長岡工業高等	専門学校	開講年度	令和04年度 (2	2022年度)	授	業科目	電気電	
———— 科目基礎情報				•				
科目番号	0045		科目区分		専門 / 必	修		
受業形態	講義			単位の種別と	単位数	履修単位	: 2	
 開設学科	電気電子シス	テム工学科		対象学年		3		
用設期 開設期	通年			週時間数	2			
教科書/教材	Electric Elec	trical Measuren	nent, written by	Takeo Abe and	d Minoru	Murayam	a	
旦当教員	内富 直隆,蔦	将哉						
到達目標								
educational achiever to understand the To understand the To understand vor To understand the To understand the To understand references to underst	ment objective ne operating pr oltage and curr ne basic princip s: 25% (C2)	es set by KOSEN inciples and metent measurement in the set of electric parts of electric parts.	N. easurable ranges ent problems and ower and electric	of basic indica d learn method c energy meas	ating instr ds to solv surements	ruments: e them: 2 s, as well	25% (C2 25% (C2 as strate	) egies to prevent
レーブリック								
	Ideal Le	evel	Standard Le	vel	Acceptab	le Level		Unacceptable Level
Achievement 1	detailed the ope and me of basic	the operating principles and measurable ranges		The student understands the operating principles and measurable ranges of basic indicating instruments.		The student vaguely understands the operating principles and measurable ranges of basic indicating instruments.		The student does not understand the operatir principles and measurable ranges of basic indicating instruments.
Achievement 2	detailed voltage measur and has	voltage and current measurement problems		voltage and current measurement problems		ent vagu nds volta neasuren s and is f hods to s	ngé and nent amiliar	The student does not understand voltage and current measurement problems and has not learned methods to solv them.
Achievement 3	detailed the bas electric electric measur as strat	The student has a detailed understanding of the basic principles of electric power and electric energy measurements, as well as strategies to prevent		he basic principles of electric power and electric energy neasurements, as well asstrategies to prevent peasurement errors		The student vaguely understands the basic principles of electric power and electric energy measurements, as well as strategies to prevent measurement errors.		The student does not understand the basic principles of electric power and electric energy measurements of strategies to prevent measurement errors.
The student has a detailed understanding of resistance and impedance measurement problems and has mastered methods to solve them.		resistance a impedance r problems an	resistance and impedance measurement problems and has learned methods to solve and		ent vagu nds resis edance ment pro learned r them.	tance blems	The student does not understand resistance of impedance measurement problems and has not learned methods to solv them.	
学科の到達目標項	ョール 三目との関係							

教育万法等	
概要	The extraordinary development of modern electrical and electronic engineering is built on a foundation of electrical and electronic measurement; there is barely any subfield of electrical and electronic engineering that is not related to measurement. This makes electrical and electronic measurement one of the most important basic subjects for students of electrical and electronic engineering. The objective of this course is not to simply list the many measuring instruments and methods currently available, but to understand the common principles of measuring instruments and the fundamentals of electrical and electronic measurement.  ORelated Courses: Mathematics, Fundamentals of Electrical and Electronic Engineering (1st year), Basic Electric Circuits (2nd year), and The Mathematics of Electricity (2nd year).
授業の進め方・方法	To measure students' level of understanding and improve academic skills, quizzes on class content will be conducted as necessary.
注意点	At its core, indicating instruments cause a mechanical meter to swing with an electrical quantity that cannot be sensed by humans. Accordingly, the knowledge of general physics (especially force and motion of objects and the action of electricity and electric current) is essential for this course. In addition, students are encouraged to review the contents of the second-year course "Basic Electric Circuits" before taking this course. This course was originally planned as an in-person class; however, due to the COVID-19 pandemic, it will be conducted remotely when necessary.

## 授業の属性・履修上の区分

□ アクティブラーニング	☑ ICT 利用	☑ 遠隔授業対応	□ 実務経験のある教員による授業

授業計画							
		週	授業内容	週ごとの到達目標			
		1週	Overview and Preparation for Electrical and Electronic Measurement	Learn the importance of electrical and electronic measurement.			
		2週	Position and Basic Concepts of Measurement	Understand the position and the basic concepts of measurement.			
前期 1stQ	1stQ 3週		Statistical Properties and Processing (1)	Gain a broad understanding of the mathematical errors and biases that form the basis of statistics.			
		4週	Statistical Properties and Processing (2)	Understand the mathematical and statistical population, mean, variance, etc., of measurements.			

Noise (1)   Index								
Learn the decide indiation required for electrical and electronic information   1st   Understand the structure and principles of movable coll-type indicator (col-type indicator of the provided col-type indicator of the principles of movable col-type indicator of the principles of movable coll-type indicator of the principles of movable coll-type indicator and open display principles   1st   1st   Measuring Direct Current with Indicating   Understand the structure and open displaying principles indicator of the principles and ammeter current dividers.   1st   Measuring Direct Current with Indicating   Understand the fundamentals of electrical electrical measurement, including volunteer multipliers and ammeter current dividers.   Understand the fundamentals of electrical measurement, including unternet fully and fundamental individual protection of the principles individual protection (color)   1st   1s		5週	1 Uni	nits and Standards (1)				
Mideating Instruments (1)		C.E	3 115	to and Ctanda		Learn the decibel notation required for electrical		
### Annual Control of 1st					. ,	and electronic information	•	
Page   Indicating Instruments (2)   Understand the structure and operating principles of thermoelectric and electrostate methods of electrical measurements (1)   Understand the fundamentals of electrical measurements (2)   Understand the fundamentals of electrical measurements (2)   Understand the fundamentals of electrical measurements (2)   Understand the fundamentals of electrical measurements (3)   Understand the fundamentals of electrical measurements (3)   Understand the fundamentals of electrical measurements (3)   Understand the fundamentals of electrical progress (4)   Understand the fundamentals of electrical measurement (1)   Understand the fundamentals of electrical measurement (1)   Understand the fundamentals of electrical measurement (2)   Understand the fundamentals of electrical measurement (3)   Understand the fundamentals of electrical measurement (4)   Understand the fundamentals of electrical measurement (5)   Understand the fundamentals of the semiconductors and fundamentals (2)   Understand the fundamentals of the semiconductors of Measurement (2)   Understand the fundamentals of the semiconductors of Measurement (2)   Understand the fundamentals of the semiconductors of Measurement (2)   Understand the fundamentals of the semiconductors of Measurement (3)   Understand the fundamentals of the semiconductors of Measurement (3)   Understand the fundamentals of the semiconductors of Measurement (3)   Understand the fundamentals of the semiconductors of Measurement (3)   Understand the fundamentals of the semiconductors of Measurement (3)   Understand the fundamentals of the semiconductors of Measurement (4)   Understand the fundamental of the semiconductors of Measurement (4)   Understand districtional circuits used in measurement.   Understand districtional circuits of the measurement of the measurem		7進	Ind	. ,				
### A Programment of the modelectric and electrostatic meters.    10日		8追	<u>Mic</u>	Midterm Examination of 1st		<u> </u>		
### Programment (1)  ### Programment (1)  ### Programment (2)  ### Programment (2)  ### Programment (2)  ### Programment (3)  ### Programment (4)  ### Programment (5)  ### Programment (5)  ### Programment (6)  ### Programment (6)  ### Programment (6)  ### Programment (7)  ### Programment (8)  ### Pro		9週	Ind	icating Instru	ments (2)	Understand the structure a of thermoelectric and elec	and operating trostatic met	g principles ers.
1日現   Instantomics (2)   1日報   Instantomics (2)   1日報   Instantomics (3)   Instantomics (3)   Instantomics (3)   Instantomics (4)   Instantomi		10	週 Me Ins	asuring Direct truments (1)	Current with Indicating	measurement, including voltmeter multipliers and		
### Programments (1) power, as well as the phasors required for AC.    13週   Instruments (2)		11			Current with Indicating	measurement, including the null method and		
13週   Measuring Alternating Current with Indicating Instruments (2)   14週   Selectronic Devices and Functional Circuits for Measurement (1)   15週   Selectronic Devices and Functional Circuits for Measurement (2)   16週   Week 16: End of Semester Examination of 1st Week 17: Exam Review / Enrichment Class   Learn about the functional circuits used in measurement.   Week 17: Exam Review / Enrichment Class   Learn about the functional circuits used in measurement.   Week 17: Exam Review / Enrichment Class   Learn about functional circuits used in measurement.   Week 17: Exam Review / Enrichment Class   Learn about functional circuits using operational manufacture of Measurement (1)   Learn about functional circuits using operational manufacture of Measurement (2)   Study the basic concepts of digital measurement.   Moves Concepts of digital measurement.   Study the basic concepts of digital measurement.   Study	2nd	dO 12		Measuring Alternating Current with Indicating Learn about alternating cur power, as well as the phase			irrent (AC) a sors required	nd AC for AC.
14回   Electronic Devices and Functional Circuits for Measurement.   15週   Electronic Devices and Functional Circuits for Measurement (2)   Learn about the functional circuits used in measurement.   Learn about the functional circuits used in measurement.   Learn about the functional circuits used in measurement.   Learn about functional circuits used in measurement.   Exam length: 50 min   Learn about functional circuits using operational ampfillers.   Exam length: 50 min   Learn about functional circuits using operational ampfillers.   Exam length: 50 min   Learn about functional circuits using operational ampfillers.   Exam length: 50 min   Learn about functional circuits using operational ampfillers.   Exam length: 50 min   Learn about phase and the methods for measuring it.   Learn about hoise that appears in electric measurements.   Exam length: 50 min   Learn about hoise that appears in electric measurements.   Learn about the various types of noise make make make make make make make mak		13			Learn about the impedance and			ance of AC
Measurement (2)   measurement (2)   measurement   meas		14:				and electronic devices nec		
Week 17: Exam Review / Enrichment Class Exam length: 50 min Lam about functional circuits using operational amplifiers.  1週 Electronic Devices and Functional Circuits for Measurement (3) 2週 Digital Measurement (1) Study the basic concepts of digital measurement. 3週 Digital Measurement (2) Study the basics concepts of digital measurement. 4週 Waveform Study the basics of the oscilloscope. 4週 Waveform Study the basics of the oscilloscope. 4週 Waveform Most electric and electronic phenomena are related to waves. Learn the basics of the mathematics required to handle these phenomena. 4週 Frequency and Phase (1) Learn about frequency spectrum, power spectral density, etc. 4回 Frequency and Phase (3) Learn about phase and the methods for measuring it. 4回 Midterm Examination of 2nd Learn about phase and the methods for measuring it. 4thQ Resonance Learn about phase of the methods for measurement. 4thQ Learn about the various types of noise. 4thQ Learn about the various types of noise. 4thQ Learn about the various types of noise. 4thQ Transmission Lines and Impedance Matching (1) Understand that resonators fulfill an important role in Ac Circuit measurements and learn the frequency response of resonant circuits, which is an important concept in high-frequency circuits, and an important concept in high-frequency circuits and important concept in high-frequency circuits and proposed of resonant circuits, which is an important concept in high-frequency circuits, and an important concept in high-frequency circuits and proposed of resonant circuits, which is an important concept in high-frequency circuits and intension in lines and important concept in high-frequency circuits and intension in lines and important concept in high-frequency circuits and intension in lines and important concept in high-frequency circuits and intension in lines and important concept in high-frequency circuits and intension in lines and important concept in high-frequency circuits and lines are apportant concept in high-frequency circuits and inten		15:					circuits used	d in
### Measurement (3) amplifiers.    28		16				Exam length: 50 min		
2周    Digital Measurement (1)   Study the basic concepts of digital measurement.   Study the basic sof the oscilloscope.   Most electric and electronic phenomena are related to waves. I per mathematics required to handle these phenomena.   Learn about frequency spectrum, power spectral density, etc.   Prequency and Phase (2)   Learn about phase and the methods for measuring it.   Learn about phase and the methods for measuring it.   Learn about noise that appears in electric measurements.   Learn about noise that appears in electric measurements and learn the frequency response of resonant circuits.   Learn about the various types of noise.   Understand that resonators fulfill an important role in AC circuit measurements and learn the frequency response of resonant circuits.   Understand distributed constant circuits, which is an important role in AC circuit measurements and learn the frequency response of resonant circuits.   Understand distributed constant circuits, which is an important role in AC circuit measurements and learn the frequency resonant circuits.   Understand distributed constant circuits, which is an important role in AC circuit measurements and learn the frequency resonant circuits.   Understand distributed constant circuits, which is an important role in AC circuit measurements and learn the frequency response of resonant circuits.   Understand distributed constant circuits, which is an important role in AC circuit measurements and learn the frequency response of resonant circuits.   Understand distributed constant circuits, which is an important role in AC circuit measurements and learn the frequency response of resonant circuits.   Understand distributed constant circuits.   Understand distributed constant circuits.   Understand distri		1週					cuits using or	perational
### Study the basics of the oscilloscope.    Age		2週	Dig	ital Measuren	nent (1)	Study the basic concepts of	of digital mea	surement.
### Prequency and Phase (1)		3週	<u>Dig</u>	ital Measuren	nent (2)	Study the basic concepts of	of digital mea	surement.
### Prequency and Phase (1) ### related to waves. Learn the basics of the mathematics required to handle these phenomena.  ### Frequency and Phase (2) ### Learn about frequency spectrum, power spectral density, etc.  ### Learn about phase and the methods for measuring it.  ### Midtern Examination of 2nd ### Exam length: 50 min    ### Learn about noise that appears in electric measurements.  ### Noise (1)   Learn about noise that appears in electric measurements.  ### Noise (2)   Learn about the various types of noise.  ### Understand that resonators fulfill an important role in AC circuit measurements and learn the frequency response of resonant circuits.  ### Transmission Lines and Impedance Matching (1)   Inderstand distributed constant circuits, which is an important concept in high-frequency circuits.  ### Magnetic Measurement   Learn about transmission lines and impedance matching.  ### Magnetic Measurement   Learn the basics of magnetic measurement.  ### Domprehensive Review and Exhibit of Electric and Electronic Measurement.  ### Domprehensive Review and Exhibit of Electric and Electronic measurement.  ### Domprehensive Review and Exhibit of Electric and Electronic measurement.  ### Domprehensive Review and Exhibit of Electric and Electronic measurement.  ### Domprehensive Review and Exhibit of Electric and Electric and Electronic measurement.  ### Domprehensive Review and Exhibit of Electric and Electronic measurement.  ### Domprehensive Review and Exhibit of Electric and Electronic measurement.  ### Domprehensive Review and Exhibit of Electric and Electronic measurement.  ### Domprehensive Review And Exhibit of Electric and Electronic measurement.  ### Domprehensive Review And Exhibit of Electric and Electric and Electronic measurement.  ### Domprehensive Review And Exhibit of Electric and Electric and Electronic Measurement.  ### Domprehensive Review And Exhibit of Electric and Electronic Measurement.  ### Domprehensive Review And Exhibit of Electric and Electric and Electronic measurement.  ### Dom		4退	<u>Wa</u>	veform		Study the basics of the os	cilloscope.	
後期  Prequency and Phase (3) Learn about phase and the methods for measuring it.  Midterm Examination of 2nd Exam length: 50 min  Noise (1) Learn about noise that appears in electric measurements.  Noise (2) Learn about the various types of noise.  Understand that resonators fulfill an important role in AC circuit measurements and learn the frequency resonant circuits.  Resonance Understand that resonators fulfill an important role in AC circuit measurements and learn the frequency resonant circuits.  13週 Transmission Lines and Impedance Matching (1) Understand distributed constant circuits, which is an important concept in high-frequency circuits.  13週 Magnetic Measurement Learn the basics of magnetic measurement.  15週 Comprehensive Review and Exhibit of Electric and Electronic Measurement Electronic Measurement.  15週 Week 16: End of Semester Examination of 2nd Week 17: Exam Review / Enrichment Class  Exam length: 50 min  Exam length: 50 min  Exam length: 50 min  Exam length: 50 min  ### Palpha	3rd(	dQ 5週	1 Fre	quency and P	hase (1)	related to waves. Learn the basics of the mathematics required to handle these		
後期    August   Midterm Examination of 2nd   Exam length: 50 min		6週	<u>I</u> Fre	quency and P	hase (2)	Learn about frequency spectrum, power spectral density, etc.		
後期  Pill Noise (1)  Learn about noise that appears in electric measurements.  Learn about the various types of noise.  Understand that resonators fulfill an important role in AC circuit measurements and learn the frequency response of resonant circuits.  Transmission Lines and Impedance Matching (1)  Transmission Lines and Impedance Matching (2)  Transmission Lines and Impedance Matching (2)  Transmission Lines and Impedance Matching (2)  Hail Magnetic Measurement  Comprehensive Review and Exhibit of Electric and Electronic Measurement  Comprehensive Review and Exhibit of Electric and Summary and supplementary explanations of electric and electronic measurement.  Comprehensive Review and Exhibit of Electric and Summary and supplementary explanations of electric and electronic measurement.  Tribuly Dybia Papa Papa Papa Papa Papa Papa Papa Pa		7週	<u>I</u> Fre	quency and P	hase (3)			
Noise (1)   Indicate that appears in the appears in the cell to measurements.   Indicate that appears in the cell to measurements and learn the frequency response of resonant circuits, which is an important concept in high-frequency circuits.     12週		8週	<u>Mic</u>	lterm Examina	ation of 2nd	Exam length: 50 min		
### Pino #	後期	9週	Noi	se (1)			pears in elect	ric
### Page  ###		10	,					
### Page #		10	<u>INOI</u>	se (2)		·	•	
### an important concept in high-frequency circuits.    13週		11	週 Res	sonance		role in AC circuit measurements and learn the frequency response of resonant circuits.		
13週	4th(	10	週 Tra	ansmission Lines and Impedance Matching (1)		an important concept in high-frequency circuits.		
15週   Comprehensive Review and Exhibit of Electric and Electronic Measurement   Summary and supplementary explanations of electric and electronic measurement.   Exam Review 16: End of Semester Examination of 2nd week 17: Exam Review / Enrichment Class   Exam length: 50 min   Exam		`	週 Tra	nsmission Lines and Impedance Matching (2)				
Electronic Measurement   electric and electronic measurement.     16週   Week 16: End of Semester Examination of 2nd   Meek 17: Exam Review / Enrichment Class   Exam length: 50 min     モデルコアカリキュラムの学習内容と到達目標   一方野   学習内容   学習内容の到達目標   一部   予選   予選   予選   予選   予選   予選   予選   予		14:	週 Ma	netic Measurement		-		
<ul> <li>でおいコアカリキュラムの学習内容と到達目標</li> <li>分野 学習内容 学習内容の到達目標</li> <li>計測方法の分類(偏位法/零位法、直接測定/間接測定、アナログ は計測/ティジタル計測)を説明できる。 相反と誤差を理解し、有効数字・誤差の伝搬を考慮した計測値の 4</li> <li>「お野別の専事では、またがよりできる。」</li> <li>「お野別の専事では、またでは、またでは、では、では、では、では、では、では、では、では、では、では、では、では、で</li></ul>		15週		mprehensive F ctronic Measu	Review and Exhibit of Electric and rement	Summary and supplementary explanations of electric and electronic measurement.		
モデルコアカリキュラムの学習内容と到達目標 分類 分野 学習内容 学習内容の到達目標 計測方法の分類(偏位法/零位法、直接測定/間接測定、アナログ は計測/ディジタル計測)を説明できる。		16	Week 16: End of		Semester Examination of 2nd	Exam length: 50 min		
	モデルコアナ	カリキュ	ラムの学	図内容と到達 コープログラス ロード コード アイア かいしょう かいかい かいかい かいかい かいかい かいかい かいかい かいかい かい				
中門的能力 中間 では、	分類						到達レベル	授業週
# 関係 では、					計測方法の分類(偏位法/零位法、直接測定/間接測定、アナ 計測/ディジタル計測)を説明できる。			
大野別の専門工学   電気・電子系分野   電気・電子系分野   計測					精度と誤差を理解し、有効数字・誤		4	
専門的能力 分野別の専門工学 電気・電子系分野 計測 電気・電子系分野 計測 について、その動作原理を理解し、電圧・電流測定に使用する方法を説明できる。 倍率器・分流器を用いた電圧・電流の測定範囲の拡大手法について説明できる。 A/D変換を用いたディジタル計器の原理について説明できる。 4 電圧降下法による抵抗測定の原理を説明できる。 ブリッジ回路を用いたインピーダンスの測定原理を説明できる。 4 有効電力、無効電力、力率の測定原理とその方法を説明できる。 4 電力量の測定原理を説明できる。 4						位について説明できる。	4	
専門的能力					計測標準とトレーサビリティの関係について説明できる。 指示計器について、その動作原理を理解し、電圧・電流測定に低		4	
専門的能力   内野別の専門工学   「電気・電子系分野   計測   倍率器・分流器を用いた電圧・電流の測定範囲の拡大手法につい 4   イン説明できる。   A/D変換を用いたディジタル計器の原理について説明できる。   4   ブリッジ回路を用いたインピーダンスの測定原理を説明できる。   4   ブリッジ回路を用いたインピーダンスの測定原理を説明できる。   4   有効電力、無効電力、力率の測定原理とその方法を説明できる。   4   電力量の測定原理を説明できる。   4   電力量の測定原理を説明できる。   4   1   1   1   1   1   1   1   1   1		\mʒ□ı ؞÷	雨气 于一				4	
電圧降下法による抵抗測定の原理を説明できる。 4 ブリッジ回路を用いたインピーダンスの測定原理を説明できる。 4 有効電力、無効電力、力率の測定原理とその方法を説明できる。 4 電力量の測定原理を説明できる。 4	専門的能力 門	T野別の男 門工学			倍率器・分流器を用いた電圧・電流の	の測定範囲の拡大手法につい	4	
ブリッジ回路を用いたインピーダンスの測定原理を説明できる。 4 有効電力、無効電力、力率の測定原理とその方法を説明できる。 4 電力量の測定原理を説明できる。 4							4	
有効電力、無効電力、力率の測定原理とその方法を説明できる。 4 電力量の測定原理を説明できる。 4							4	
電力量の測定原理を説明できる。 4					ブリッジ回路を用いたインピーダン	スの測定原理を説明できる。	4	
			I .				1	i e
					有効電力、無効電力、力率の測定原	理とその方法を説明できる。	4	
717 27(2) 7 3311/37 2 2 3 6					電力量の測定原理を説明できる。		4	
評価割合								

	Midterm Examination of 1st		Midterm Examination of 2nd	End of Semester Examination of 2nd	合計
総合評価割合	10	20	30	40	100
Basic Proficiency	0	0	0	0	0
Specialized Proficiency	10	20	30	40	100
Cross Area Proficiency	0	0	0	0	0