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Ref	No.

# Sri krishna Institute of Technology, Bangalore



COURSE PLAN

Academic Year 2019-2020

Program:	B E – Mechanical Engineering
Semester :	4
Course Code:	18ME46B
Course Title:	MECHANICAL MEASUREMENTS AND METROLOGY
Credit / L-T-P:	3 / 3-0-0
Total Contact Hours:	42
Course Plan Author:	Mr.SHANKAREGOWDA K C

# Academic Evaluation and Monitoring Cell

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Note : Remove "Table of Content" before including in CP Book Each Course Plan shall be printed and made into a book with cover page Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels

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# 18ME36B PC : Mechanical Measurement & Metrology

# A. COURSE INFORMATION

#### 1. Course Overview

Degree:	B.E	Program:	ME
Year / Semester : II/IV SEM Ad		Academic Year:	2019-20
Course Title:	MECHANICAL MEASUREMENTS AND METROLOGY	Course Code:	18ME46B
Credit / L-T-P:	3-0-0	SEE Duration:	180 minutes
Total Contact Hours:	42	SEE Marks:	60Marks
CIA Marks:	40	Assignment	1 / Module
Course Plan Author:	Mr.SHANKAREGOWDA K C	Sign	Dt:
Checked By:		Sign	Dt:

#### 2. Course Content

Mod	Module Content	Teaching	Module	Blooms
ule		Hours	Concepts	Level
1	Introduction to Metrology : Definition, objectives and concept of metrology, Need of inspection, Principles, process, methods of measurement, Classification and selection of measuring instruments and systems. Accuracy, precision and errors in measurement System of measurement, Material Standard, Wavelength Standards, Subdivision of standards, Line and End standards, Classification of standards and Traceability, calibration of End bars (Numerical Problems), standardization Linear Measurement and angular measurements: Slip gauges-Indian standards on slip gauge, method of selection of slip gauge, care of slip gauge, slip gauge accessories, problems on building of slip gauges (M87, M112).Measurement of anglessine bar, sine center, angle gauges, optical instruments for angular measurements, Auto collimator-applications for measuring straightness and squareness	8	Metrology measurements & standards,slip gauges	L2 Underst and
2	System of Limits, Fits, Tolerance and Gauging: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis system, types of fits and their designation (IS 919-1963), geometric tolerance, position-	8	Fits, Limits & tolerences, comparator	L2 Underst and

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Copyright	tolera gaug of ga and g Com mech indica press Zeiss	AS. All rights reserved. ances. Classifi es (Taylor's pl uges-plain plu gauge material parators:Funct nanical-Johnso ator, electrica sure gauges, S s ultra-optimete	cation of gauges, brief concept of design of rinciples), Wear allowance on gauges, Types g gauge, ring gauge, snap gauge, limit gauge s ional requirements, classisfication, in Mikrokator, sigma comparators, dial II- principles, , LVDT, Pneumatic- back Solex comparators and optical comparators- er					
3	Measu Termir minor thread thread Gear consta tanger involut Advan	rement of scre hology of scre diameter, pit s by 2-wire a gauges, Tool tooth termino nt chord meth at method, mea e profile. Gear ces in metrolo	ew thread and gear: w threads, measurement of major diameter, ch, angle and effective diameter of screw and 3-wire methods, best size wire. Screw maker's microscope. blogy, tooth thickness measurement using od, addendum comparator method and base asurement of pitch, concentricity, run out, and r roll tester for composite error. gy:	8	Scre p ac	ew thread rofile & etrology lvances	L2 Underst and	
4	Measu metho Definit measu precisi repeat Errors Transo transo transd advant Interm systen device Termir	irement syste ds: ion, signific irement syste on, calibrat ability, linearity in measureme ducers, trans ucers, electr tages of each t ediate modify ns, inherent s, input circ nating devices,	ems and basic concepts of measurement cance of measurement, generalized em, definitions and concept of accuracy, ion, threshold, sensitivity, hysteresis, y, loading effect, system response-time delay. ent, classification of errors. offer efficiency, primary and secondary ical, mechanical, electronic transducers, type transducers. <i>v</i> ing and terminating devices: Mechanical problems, electrical intermediate modifying uitry, ballast circuit, electronic amplifiers. Cathode ray oscilloscope, Oscillographs	8	Tra Mod ter d	nsducers ifying and minating levices	L2 Underst and	
5	Force, indirec Types and ro Pressu Bridge Measu Theory prepar of stra bridge Strain Resist materi	Torque and t method, for of dynamome pe brake dyna ure measurer man gauge, M irement of stra of strain gau ation and mou in measureme circuit, orient gauge based l ance thermon als used for co	Pressure Measurement:Direct methods and ce measuring inst. Torque measuring inst., eters, Absorption dynamometer, Prony brake amometer, and power measuring instruments. nent, principle, use of elastic members, lcLeod gauge, Pirani gauge. in and temperature: ges, types, electrical resistance strain gauge, inting of strain gauges, gauge factor, methods ent. Temperature Compensation, Wheatstone ation of strain gauges for force and torque, oad cells and torque sensors. neters, thermocouple, law of thermocouple, onstruction, pyrometer, optical pyrometer	08	Mea D Mea	easuring Devices Isurement arameters	L2 Underst and	

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Available
In Lib
In Lib
In dept
Available

### 4. Course Prerequisites

SNo	Course	Course Name	Module / Topic / Description	Sem	Remarks	Blooms
	Code					Level
1	-	-	-	-	-	-
	18ELE1	Basic Electrical,	1,2,3	1 &11		L2
	3/23					
	18ELN1	Basic	4,5	1 &11		L2
	4/24	Electronics				

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

### **B. OBE PARAMETERS**

#### 1. Course Outcomes

#	COs		Concept	Instr	Assessment	Blooms'
		Hours		Method	Method	Level
17ME46B	6B Students should be able to understand		Metrology	Chalk	Assignment,	L2
1	the concept of metrology and		measurement	and	Unit Test &	Understand
	standards of measurement.		s &	board	IA	
			standards			
17ME46B	Students should be able to acquire the	9	Fits, Limits &	Chalk	Assignment,	L2
2	knowledge of limit, fit, tolerance.		tolerances	and	Unit Test &	Understand
				board	IA	
17ME46B	Students should be able to understand	7	Fits, Limits &	Chalk	Assignment,	L2
3	the knowledge of linear and angular		tolerances	and	Unit Test &	Understand
	measurement			board	IA	
17ME46B	Students should be able to Understand	8	Transduce	Chalk	Assignment,	L2
4	the concept of transducers,		rs &	and	Unit Test &	Understand
	measurement system, terminating		terminatin	board	IA	
	devices.		g devices.			
17ME46B	Students should be able to Understand	8	Force &	Chalk	Assignment,	L2
5	the measurement of Force, Torque,		Temperature	and	Unit Test &	Understand
	Temperature and strain.			board	IA	

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-		Total	40	-	-	-	-			

Note: Identify a max of 2 Concepts per Module. Write 1 CO per concept.

#### 2. Course Applications

SNo	Application Area	CO	Level
1	Metrology is used in calibration and quality control	CO1	L2
2	Slip gauges are used as a reference for the calibration of measuring equipment used in machine shops	CO1	L2
3	Limit, fits are used in finding out the geometrical tolerance of component	CO2	L2
4	Comparators are used in mass production to maintain required tolerances at all stages of manufacturing	CO2	L3
5	Screw thread are used to converts rotary motion into linear motion in simple machine	CO3	L2
6	Laser interferometers are used as non -contact sensor in industry application	CO3	L2
7	Transducers are used in medicine, such as in sonograph machines, music engineering and recording ,safety systems like train brakes.	CO4	L2
8	Cathode ray oscilloscope are used for Measurement of voltage ,current,frequency.	CO4	L2
9	Forces are used in weighing of an object Dynamics of vehicles Control applications such as deployment of air bag in a vehicle Study of behavior of materials under different types of loads Vibration studies Seismology or monitoring of earthquakes	CO5	L2

Note: Write 1 or 2 applications per CO.

#### 3. Articulation Matrix

#### (CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO1	PO	Level										
			2	3	4	5	6	7	8	9	10	11	12	
18ME46B.1	Students should be able to		-	-	-	-	-	-	-	-	-	-	-	L2
	understand the concept of	2												
	metrology and standards of	2												
	measurement.													
18ME46B.2	Students should be able to	√ √	-	-	-	-	-	-	-	-	-	-	-	L2
	acquire the knowledge of limit,													
	fit, tolerance.													
18ME46B.3	Students should be able to	√ (	-	-	-	-	-	-	-	-	-	-	-	L2
	understand the knowledge of													
	linear and angular	-												
	measurement													
18ME46B.4	Students should be able to	√ √	-	-	-	-	-	-	-	-	-	-	-	L2
	Understand the concept of	2												
	transducers, measurement	-												
	system, terminating devices.													
18ME46B.5	Students should be able to		-	-	-	-	-	-	-	-	-	-	-	L2
	Understand the measurement of													
	Force, Torque, Temperature	,												
	and strain.													
Note: Mentio	on the mapping strength as 1, 2, or	3									•	-		

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#### 4. Mapping Justification

Maj	Mapping Justification N				
co	PO		Level		
CO1	PO1	Apply the knowledge of measurement and metrology.	L2		
CO1	PO2	Since it is basic science -No mapping	12		
CO1	PO3	Atudents will not be Designing/developing of solution-No mapping	 L2		
CO1	PO4	Since no conduction on investigations of complex Problems-No mapping	L2		
CO1	PO5	No Modern tools are used -No mapping	L2		
CO1	PO6	No inpact on engineers and society-No mapping	L2		
CO1	PO7	Will not be affected on environment and sustainability-No mapping	L2		
CO1	PO8	Since the study is limited to basics -No mapping	L2		
CO1	PO9	Will not be working either Individual nor team work-No mapping	L2		
CO1	PO10	NO instruction will be given -No mapping	L2		
CO1	PO11	No application of management and finance principles involved -No mapping	L2		
CO1	PO12	Due to change in technology-No mapping	L2		
CO2	PO1	Apply the knowledge of limits, fit, tolerance'	L2		
CO2	PO2	Since it is basic science -No mapping	L2		
CO2	PO3	Students will not be Designing/developing of solution-No mapping	L2		
CO2	PO4	Since no conduction on investigations of complex Problems-No mapping	L2		
CO2	PO5	No Modern tools are used -No mapping	L2		
CO2	PO6	Impact on engineers and society through improved productivity and efficiency	L2		
CO2	PO7	Will not be affected on environment and sustainability-No mapping	L2		
CO2	PO8	Since the study is limited to basics -No mapping	L2		
CO2	PO9	Will not be working either Individual nor team work-No mapping	L2		
CO2	PO10	NO instruction will be given -No mapping	L2		
CO2	PO11	No application of management and finance principles involved -No mapping	L2		
CO2	PO12	Due to change in technology-No mapping	L2		
CO3	PO1	Apply the knowledge of leaner and angular measurement.	L2		
CO3	PO2	Since it is basic science -No mapping	L2		
CO3	PO3	Students will not be Designing/developing of solution-No mapping	L2		
CO3	PO4	Since no conduction on investigations of complex Problems-No mapping	L2		
CO3	PO5	No Modern tools are used -No mapping	L2		
CO3	PO6	Impact on engineers and society through improved productivity and efficiency	L2		
CO3	PO7	Will affect on environment and sustainability in utilizing resources	L2		
CO3	PO8	Since the study is limited to basics -No mapping	L2		
CO3	PO9	Will not be working either Individual nor team work-No mapping	L2		
CO3	PO10	NO instruction will be given -No mapping	L2		

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CO3	PO11	No application of management and finance principles involved -No mapping	L2
CO3	PO12	Due to change in technology-No mapping	L2
CO4	PO1	Apply the knowledge of terminating and modifying devices.	L2
CO4	PO2	Since it is basic science -No mapping	L2
CO4	PO3	Students will not be Designing/developing of solution-No mapping	L2
CO4	PO4	Since no conduction on investigations of complex Problems-No	L2
004	DOC	mapping	1.0
004	P05	No Modern tools are used -No mapping	L2
004	P06	Impact on engineers and society through improved driving mechanism	L2
CO4	P07	Will affect on environment and sustainability in automation	L2
CO4	P08	Since the study is limited to basics -No mapping	L2
CO4	P09	Will not be working either Individual nor team work-No mapping	L2
CO4	PO10	NO instruction will be given -No mapping	L2
CO4	PO11	No application of management and finance principles involved -No mapping	L2
CO4	PO12	Due to change in technology-No mapping	L2
CO5	PO1	To know the knowledge of force, torque and temeperature	L2
		measurement.	
CO5	PO2	Since it is basic science -No mapping	L2
CO5	PO3	Students will not be Designing/developing of solution-No mapping	L2
CO5	PO4	Since no conduction on investigations of complex Problems-No mapping	L2
CO5	PO5	Modern tools are used	L2
CO5	PO6	Impact on engineers and society through improved processing methods	L2
CO5	PO7	Will not be affected on environment and sustainability-No mapping	L2
CO5	PO8	Since the study is limited to basics -No mapping	L2
CO5	PO9	Will not be working either Individual nor team work-No mapping	L2
CO5	PO10	NO instruction will be given -No mapping	L2
CO5	P011	No application of management and finance principles involved -No mapping	L2
CO5	P012	Due to change in technology-No mapping	L2

Note: Write justification for each CO-PO mapping.

#### 5. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					

# Note: Write Gap topics from A.4 and add others also.

#### 6. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					

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Note: Anything not covered above is included here.

#### C. COURSE ASSESSMENT

#### 1. Course Coverage

Mod	Title	Teaching		No. o	f quest	ion in	Exam		CO	Levels
ule #		Hours	CIA-1	CIA-2	CIA-3	Asg	Extra	SEE		
							Asg			
1	Introduction to metrology and	80 b	2	-	-	1	1	2	CO1,	L1, L2
	measurement								CO1	
2	System of fits,limits,and tolerance	9 09	2	-	-		1	2	CO2,	L2
	and gauging								CO2	
3	Measurement of screw thread and	d 07	-	2	-	1	1	2	CO3,	L2
	gear and advances in metrology								CO3	
4	Measurement system and	80 b	-	2	2		1	2	CO4,	L2,
	Measurement methods								C08	
5	Measurement c	f 08	-	-	2	1	1	2	CO5,	L2
	force,pressure ,torque ,strain and	k							CO5	
	temperature									
-	Total	40	4	4	4	5	5	10	-	-

Note: Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

#### 2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	30	CO1, CO1, CO2, CO2	, I2
CIA Exam – 2	30	CO3, CO3, CO4, C08	L1, L2,
CIA Exam – 3	30	CO5, CO5	L1
Assignment - 1	05	CO1, CO1, CO2, CO2	L2, L3, L4, L3
Assignment - 2	05	CO3, CO3, CO4, CO4	L1, L2, L3, L1
Assignment - 3	05	CO5, CO5	L3, L4
Seminar - 1	05	CO1, CO1, CO2, CO2	L2, L3, L4, L3
Seminar - 2	05	CO3, CO3,CO4,CO4	L1, L2, L3, L1
Seminar - 3	05	CO5, CO5	L3, L4
Other Activities – define –		CO1 to CO5	L2, L3, L4
Slip test			
Final CIA Marks	40	-	-

Note : Blooms Level in last column shall match with A.2 above.

### D1. TEACHING PLAN - 1

#### Module - 1

Title:	Divide and Conquer	Appr	8 Hrs
		Time:	
а	Course Outcomes	-	Blooms
-	The student should be able to:	-	Level
1	Students should be able to Understand the objectives and methods of	CO1	L2

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0	Ctudente elevid les elle te ldertification and calection of alle source	004	1.0
2	Students should be able to identification and selection of slip gauge	COT	L3
b	Course Schedule	-	-
Class No	Module Content Covered	CO	Level
1	Introduction to Metrology objectives and concept of Metrology methods of	C01	L2
	measurement, Classification and selection of measuring instruments and		
	systems.		
2	Accuracy, precision and errors in measurement Classification of standards	C01	L2
	and Traceability		
3	Calibration of End bars (Numerical Problems)	C01	L2
	· · ·		
4	Standardization System of measurement, Material Standard, Wavelength	C01	L2
	Standards, Subdivision of standards		
5	Linear Measurement and angular measurements: Slip gauges- Indian	C01	L2
	standards on slip gauge, method of selection of slip gauge, stack of slip		
	gauge, adjustable slip gauge, wringing of slip gauge, care of slip gauge,		
6	Slip gauge accessories, problems on building of slip gauges (M87, M112).	C01	L2
7	Management of english they aire contain and a second section.	004	10
1	Measurement of angles- sine bar, sine center, angle gauges, optical	CUI	LZ
	instruments for angular measurements		
8	Auto collimator-applications for measuring straightness and squareness	C01	12
0	Auto commator-applications for measuring straightness and squareness	001	LZ
c	Application Areas	CO	Level
1	Metrology is used in calibration and quality control	CO1	12
2	Slip gauges are used as a reference for the calibration of measuring	CO1	12
-	equinment used in machine shons	001	
d	Paviaw Quastians		
u	Review Questions	-	-
1			LZ
2	List the objectives of measurement system	CO1	L2
3	Explain line and end standards	CO1	L2
4	Explain with neat sketch international prototype meter	CO1	L2
5	Explain with neat sketch imperial standard yard	CO1	L2
6	Define measurement	CO1	L2
7	Write a brief note on slip gauges	CO1	L2
8	Define the terms accuracy, precision.	CO1	L2
9	Explain calibration of end bars	CO1	L2
10	Explain the wringing phenomena of slip gauges with neat figure	CO1	12
11	With a neat figure, explain the principle of sine bar. What are $\Delta inv$ points?	CO1	12
	Explain in detail	001	
10	Explain in detail.	001	1.2
12	Explain now the straightness can be measured by using an autocollimator.	001	
13	Build the following dimensions using M-112 set: 1) 33.4565mm II) 87.1025mm	CO1	L3
	III) 09.∠075 mm I) 35.4875 mm, II) 78.3665 mm	<u> </u>	
14	List the slips to be wrung together to produce an overall dimension of 92.357	CO1	L3
	mm using two protection slips of 2.500 mm size		

15

Build the following angles: i) 49° 36' 48" ii) 35° 32' 36" iii) 37°9'18"

L3

CO1

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16	A calibrated me	ter and har has an actual length 1000 0006 mm. It is to be	CO1 I.3

е 1	Experiences	- CO1	- L2
•	Experiences		
	used in the calibration of two bars A and B each having a length of 500 mm. When compared with meter bar A + B was found to be shorter by 0.0003 mm. In comparing A with B it was found that A was 0.0005 mm longer than B. Find the actual length of A and B.		
16	A calibrated meter and bar has an actual length 1000.0006 mm. It is to be	CO1	L3

# Module – 2

Title:	Divide and Conquer	Appr	9 Hrs
		Time:	
a	Course Outcomes	-	Blooms
-	The student should be able to:	-	Level
1	Students should be able to Understand the concepts of	CO2	L4
	tolerance,limits,fits ,geometric tolerance		
2	Students should be able to Understand the principle of comparator	CO2	L3
b	Course Schedule	-	-
Class No	Module Content Covered	CO	Level
1	System of Limits, Fits, Tolerance and Gauging: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly,	CO2	L2
2	Limits of size, Indian standards, concept of limits of size and tolerances, definition of fits,	CO2	L2
3	Hole basis system, shaft basis system, types of fits and their designation (IS 919-1963)	CO2	L2
4	Geometric tolerance, position-tolerances. Classification of gauges,	CO2	L2
5	Brief concept of design of gauges (Taylor's principles), Wear allowance on gauges,	CO2	L2
6	Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials	CO2	L2
7	Comparators: Functional requirements, classification, mechanical-Johnson Mikrokator, sigma comparators,	CO2	L2
8	Dial indicator, electrical comparators, LVDT,		
9	Pneumatic- back pressure gauges, Solex comparators and optical comparators- Zeiss ultra-optimeter		
C	Application Areas	CO	Level
1	Limit, fits are used in finding out the geometrical tolerance of component	CO2	L2
2	Comparators are used in mass production to maintain required tolerances at all stages of manufacturing	CO2	L2

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CO2

CO2

CO2

CO2

CO2

\_

L1

L2

L2

L2

L2

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d	Review Questions	
1	Explain types of fits with sketches.	
2	Write notes on: tolerance, allowance, Compound tolerances, Gauge tolerance.	
3	What are the concepts of interchangeability and selective assembly? Which is advantageous?	
4	With neat figure, explain: i) Plug gauges, ii) Ring gauges, iii) Snap gauges	
5	What are the various types of fits used for the purpose of assembly of machine parts? Explain each with neat figure.	
6	Explain Hole basis and shaft basis system of tolerances.	
7	List the important design principles of a comparator. With a neat sketch explain the working of Reed type comparator	
8	Explain with a neat sketch induction type electrical comparator.	

	machine parts? Explain each with neat figure.		
6	Explain Hole basis and shaft basis system of tolerances.	CO2	L2
7	List the important design principles of a comparator. With a neat sketch	CO2	L2
	explain the working of Reed type comparator		
8	Explain with a neat sketch induction type electrical comparator.	CO2	L2
9	Sketch and explain the following comparators: i) Zeiss optimeter ii) Solex comparators.	CO2	L2
10	Determine the dimensions of hole and shaft for a fit 30H8f7. The given data are: i = $0.45D^{1/3} + 0.001D$ , IT8 = 25i, IT7 = 16i. Fundamental deviation for shaft 'f' is $-5.5D^{0.41}$ . 30 mm diameter lies in the diameter step of 18-30 mm. Sketch the fit and comment on the same. the limit of tolerance and allowance for a 25mm shaft and hole pair designated by : H8 d9 [ H8 : IT8 = 25i, d9 : IT9 = 40i , i = $0.45D^{1/3} + 0.001D$ ] [Fundamental deviation = $-16D^{\circ} 44$ ].	CO2	L2
11	Explain with a neat sketch, construction and working of "Johnson Mikrokator" comparator.	CO2	L2
е	Experiences	-	-
1			

### E1. CIA EXAM – 1

### a. Model Question Paper - 1

Crs Code	<u>.</u>	18ME46B	Sem: IV		Marks	: 4	10	Time:	75 m	5 minutes		
Cour	se:	MECHANIC	AL MEASU	JREMENTS A	ND Me	ETROL	OGY					
-	-	Note: Answ	er any 2 qu	estions, each	carry e	qualm	arks.		M	larks	CO	Level
1	а	With a neat figure, explain the principle of sine bar. What are Airy points? Explain in detail.								10	CO1	L1
	b	Explain how	/ the straigh	ntness can be	measu	ired by	using an	autocollimator		10	CO1	L2
					OR							
2	а	Build the following dimensions using M-112 set: i) 33.4565mm i 87.1025mm iii) 69.2875 mm i) 35.4875 mm, ii) 78.3665 mm							ii)	10	CO1	L2
	b	Explain the wringing phenomena of slip gauges with neat figure.					10	CO1	L2			
3	а	With neat fig	gure, expla	n: i) Plug gau	ges, ii)	Ring g	auges, ii	i) Snap gauges		10	CO2	L2
	b	Explain Hole basis and shaft basis system of tolerances.							10	CO2	L2	
					OR							
4	а	Determine t	he dimensi	ons of hole ar	nd sha	ft for a	fit 30H8f	7. The given d	ata	10	CO2	L2

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are: i = 0.45D <sup>1/3</sup> + 0.001D, IT8 = 25i, IT7 = 16i. Fundamental deviation for shaft 'f' is -5.5D <sup>0.41</sup> . 30 mm diameter lies in the diameter step of 18-30 mm Sketch the fit and comment on the same. the limit of tolerance and allowance for a 25mm shaft and hole pa designated by : H8 d9 [ H8 : IT8 = 25i, d9 : IT9 = 40i , i = 0.45D <sup>1/3</sup> +0.001D [Fundamental deviation = - 16D ° 44 ].	r r ]		
b Explain with a neat sketch, construction and working of "Johnso Mikrokator" comparator.	n 10	C02	L2

# b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions								
Crs C	ode:	18ME46	6B Sem: IV Marks: 5 / 10 Time: 90	) – 120 i	minutes	;		
Cours	ourse: MECHANICAL MEASUREMENTS AND METROLOGY							
Note:	Each	student	to answer 2-3 assignments. Each assignment carries equal mark.					
SNo		USN	Assignment Description	Marks	со	Level		
1			what are airy points	5	CO1	L2		
2			Discuss the following standards of measurements	5	CO1	L2		
			a. line standard b. wave length standard					
3			Distinguish clearly between line standard and end standard	5	CO1	L2		
4			Discuss the procedure for the calibration of end bars	5	CO1	L2		
5			Explain the wringing phenomena of slip gauges	5	CO1	L2		
6			write a brief note on the manufacture of slip gauges	5	CO1	L2		
7			Four length bars A,B,C and D are to be calibrated using a	5	CO1	L2		
			calibrated bar whose length is nearly equal to sum of all the four					
			length bars. explain the procedure.					
8			Give the details of M87 and M45 set of slip gauges	5	CO1	L2		
9		Build a dimension of 78.3665 mm using M112 set slip gauges	5	CO1	L2			
10			Give details of M-87 set and hence build the following	5	CO1	L2		
			dimensions					
			a. 49.3825 mm b. 87.3215					
11			Explain the NPL method of deriving end standard from line	5	CO1	L2		
			standards					
12			Discuss with block diagram generalized measurement system	5	CO1	L2		
			with example for each stage elements					
13			Describe the three stages of measurement with suitable	5	CO1	L2		
			example					
14			Define and state the signifance of following terms in	5	CO1	L2		
			measurement					
			a. Accuracy b. precision c. sensitivity d. repeatability					
15			Define an error .how are error classified.	5	CO1	L2		
16			Explain with a neat sketch vernier bevel protractor	5	CO1	L2		
17			with a neat sketch explain optical bevel protractor	5	CO1	L2		
18			Write a note on sine bar	5	CO1	L2		
19			Explain the use of sine bar for measuring known and unknown	5	CO1	L2		
			angles					
20			Distinguish between angle gauges and slip gauges	5	CO1	L2		

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1	L2
1	
1	
1	
	L2
1	L2
1	L2
2	L2
	D1 D1 D2

# D2. TEACHING PLAN - 2

#### Module – 3

Title:	Divide and Conquer	Appr	7 Hrs
		Time:	1110
а	Course Outcomes	-	Blooms
-	The student should be able to:	-	Level
1	Students should be able to Understand the screw thread profile and its terminology	CO3	L2
2	Students should be able to Understand the advances of metrology	CO3	L2
b	Course Schedule		
Class No	Module Content Covered	CO	Level
1	Measurement of screw thread and gear: Terminology of screw threads,	CO3	L2
2	Measurement of major diameter minor diameter, pitch, angle and effective	CO3	L2
	diameter of screw threads by 2-wire		
3	3-wire methods, best size wire	CO3	L2
4	Screw thread gauges, Tool maker's microscope.	CO3	L2
5	Gear tooth terminology, tooth thickness measurement using constant chord method,	CO3	L2
6	Addendum comparator method and base tangent method	CO3	L2
7	Measurement of pitch, concentrically, run out, and involute profile. Gear roll tester for composite error.	CO3	L2
C	Application Areas	СО	Level
1	Screw thread are used to converts rotary motion into linear motion in simple	CO3	L2
	machine		
2	Laser interferometers are used as non -contact sensor in industry application	CO3	L2

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d	Review Questions	-	-
1	Explain the two wire method to find the effective diameter of screw thread.	CO3	L2
2	With a neat sketch explain the gear pitch checking instrument.	CO3	L2
3	With neat sketches explain how would you measure the major and minor diameters of internal screw threads.	CO3	L2
4	Briefly explain the working of a tool-maker's microscope.	CO3	L2
5	Explain the 3 wire method of measuring the effective diameter of a screw thread.	CO3	L2
6	What is the principle of interferometry? How is it adapted in optical interferometer?	CO3	L2
7	What is LASER? State application of its. Explain laser interferometer	CO3	L2
8	With neat sketch explain coordinate measuring machine .	CO3	L2
9	Explain with a neat sketch, the gear tooth vernier calliper.	CO3	L2
е	Experiences	-	-
1		CO1	L2
2			

#### Module – 4

Title:	Divide and Conquer	Appr	8 Hrs
		Time:	
а	Course Outcomes	-	Blooms
-		-	Level
1	Students should be able to Understand the concept of measurement system	CO4	L2
2	Students should be able to Understand the methods of measuring devices	CO4	L2
b	Course Schedule		
Class No	Module Content Covered	CO	Level
1	Measurement systems and basic concepts of measurement methods:	CO4	L2
	Definition, significance of measurement, generalized measurement system,		
2	Definitions and concept of accuracy, precision, calibration, threshold,	CO4	L2
	sensitivity, hysteresis, repeatability		
3	Linearity, loading effect, system response-time delay. Errors in	CO4	L2
	measurement, classification of errors.		
4	Transducers, transfer efficiency, primary and secondary transducers,	CO4	L2
	electrical, mechanical,		
5	Electronic transducers, advantages of each type transducers.	CO4	L2
6	Intermediate modifying and terminating devices: Mechanical systems,	CO4	L2
	inherent problems,		
7	Electrical intermediate modifying devices, input circuitry, ballast circuit,	CO4	L2
	electronic amplifiers.		
8	Terminating devices, Cathode ray oscilloscope, Oscillographs	CO4	L2
C	Application Areas	CO	Level
1	Transducers are used in medicine, such as in sonograph machines, music	CO4	L2
	engineering and recording ,safety systems like train brakes.		

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2	Cathode ray oscilloscope are used for Measurement of voltage current, frequency.	CO4	L2					
d	Review Questions	-	-					
1	With a suitable example, explain the generalized measurement system.	CO4	L2					
2	With a block diagram, distinguish between primary and secondary transducers.	CO4	L2					
3	Explain with sketch the construction and working of an electronic transducer.	CO4	L2					
4	State the advantages of electric transducer over other transducers.	CO4	L2					
5	Explain with sketches i) Photoelectric transducers ii) Photoconductive CO4 transducers							
6	What is error? Classify the errors. Explain each type of error.	CO4	L2					
7	What is the requirement of an intermediate modifying device? Explain the inherent problems, with a mechanical system.	CO4	L2					
8	With a neat figure, explain the ballast circuit.	CO4	L2					
9	Explain the working of a CRO.	CO4	L2					
10	State the advantages of electrical signal conditioning elements.	CO4	L2					
11	What are electronic amplifiers? With a neat sketch, explain chopper amplifier.	CO4	L2					
12	With a neat figure, explain the terminating devices.	CO4	L2					
e	Experiences	-	-					
1		CO4	L2					

# E2. CIA EXAM – 2

### a. Model Question Paper - 2

Crs		18ME46B	Sem:	IV	Marks:	40	Time:	75 minute	minutes			
Code	<b>e</b> :											
Cour	se:	MECHANIC	MECHANICAL MEASUREMENTS AND METROLOGY									
-	-	Note: Answe	Note: Answer any 2 questions, each carry equal marks.									
1	а	With a suita	Nith a suitable example, explain the generalized measurement system.									
	b	With a blo transducers	Vith a block diagram, distinguish between primary and secondary ransducers.									
					OR							
2	а	State the ad	lvantages o	f electric tran	sducer over	other trans	ducers.	10	CO3	L2		
	b	Explain with sketches i) Photoelectric transducers ii) Photoconductive transducers						ive 10	CO3	L2		
3	а	Briefly expla	ain the work	ng of a tool-r	maker's micro	oscope.		10	CO4	L2		
	b	What is the requirement of an intermediate modifying device? Explain the inherent problems, with a mechanical system.						he 10	CO4	L2		
					OR							
4	а	With a neat	figure, expla	ain the ballas	st circuit.			10	CO4	L2		
	b	Explain with	a neat sket	ch, the gear	tooth vernier	calliper.		10	CO4	L2		

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#### b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

					Moc	del /	Assignmen	t Questions	3			
Crs C	ode: 1	8ME46B	Sem:		IV		Marks:	5 / 10	Time:	90 – 120	minutes	3
Cours	Course: MECHANICAL MEASUREMENTS AND METROLOGY											
Note:	Eachs	student to	answe	r 2-3 a	assignme	ents	. Each ass	ignment ca	rries equal marl	<b>K</b> .	1	1
SNo	U	SN			As	sig	nment Des	cription		Marks	CO	Level
1			Briefly e	xplair	the work	king	of a tool-n	naker's mic	roscope	5	CO3	L2
2		I	Expain \	with s	ketches					5	CO4	L2
		i	a. hyste	rsis	b. thresh	old	c. sensiti	vity d. load	ing effect			
3			Explain	the ge	eneralized	d m	easuremer	nt system. g	give example	5	CO4	L2
4			Discuss vith exa	with mple	block dia for each	agra stag	am genera ge element	alized mea:	surement syste	m 5	CO4	L2
5		l	Explain example	the o	concept	ofa	accuracy a	and precisi	ion with suitab	le 5	CO4	L2
6		l	Define electrica	a tra al tran	ansducer sducer	.m	ention any	y five med	hanical and fiv	/e 5	CO4	L2
7		(	Give th application	e cla ion	ssificatio	n c	of mechan	ical transc	lucers with the	eir 5	CO4	L2
8			Explain element	briefl s	y the va	iriou	us types o	of mechai	nical transduce	rs 5	CO4	L2
9		,	Nith an	exam	ple expla	in a	a primary a	nd second	transducer	5	CO4	L2
10			What ar nechan	e the ical tr	advantaç ansducer	ges s el	of electric lements	al transduc	er elements ov	er 5	CO4	L2
11			Differen	tiate b	etween r	nec	hanical an	d electrical	transducer	5	CO3	L2
12			Nith nea	at ske	tch expla	in c	oordinate	measuring	machine .	5	CO3	L2
13			Explain	with a	neat ske	etch	, the gear t	tooth vernie	er calliper.	5	CO3	L2
14			Derive t	he ex	pression	for l	best size w	vire		5	CO3	L2
15		I	Explain	the pr	ofiles of g	gea	r measurei	ment		5	CO3	L2
16			Explain	the co	ordinate	me	asuring ma	achine with	neat sketch	5	CO3	L2
17							_					

# D3. TEACHING PLAN - 3

#### Module – 5

Title:	Divide and Conquer	Appr	8 Hrs
		Time:	
а	Course Outcomes	-	Blooms
-	The student should be able to:	-	Level
1	Students should be able to describe functioning of force, torque, pressure etc.	CO5	L2
2	Students should be able to describe functioning of strain ,temperature	CO5	L2
b	Course Schedule		
Class No	Module Content Covered	CO	Level
1	Force, Torque and Pressure Measurement: Direct methods and indirect		L2
	method,		
2	Force measuring inst. Torque measuring inst., Types of dynamometers,	C05	L2

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3	Absorption dynamometer,Prony brake and rope brake dynamometer, and	C05	L2
	power measuring instruments		
4	Pressure measurement, principle, use of elastic members, Bridgeman gauge,	C05	L2
	McLeod gauge, Pirani gauge.	0.05	
5	Measurement of strain and temperature: Theory of strain gauges, types,	C05	L2
6	electrical resistance strain gauge, preparation and mounting of strain gauges	COF	10
0	Gauge factor, methods of strain measurement. Temperature Compensation, Wheatstone bridge circuit	005	
7	Orientation of strain gauges for force and torque. Strain gauge based load	C05	12
	cells and torque sensors.	000	
8	Resistance thermometers, thermocouple, law of thermocouple, materials	C05	L2
	used for construction, pyrometer, optical pyrometer		
		C05	
C	Application Areas	CO	Level
1	Strain gauges are widely used in microelectromechanicalsystem(MEMS) to	C05	L2
	measure strains such as those induced by force, acceleration, pressure or		
	sound. As example, airbags in cars are often triggered with MEMS		
	accelerometers		
d	Review Questions	C05	-
1	Give the classification of dynamometers with brief working principle of each	C05	L2
	class.		
2	Explain with a neat sketch, the measurement of torque using prony brake	C05	L2
	aynamometer.	005	1.0
3	Explain with a neat sketch McLeod gauge used for pressure measurement.	C05	L2
4	Explain the working of a resistance thermometer.	C05	L2
5	Define i) Gauge factor ii) Cross Sensitivity iii) strain gauge	C05	L2
7	Sketch the arrangement and explain the method of mounting strain gauges to	C05	LZ
1	measure the	005	
	bending strain		
8	Sketch and explain the working of a platform balance.	C05	12
9	Discuss the construction and working of an optical pyrometer.	C05	 L2
10	What are the necessary precautions to be taken while mounting strain	C05	L1
-	gauges?		
11	Explain with a neat sketch any one type of mechanical strain gauge.	C05	L2
12	Explain with a neat sketch, the working of hydraulic dynamometer.	C05	L2
13	With a neat sketch, explain the Bridgeman gauge, used for pressure	C05	L2
	measurement.		
14	Explain with neat sketch, the working principle of resistance thermometer	C05	L2
15	Explain using neat sketch, working principle of null balance type strain	C05	L2
	measurement.		
16	Explain law of intermediate temperature, with figure	C05	L2
е	Experiences	-	-
1			

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### E3. CIA EXAM – 3

### a. Model Question Paper - 3

Crs		18ME46B	Sem:	IV	Marks:	40	Time:	75 minute	minutes		
Code	e:										
Cour	se:	MECHANIC	AL MEASU	REMENTS A	ND METRO	LOGY					
-	-	Note: Answe	er any 2 que	stions, each	carry equal i	narks.		Marks	СО	Level	
1	а	Give the cla	ssification c	of dynamome	ters with bri	ef working p	rinciple of ea	ich 10	CO5	L2	
		class.									
	b	Explain with	n a neat ske	etch, the me	asurement o	f torque usir	ng prony bra	ke 10	CO5	L2	
		dynamomet	er.								
					OR						
2	а	Explain with	a neat sket	ch McLeod g	auge used fo	or pressure n	neasurement	. 10	CO5	L2	
	b	Explain the	working of a	resistance t	nermometer.			10	CO5	L4	
3	а	Explain with	a neat sket	ch any one ty	/pe of mecha	anical strain g	gauge.	10	CO5	L2	
	b	Explain with	a neat sket	ch, the worki	ng of hydrau	lic dynamom	eter.	10	CO5	L2	
					OR						
4	а	With a nea	at sketch, e	explain the	Bridgeman	gauge, use	d for pressu	ure 10	CO5	L2	
		measureme	nt.								
	b	Explain with	neat sketch	, the working	principle of	resistance th	nermometer	10	CO5	L2	

#### b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

				Model	Assignmer	t Questions				
Crs C	ode:	18ME46	3 Sem:	IV	Marks:	5 / 10	Time: 9	90 – 120	minutes	\$
Cours	se:	MECH METROL	ANICAL ME OGY	EASUREME	ENTS AN	ID				
Note:	Each	student to	o answer 2-3 a	issignments	s. Each ass	ignment carr	ies equal mark.			
SNo	L I	USN		Assig	nment Des	cription		Marks	СО	Level
1			What are the r	nethods of	force meas	urement		5	CO5	L2
2			Explain with a	neat sketch	n the analyt	ical balance		5	CO5	L2
3			Explain hydrai	ulic dynamo	meter with	neat sketch			CO5	L2
4			With the help prony brake c	of neat sl lynamomete	ketch expla er	ain the work	ing principle o	f 5	CO5	L2
5			Explain with a	neat sketch	n working o	f proving ring	9	5	CO5	L2
6			What are elec	tric dynamo	meters ? H	ow they are	classified	5	CO5	L2
7			Explain the typ	pes of press	sure measu	ring devices		5	CO5	L2
8			Explain how a	a bridge gag	je is used t	o measure p	ressures.	5	CO5	L2
9			Explain with a McLeod gauge	a neat sketo e	the meas	surement of	low pressure by	/ 5	CO5	L2
10			Where pirani ( neat sketch	gauge is us	ed and giv	e the workir	ng principle with	n 5	CO5	L2
11			What is therm	ocouple? E	xplain the	principle on v	which it works	5	CO5	L2
12			State the laws	governing	the functior	ning of therm	ocouples	5	CO5	L2
13			Write a short r	notes on the	ermocouple	?		5	CO5	
14			Describe the c	construction	and workir	ng of radiatio	n on pyrometer	5	CO5	
15			Describe the c	construction	and workin	ng of optical I	pyrometer	5	CO5	

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# F. EXAM PREPARATION

### 1. University Model Question Paper

Course:		MECHANICAL MEASUREMENTS AND METROLOGY Month /	Year	May /2	020
Crs (	Code:	18ME46B Sem: IV Marks: 100 Time:	1	180 m	nutes
-	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	СО	Level
1	а	What is metrology? State the objectives of Metrology.	8	CO1	L2
	b	Explain with a neat sketch International Prototype meter and imperial	12	CO1	L2
		standard yard.			
		OR			
2	а	Using MI12 set of slip gauges, build the following dimensions i) 48.3275	8	CO1	L2
		ii) 68.208.			
	b	Four length bars A, B, C & U) of approximately 250mm each are to be calibrated with standard calibrated metre bar which is actually 0.0008mm	12	CO1	
		hers than a metre. It is also found that bar B is 0.0002mm longer than bar A			
		bar 'A' 1 be length of all four bars put together is 0.0003mm longer than the			
		calibrated standard metre. Determine the actual dimension of each bar			
3	а	Explain how the straightness can be measured by using an autocollimator	10	CO2	12
	b	Explain with neat sketch the method of measuring taper angles using sine	10	CO2	 L2
	-	centre		001	
		OR			
4	а	Explain with a neat sketch, construction and working of "Johnson Mikrokator" comparator.	10	CO2	L2
	b	With a neat sketch, explain the construction and principle of Solex Pneumatic Comparator.	10	CO2	
5	а	Explain the two wire method to find the effective diameter of screw thread.	10	C03	L2
	b	With neat sketches explain how would you measure the major and minor diameters of internal screw threads.	10	CO3	L2
		OR			
6	а	Briefly explain the working of a tool-maker's microscope.	10	CO3	L2
	b	What are Tactile sensors? Explain different types of tactile sensors.	10	CO3	
7	а	Explain the working of a CRO.	10	CO4	L2
	b	Explain with sketches i)Photoelectric transducers ii) Photoconductive transducers	10	CO4	L2
		OR			
8	а	With a block diagram, distinguish between primary and secondary transducers.	10	CO4	L2
	b	State any four terminating devices. Explain any two.	10	CO4	
9	а	Explain with a neat sketch McLeod gauge used for pressure measurement.	10	CO5	L2
	b	Explain the working of a resistance thermometer.	10	CO5	L2
		OR			
10	а	Explain with a neat sketch, the measurement of torque using prony brake dynamometer.	10	CO5	L2
	b	Briefly explain the laws of Thermocouple.	10	CO5	

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### 2. SEE Important Questions

Course:		MECHANICAL MEASUREMENTS AND METROLOGY Month /	Year	May /2	018
Crs (	Code:	18ME46B Sem: IV Marks: 100 Time:		180 mi	nutes
	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Mod	Q no.	Important Question	Marks	СО	Year
ule					
1	1	State the objectives of metrology	4	CO1	2017
	2	Explain with a neat sketch International Prototype meter	6	CO1	2017
	3	Explain how the straightness can be measured by using an autocollimator.	6	C01	2017
					2017
2	1	Explain with neat sketch the method of measuring taper angles using sine centre	6	CO2	2018
	2	Explain hole basis system and shaft basis system	4	CO2	2005
	3	Differentiate a) clearance fit and interference fit b)unilateral tolerance and bilateral tolerance	6	CO2	2018
3	1	Illustrate with a neat sketch the working of sigma comparator	8	CO3	2018
	2	With a neat sketch ,the explain the construction and principle of solex pneumatic comparator	8	CO3	2018
4	1	Explain the working of generalized measurement system with block diagram taking the example	8	CO4	2018
	2	Define the following terms with reference to measuring system a) threshold b) hysteresis	8	CO4	2018
5	1	With a neat sketch ,describe the bridge gauge for pressure measurement	8	CO5	2018
	2	How are dynamometer classified? Explain with neat sketch prony brake dynamometer.	8	CO5	2018
	3	State and explain any four inherent problems associated in mechanical system	8	CO5	2018
	4	State any four terminating devices .explain any two	8	CO5	
	5	Explain the working principle of radiation pyrometer	4	CO5	2018
	6	Illustrate the working of electrical resistance strain gauge	6	CO5	2018
	7	Briefly explain the laws of thermocouple.	6	CO5	2016

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#### G. Content to Course Outcomes

### 1. TLPA Parameters

# Table 1: TLPA – Example Course

Мо	Course Content or Syllabus	Content	Blooms'	Final	Identified	Instructio	Assessment
dul	(Split module content into 2 parts which have	Teachin	Learning	Bloo	Action	n	Methods to
e-	similar concepts)	g Hours	Levels	ms'	Verbs for	Methods	Measure
#			for	Level	Learning	for	Learning
			Content			Learning	
Α	В	С	D	E	F	G	Н
1	Introduction to Metrology : Definition, objectives	8	L2	L2	Understa	Chalk	Assignment
	and concept of metrology, Need of inspection,				nd	and	-1
	Principles, process, methods of measurement,					Board	
	Classification and selection of measuring						
	instruments and systems. Accuracy, precision						
	and errors in measurement						
	System of measurement, Material Standard,						
	Wavelength Standards, Subdivision of						
	standards, Line and End standards,						
	Classification of standards and iraceability,						
	calibration of End bars (numerical Problems),						
	standardization						
	Linear Measurement and angular						
	measurements. Slip gauges- indian standards						
	on slip gauge, method of selection of slip						
	gauge, stack of slip gauge, aujustable slip						
	gauge, wringing of slip gauge, care of slip						
	building of slip gauges (M87						
	M112) Measurement of angles- sine bar sine						
	center, angle gauges, optical instruments for						
	angular measurements Auto collimator-						
	applications for measuring straightness and						
	squareness						
	•						
2	System of Limits, Fits, Tolerance and	9	L2	L2	Understa	Chalk	Assignment-
	Gauging: Definition of tolerance, Specification				nd	and	1
	in assembly, Principle of interchangeability					Talk	
	and selective assembly, limits of size, Indian						
	standards, concept of limits of size and						
	tolerances, definition of fits, hole basis system,						
	shaft basis system, types of fits and their						
	designation (IS 919-1963), geometric						
	tolerance, position-tolerances. Classification of						
	gauges, brief concept of design of gauges						
	(Taylor's principles), Wear allowance on						
	gauges, Types of gauges-plain plug gauge,						
	ring gauge, snap gauge, limit gauge and						
	gauge materials						
	Comparators:Functional requirements,						

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	classist Mikroka indicato Pneum compar ultra-op	fication, ator, sigma or, electrical- atic- back p rators and opt otimeter	mechanical-Johnson comparators, dial principles, , LVDT, ressure gauges, Solex tical comparators- Zeiss							
3	Measure Termino major d and effe wire and thread g Gear t measure addendu tangent concentr roll teste Advance	ement of screw logy of screw iameter, mino ctive diamete 3-wire metho auges, Tool m ooth termino ement using im comparat method, n ricity, run out, r for composite s in metrology	v thread and gear: threads, measurement of or diameter, pitch, angle r of screw threads by 2- ds, best size wire. Screw aker's microscope. blogy, tooth thickness constant chord method, or method and base neasurement of pitch, and involute profile. Gear e error. v:	7	L2	L2	Understa nd	Chalk and Board	Assignment- 1	
4	Measure measure Definition generaliz and con- threshold linearity, delay. E errors. Transdu seconda electroni type tran Intermed devices: problems devices, amplifier oscillosc	ement systems ement methods n, significan zed measurer cept of accura d, sensitivity, loading effect rrors in meas cers, transfer ry transducers c transducers stucers. liate modify Mechanica s, electrical input circuitry s. Terminatin ope, Oscillogr	s and basic concepts of s: ice of measurement, ment system, definitions icy, precision, calibration, hysteresis, repeatability, ct, system response-time urement, classification of efficiency, primary and s, electrical, mechanical, s, advantages of each ving and terminating al systems, inherent intermediate modifying , ballast circuit, electronic g devices, Cathode ray aphs	8	L2	L2	Understa nd	Chalk and Board	Assignment- 1	
5	Force, Measure method, measurii Absorpti rope t measure measure member Pirani ga Measure	Torque ement:Direct force me ng inst., Ty on dynamom prake dynar ng instr ement, princ s, Bridgeman auge. ement of strain	and Pressure methods and indirect easuring inst. Torque pes of dynamometers, eter, Prony brake and nometer, and power ruments. Pressure iple, use of elastic gauge, McLeod gauge, and temperature:	8	L2	L2	Understa nd	Chalk and Board	Assignment- 2	

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Theory of strain gauges, types, electrical	
resistance strain gauge, preparation and	
mounting of strain gauges, gauge factor,	
methods of strain measurement. Temperature	
Compensation, Wheatstone bridge circuit,	
orientation of strain gauges for force and	
torque, Strain gauge based load cells and	
torque sensors.	
Resistance thermometers, thermocouple, law of	
thermocouple, materials used for construction,	
pyrometer, optical pyrometer	

# 2. Concepts and Outcomes:

# Table 2: Concept to Outcome – Example Course

Mc dul e- #	Learning or Outcome from study of the Content or Syllabus	Identified Concepts from Content	Final Concept	Concept Justification (What all Learning Happened from the study of Content / Syllabus. A short word for learning or	CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark)	Course Outcome Student Should be able to
	<b>*</b>	*	77	outcome)		a.
A	<u>I</u> Otivale rete	J	K		M Lladoueteurd	<u>/N</u>
1	Students	N 4		Comprenena the	- Understand	Understand the
	snould be	Measurem		method of	measuring	measurement
	able to	ent		measurement	equipment	metnoa
			Metrology			
	metrology and					
	standards of					
	stanuarus or					
2	Studonte			Lindorstanding about	Understand	Inderstand concept
2	should be	Mechanis		measuring	measuring	and relationships of
	able to	m		mechanisms	mechanisms	limit fit tolerance
	acquire the		measuring	meenamismis	meenamismis	
	knowledge		principles			
	of limit fit					
	toloronoo					
2	Studente			Have knowledge of	Understand	Inderstand different
5	should be	Instrument		linear and angular	features of	instrument of linear
	able to	monument		measurement	components	and angular
	understand				oomponenta	anu angulai measurement
	the		Maasuramant			measurement
	knowledge		measurement			
	of linear and					
	angular					
	megsurement					
	Studente		Devices	I Inderstand the	Comprehend the	I Inderstand the
4	should be	Transduce	DEVICES	working of	working of	working terminating
	should be	Transduce		working of	working of	working terminating

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	able to		rs		terminating devices	terminating devices	devices
	understa	and					
	the conc	ept of					
	transduc	ers,					
	measure	ement					
	system,						
	terminati	ing					
	devices.						
5	Students	6	Mesurer	me	Explain the working	Understand different	Analyse the different
	should b	е	nt		of different	measuring devices	measuring devices
	able to			Devices	measuring devices		for force, torque,
	Understa	and					temperature.
	the						
	measure	ement					
	of Force	,					
	Torque,						
	Tempera	ature					
	and strai	in.					