operation. ▪ Deflection, restoring and damping torques.	5th	2
6.	PMMC - Ammeters	▪ Basic Single- Range ammeter. ▪ Multi-Range ammeter.	6th	2
7.	Midterm Exam	▪ Previous topics	7th	2
8.	PMMC - Voltmeter	▪ Basic Single- Range voltmeter. ▪ Multi-range voltmeter. ▪ Loading effect of voltmeter.	8th	2

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9.	Electro-dynamic wattmeter	▪ Electro-dynamic and ferro-dynamic materials. ▪ Basic wattmeter circuit. ▪ Active power and power factor.	9th	2
10.	DC balanced bridges and AC balanced bridges	▪ DC Balanced Resistive Wheatstone Bridge. ▪ Schering Balanced (ac) Bridge. ▪ Maxwell-Wien (ac) Balanced Bridge.	10th	2
11.	Transducers and measurement of non-electrical quantities	▪ Classification and physical Effects. ▪ Dynamic parameters and their correction.	11th	2
12.	Resistance Changing transducer	▪ Potentiometers. ▪ Resistive Transducer Detectors (RTDs).	12th	2
13.	Thermistors	▪ Measuring Circuits with Thermistors. ▪ Strain Gauges. ▪ Temperature Effects.	13th	2
14.	Capacitive Transducers and Inductive Transducers	▪ Capacitive Transducers. ▪ Inductive Transducers. ▪ Thermocouple Transducers	14th	2
15.	Digital Optical Transducers	▪ Incremental Sensors. ▪ Digital Encoders.	15th	2
16.	Final Exam	▪ All topics	16th	2
Number of Weeks /and Units Per Semester			**16**	**32**

B - Practical Aspect:

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Order	Tasks/ Experiments	Number of Weeks	Contact hours
1.	An Experiment to be familiarize with Measuring Instruments and Tools and How to present a report.	1st	2
2.	Errors of Measurements and Systematic & random errors.	2nd	2
3.	Single-Range & Multi-Range Ammeter.	3rd	2
4.	Single-Range & Multi-Range Voltmeter and Loading Effect of Voltmeter.	4th	2
5.	Electro-dynamic Wattmeter and Active Power.	5th	2
6.	DC resistive Balanced Wheatstone Bridge.	6th	2
7.	Schering AC Capacitive Wheatstone Bridge and Maxwell-Wien Inductive Balanced Bridge.	7th	2
8.	Resistive Transducers and Potentiometers.	8th	2
9.	Thermocouple Transducers.	9th	2
10.	Capacitive Transducers.	10th	2
11.	Inductive Transducers.	11th	2
12.	Optical Transducers.	12th	2
13.	Simulated Test.	13th	2
14.	Review	14th	2
15.	Final Practical Exam	15th	2
Number of Weeks /and Units Per Semester		**15**	**30**

VI. Teaching strategies of the course:

- Active Lectures
- Discussions.
- Laboratory hands-on work.
- Seminar
- Projects and Report Presentations.

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VII. Assignments:

No	Assignments	Aligned CILOs(symbols)	Week Due	Mark
1.	Errors of Measurements. Methods of measurements.	a1, a2, b1, b2, c1, c2, d1, d2	1st &2ed	3
2.	Analog Measuring Instrument. Digital Measuring Instruments.	a1, a2, b1, b2, c1, c2, d1, d2	3ed & 6th	3
3.	Balanced DC & AC Bridges.	a1, a2, b1, b2, c1, c2, d1, d2	7th & 9th	3
4.	Resistive Transducers.	a1, a2, b1, b2, c1, c2, d1, d2	10thto11th	3
5.	Capacitive & Inductive Transducers.	a1, a2, b1, b2, c1, c2, d1, d2	12th to 14th	3
	Total			**15**

VIII. Schedule of Assessment Tasks for Students During the Semester:

No.	Assessment Method	Week Due	Mark	Proportion of Final Assessment
1.	Assignments& Homework	2nd to 15th	15	10%
2.	Lab work and experiments reports	4th to 13th	15	10%
3.	Midterm Exam	7th	30	20%
4.	Final Exam (Practical)	15th	15	10%
5.	Final Exam	16th	75	50%
	Sum		**150**	**100%**

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IX. Learning Resources:

- *Written in the following order: (Author - Year of publication – Title – Edition – Place of publication – Publisher).*

1- Required Textbook(s) (maximum two).

1. HS Kalsi Electronic Instrument Mc Graw Hill 2nd Edition.
2. Curtis D. Johnson, Process Control Technology, Pearson international Edition 8th Edition
3. U. A. Bakshi, A. V. Bakshi, Measurement & Instrumentation, technical Publication.

2- Essential References.

1. Electrical Measurement and Instrumentation, M. Sedlacek. Vladimir Haasz, Czech Technical University of Prague, Czech Republic, 1996.-

3- Electronic Materials and Web Sites *etc*.

1. Faculty Electronic Library.

X. Course Policies:

1.	**Class Attendance:** - The students should have more than 75% of attendance according to rules and regulations of the faculty.
2.	**Tardy:** - The students should respect the timing of attending the lectures. They should attend within 15 minutes from starting of the lecture.
3.	**Exam Attendance/Punctuality:** - The student should attend the exam on time. The punctuality should be implemented according to rules and regulations of the faculty for mid-term exam and final exam.
4.	**Assignments & Projects:** - The assignment is given to the students after each chapter; the student has to submit all the assignments for checking on time.

Prepared by	Head of Department	Quality Assurance Unit	Dean of the Faculty	Academic Development Center & Quality Assurance
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5.	**Cheating:** - If any cheating occurred during the examination, the student is not allowed to continue and he has to face the examination committee for enquiries.
6.	**Plagiarism:** - If one student attends the exam on another behalf; he will be dismissed from the faculty according to the policy, rules and regulations of the university.
7.	**Other policies:** - All the teaching materials should be kept out the examination hall and mobile phones are not allowed. - Mutual respect should be maintained between the student and his teacher and also among students. Failing in keeping this respect is subject to the policy, rules and regulations of the university.

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