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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

# 18ME36B PC : Mechanical Measurement & Metrology

## A. COURSE INFORMATION

### 1. Course Overview

| | | | |
|---|---|---|---|
| Degree: | B.E | Program: | ME |
| Year / Semester : | II/IV SEM | 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

| Module | Module Content | Teaching Hours | Module Concepts | Blooms 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<br>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<br>Linear Measurement and angular measurements: Slip gauges-Indian 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, slip gauge accessories, problems on 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 | 8 | Metrology measurements & standards,slip gauges | L2 Understand |
| 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 Understand |

| | | | | |
|---|---|---|---|---|
| | 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<br><br>Comparators:Functional requirements, classisfication, mechanical-Johnson Mikrokator, sigma comparators, dial indicator, electrical- principles, , LVDT, Pneumatic- back pressure gauges, Solex comparators and optical comparators-Zeiss ultra-optimeter | | | |
| 3 | Measurement of screw thread and gear:<br>Terminology of screw threads, measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3-wire methods, best size wire. Screw thread gauges, Tool maker's microscope.<br>Gear tooth terminology, tooth thickness measurement using constant chord method, addendum comparator method and base tangent method, measurement of pitch, concentricity, run out, and involute profile. Gear roll tester for composite error.<br>Advances in metrology: | 8 | Screw thread profile & metrology advances | L2 Understand |
| 4 | Measurement systems and basic concepts of measurement methods:<br>Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-time delay. Errors in measurement, classification of errors.<br>Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers.<br>Intermediate modifying and terminating devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs | 8 | Transducers Modifying and terminating devices | L2 Understand |
| 5 | Force, Torque and Pressure Measurement:Direct methods and indirect method, force measuring inst. Torque measuring inst., Types of dynamometers, Absorption dynamometer, Prony brake and rope brake dynamometer, and power measuring instruments. Pressure measurement, principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.<br>Measurement of strain and temperature:<br>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.<br>Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer | 08 | Measuring Devices Measurement of parameters | L2 Understand |

## 3. Course Material

| Module | Details | Available |
|---|---|---|
| 1 | Text books | |
| | Engineering metrology by R.K JAIN | In Lib |
| | Instrumentation ,measurements, and analysis by B C NAKRA | In Lib |
| 2 | Reference books | |
| | Mechanical ,measurements and metrology by Dr. T Chandrashekar. | In dept |
| | | |
| | | |
| 3 | Others (Web, Video, Simulation, Notes etc.) | |
| | • https://www.youtube.com/watch?v=HpIEeBtJupY<br>• https://www.youtube.com/watch?v=oPHvbWDe2YA<br>• **https://www.youtube.com/watch?v=5qnZ4bA-1PY** | Available |
| | | |

## 4. Course Prerequisites

| SNo | Course Code | Course Name | Module / Topic / Description | Sem | Remarks | Blooms Level |
|---|---|---|---|---|---|---|
| 1 | - | - | - | - | - | - |
| | 18ELE13/23 | Basic Electrical, | 1,2,3 | I &II | | L2 |
| | 18ELN14/24 | Basic Electronics | 4,5 | I &II | | L2 |

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 | Teach. Hours | Concept | Instr Method | Assessment Method | Blooms' Level |
|---|---|---|---|---|---|---|
| 17ME46B1 | Students should be able to understand the concept of metrology and standards of measurement. | 8 | Metrology measurements & standards | Chalk and board | Assignment, Unit Test & IA | L2 Understand |
| 17ME46B2 | Students should be able to acquire the knowledge of limit, fit, tolerance. | 9 | Fits, Limits & tolerances | Chalk and board | Assignment, Unit Test & IA | L2 Understand |
| 17ME46B3 | Students should be able to understand the knowledge of linear and angular measurement | 7 | Fits, Limits & tolerances | Chalk and board | Assignment, Unit Test & IA | L2 Understand |
| 17ME46B4 | Students should be able to Understand the concept of transducers, measurement system, terminating devices. | 8 | Transducers & terminating devices. | Chalk and board | Assignment, Unit Test & IA | L2 Understand |
| 17ME46B5 | Students should be able to Understand the measurement of Force, Torque, Temperature and strain. | 8 | Force & Temperature | Chalk and board | Assignment, Unit Test & IA | L2 Understand |

| - | **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<br>Control applications such as deployment of air bag in a vehicle<br>Study of behavior of materials under different types of loads<br>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 2 | PO 3 | PO 4 | PO 5 | PO 6 | PO 7 | PO 8 | PO 9 | PO 10 | PO 11 | PO 12 | Level |
| 18ME46B.1 | Students should be able to understand the concept of metrology and standards of measurement. | √ | - | - | - | - | - | - | - | - | - | - | - | L2 |
| 18ME46B.2 | Students should be able to acquire the knowledge of limit, fit, tolerance. | √ | - | - | - | - | - | - | - | - | - | - | - | L2 |
| 18ME46B.3 | Students should be able to understand the knowledge of linear and angular measurement | √ | - | - | - | - | - | - | - | - | - | - | - | L2 |
| 18ME46B.4 | Students should be able to Understand the concept of transducers, measurement system, terminating devices. | √ | - | - | - | - | - | - | - | - | - | - | - | L2 |
| 18ME46B.5 | Students should be able to Understand the measurement of Force, Torque, Temperature and strain. | √ | - | - | - | - | - | - | - | - | - | - | - | L2 |
| **Note: Mention the mapping strength as 1, 2, or 3** | | | | | | | | | | | | | | |

## 4. Mapping Justification

| Mapping | | Justification | Mapping Level |
|---|---|---|---|
| **CO** | **PO** | **-** | **-** |
| CO1 | PO1 | Apply the knowledge of measurement and metrology. | L2 |
| CO1 | PO2 | Since it is basic science -No mapping | L2 |
| 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 |

| | | | |
|---|---|---|---|
| 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 mapping | L2 |
| CO4 | PO5 | No Modern tools are used -No mapping | L2 |
| CO4 | PO6 | Impact on engineers and society through improved driving mechanism | L2 |
| CO4 | PO7 | Will affect on environment and sustainability in automation | L2 |
| CO4 | PO8 | Since the study is limited to basics -No mapping | L2 |
| CO4 | PO9 | 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 measurement. | L2 |
| 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 | PO11 | No application of management and finance principles involved -No mapping | L2 |
| CO5 | PO12 | 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 | | | | | |
| | | | | | |
| | | | | | |

ME

Prepared by Checked by Approved

Note: Anything not covered above is included here.

## C. COURSE ASSESSMENT

### 1. Course Coverage

| Module # | Title | Teaching Hours | No. of question in Exam | | | | | | CO | Levels |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | CIA-1 | CIA-2 | CIA-3 | Asg | Extra Asg | SEE | | |
| 1 | Introduction to metrology and measurement | 08 | 2 | - | - | 1 | 1 | 2 | CO1, CO1 | L1, L2 |
| 2 | System of fits,limits,and tolerance and gauging | 09 | 2 | - | - | | 1 | 2 | CO2, CO2 | L2 |
| 3 | Measurement of screw thread and gear and advances in metrology | 07 | - | 2 | - | 1 | 1 | 2 | CO3, CO3 | L2 |
| 4 | Measurement system and Measurement methods | 08 | - | 2 | 2 | | 1 | 2 | CO4, C08 | L2, |
| 5 | Measurement of force,pressure ,torque ,strain and temperature | 08 | - | - | 2 | 1 | 1 | 2 | CO5, CO5 | L2 |
| - | **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 – Slip test | | CO1 to CO5 | L2, L3, L4 . .. |
| **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 Time: | 8 Hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | - | **Blooms** |
| - | The student should be able to: | - | **Level** |
| 1 | Students should be able to Understand the objectives and methods of | CO1 | L2 |

| | | | |
|---|---|---|---|
| | measurement | | |
| 2 | Students should be able to Identification and selection of slip gauge | CO1 | L3 |
| | | | |
| **b** | ***Course Schedule*** | - | - |
| **Class No** | **Module Content Covered** | **CO** | **Level** |
| 1 | Introduction to Metrology objectives and concept of Metrology methods of measurement, Classification and selection of measuring instruments and systems. | C01 | L2 |
| 2 | Accuracy, precision and errors in measurement Classification of standards and Traceability | C01 | L2 |
| 3 | Calibration of End bars (Numerical Problems) | C01 | L2 |
| 4 | Standardization System of measurement, Material Standard, Wavelength Standards, Subdivision of standards | C01 | L2 |
| 5 | Linear Measurement and angular measurements: Slip gauges- Indian 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, | C01 | L2 |
| 6 | Slip gauge accessories, problems on building of slip gauges (M87, M112). | C01 | L2 |
| 7 | Measurement of angles- sine bar, sine center, angle gauges, optical instruments for angular measurements | C01 | L2 |
| 8 | Auto collimator-applications for measuring straightness and squareness | C01 | L2 |
| | | | |
| **c** | **Application Areas** | **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 |
| | | | |
| **d** | **Review Questions** | - | - |
| 1 | Define the term metrology | CO1 | L2 |
| 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 | L2 |
| 11 | With a neat figure, explain the principle of sine bar. What are Airy points? Explain in detail. | CO1 | L2 |
| 12 | Explain how the straightness can be measured by using an autocollimator. | CO1 | L2 |
| 13 | Build the following dimensions using M-112 set: i) 33.4565mm ii) 87.1025mm iii) 69.2875 mm i) 35.4875 mm, ii) 78.3665 mm | CO1 | L3 |
| 14 | List the slips to be wrung together to produce an overall dimension of 92.357 mm using two protection slips of 2.500 mm size | CO1 | L3 |
| 15 | Build the following angles: i) 49° 36' 48" ii) 35° 32' 36" iii) 37°9'18" | CO1 | L3 |

| | | | |
|---|---|---|---|
| 16 | A calibrated meter and bar has an actual length 1000.0006 mm. It is to be 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. | CO1 | L3 |
| **e** | **Experiences** | - | - |
| 1 | | CO1 | L2 |

## Module – 2

| Title: | Divide and Conquer | Appr Time: | 9 Hrs |
|---|---|---|---|
| **a** | ***Course Outcomes*** | - | **Blooms** |
| - | The student should be able to: | - | **Level** |
| 1 | Students should be able to Understand the concepts of tolerance,limits,fits ,geometric tolerance | CO2 | L4 |
| 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 |

| | | | |
|---|---|---|---|
| **d** | **Review Questions** | - | - |
| 1 | Explain types of fits with sketches. | CO2 | L1 |
| 2 | Write notes on: tolerance, allowance, Compound tolerances, Gauge tolerance. | CO2 | L2 |
| 3 | What are the concepts of interchangeability and selective assembly? Which is advantageous? . | CO2 | L2 |
| 4 | With neat figure, explain: i) Plug gauges, ii) Ring gauges, iii) Snap gauges | CO2 | L2 |
| 5 | What are the various types of fits used for the purpose of assembly of machine parts? Explain each with neat figure. | CO2 | L2 |
| 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 explain the working of Reed type comparator | CO2 | L2 |
| 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 ° 44 ]. | CO2 | L2 |
| 11 | Explain with a neat sketch, construction and working of "Johnson Mikrokator" comparator. | CO2 | L2 |
| **e** | **Experiences** | - | - |
| 1 | | | |

## E1. CIA EXAM – 1

### a. Model Question Paper - 1

| Crs Code: | 18ME46B | Sem: IV | | Marks: | 40 | Time: | 75 minutes |
|---|---|---|---|---|---|---|---|
| Course: | MECHANICAL MEASUREMENTS AND METROLOGY | | | | | | |

| - | - | **Note: Answer any 2 questions, each carry equal marks.** | **Marks** | **CO** | **Level** |
|---|---|---|---|---|---|
| 1 | a | With a neat figure, explain the principle of sine bar. What are Airy points? Explain in detail. | 10 | CO1 | L1 |
| | b | Explain how the straightness can be measured by using an autocollimator. | 10 | CO1 | L2 |
| | | OR | | | |
| 2 | a | Build the following dimensions using M-112 set: i) 33.4565mm ii) 87.1025mm iii) 69.2875 mm i) 35.4875 mm, ii) 78.3665 mm | 10 | CO1 | L2 |
| | b | Explain the wringing phenomena of slip gauges with neat figure. | 10 | CO1 | L2 |
| | | | | | |
| 3 | a | With neat figure, explain: i) Plug gauges, ii) Ring gauges, iii) Snap gauges | 10 | CO2 | L2 |
| | b | Explain Hole basis and shaft basis system of tolerances. | 10 | CO2 | L2 |
| | | OR | | | |
| 4 | a | Determine the dimensions of hole and shaft for a fit 30H8f7. The given data | 10 | CO2 | L2 |

| | | | | | |
|---|---|---|---|---|---|
| | | 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.<br>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 ° 44 ]. | | | |
| | b | Explain with a neat sketch, construction and working of "Johnson Mikrokator" comparator. | 10 | C02 | L2 |

## b. Assignment -1

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

| Model Assignment Questions | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crs Code: | 18ME46B | Sem: | IV | Marks: | 5 / 10 | Time: | 90 – 120 minutes |
| Course: | MECHANICAL MEASUREMENTS AND METROLOGY | | | | | | |

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

| SNo | USN | Assignment Description | Marks | CO | Level |
|---|---|---|---|---|---|
| 1 | | what are airy points | 5 | CO1 | L2 |
| 2 | | Discuss the following standards of measurements<br>a. line standard b. wave length standard | 5 | CO1 | L2 |
| 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 calibrated bar whose length is nearly equal to sum of all the four length bars. explain the procedure. | 5 | CO1 | L2 |
| 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 dimensions<br>a. 49.3825 mm b. 87.3215 | 5 | CO1 | L2 |
| 11 | | Explain the NPL method of deriving end standard from line standards | 5 | CO1 | L2 |
| 12 | | Discuss with block diagram generalized measurement system with example for each stage elements | 5 | CO1 | L2 |
| 13 | | Describe the three stages of measurement with suitable example | 5 | CO1 | L2 |
| 14 | | Define and state the signifance of following terms in measurement<br>a. Accuracy b. precision c. sensitivity d. repeatability | 5 | CO1 | L2 |
| 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 angles | 5 | CO1 | L2 |
| 20 | | Distinguish between angle gauges and slip gauges | 5 | CO1 | L2 |

| | | | | | |
|---|---|---|---|---|---|
| 21 | | Select the sizes of angle gauges required to build<br>a. $31^0\ 29'\ 24''$ b. $102^0\ 8'\ 42''$ c. $49^0$ 36' 48'' | 5 | CO1 | L2 |
| 22 | | Give the sizes of angle gauges required to build the following angles<br>a. $57^0$ 34' 9'' b. $12^0$ 20' 36'' | 5 | CO1 | L2 |
| 23 | | Sketch and explain sine bar highlighting its applications | 5 | CO1 | L2 |
| 24 | | Distinguish between systematic error and random error | 5 | CO1 | L2 |
| 25 | | 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 ° 44 ]. | | CO2 | L2 |

## D2. TEACHING PLAN - 2

### Module – 3

| Title: | Divide and Conquer | Appr Time: | 7 Hrs |
|---|---|---|---|
| **a** | ***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 diameter of screw threads by 2-wire | CO3 | L2 |
| 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** | **CO** | **Level** |
| 1 | Screw thread are used to converts rotary motion into linear motion in simple machine | CO3 | L2 |
| 2 | Laser interferometers are used as non -contact sensor in industry application | CO3 | L2 |

| | | | |
|---|---|---|---|
| | | | |
| **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 |
| | | | |
| **e** | **Experiences** | - | - |
| 1 | | CO1 | L2 |
| 2 | | | |

## Module – 4

| Title: | Divide and Conquer | Appr Time: | 8 Hrs |
|---|---|---|---|
| **a** | ***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: Definition, significance of measurement, generalized measurement system, | CO4 | L2 |
| 2 | Definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability | CO4 | L2 |
| 3 | Linearity, loading effect, system response-time delay. Errors in measurement, classification of errors. | CO4 | L2 |
| 4 | Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, | CO4 | L2 |
| 5 | Electronic transducers, advantages of each type transducers. | CO4 | L2 |
| 6 | Intermediate modifying and terminating devices: Mechanical systems, inherent problems, | CO4 | L2 |
| 7 | Electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers. | CO4 | L2 |
| 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 engineering and recording ,safety systems like train brakes. | CO4 | L2 |

| | | | |
|---|---|---|---|
| 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 transducers | CO4 | L2 |
| 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 Code: | 18ME46B | Sem: | IV | Marks: | 40 | Time: | 75 minutes |
|---|---|---|---|---|---|---|---|
| Course: | MECHANICAL MEASUREMENTS AND METROLOGY | | | | | | |

| - | - | **Note: Answer any 2 questions, each carry equal marks.** | **Marks** | **CO** | **Level** |
|---|---|---|---|---|---|
| 1 | a | With a suitable example, explain the generalized measurement system. | 10 | CO3 | L2 |
| | b | With a block diagram, distinguish between primary and secondary transducers. | 10 | CO3 | L2 |
| | | OR | | | |
| 2 | a | State the advantages of electric transducer over other transducers. | 10 | CO3 | L2 |
| | b | Explain with sketches i) Photoelectric transducers ii) Photoconductive transducers | 10 | CO3 | L2 |
| | | | | | |
| 3 | a | Briefly explain the working of a tool-maker's microscope. | 10 | CO4 | L2 |
| | b | What is the requirement of an intermediate modifying device? Explain the inherent problems, with a mechanical system. | 10 | CO4 | L2 |
| | | OR | | | |
| 4 | a | With a neat figure, explain the ballast circuit. | 10 | CO4 | L2 |
| | b | Explain with a neat sketch, the gear tooth vernier calliper. | 10 | CO4 | L2 |
| | | | | | |
| | | | | | |

## b. Assignment – 2

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

| Model Assignment Questions | | | | | | | |
|---|---|---|---|---|---|---|---|
| Crs Code: | 18ME46B | Sem: | IV | Marks: | 5 / 10 | Time: | 90 – 120 minutes |
| Course: | MECHANICAL MEASUREMENTS AND METROLOGY | | | | | | |
| Note: Each student to answer 2-3 assignments. Each assignment carries equal mark. | | | | | | | |

| SNo | USN | Assignment Description | Marks | CO | Level |
|---|---|---|---|---|---|
| 1 | | Briefly explain the working of a tool-maker's microscope | 5 | CO3 | L2 |
| 2 | | Expain with sketches<br>a. hystersis b. threshold c. sensitivity d. loading effect | 5 | CO4 | L2 |
| 3 | | Explain the generalized measurement system. give example | 5 | CO4 | L2 |
| 4 | | Discuss with block diagram generalized measurement system with example for each stage element | 5 | CO4 | L2 |
| 5 | | Explain the concept of accuracy and precision with suitable example | 5 | CO4 | L2 |
| 6 | | Define a transducer .mention any five mechanical and five electrical transducer | 5 | CO4 | L2 |
| 7 | | Give the classification of mechanical transducers with their application | 5 | CO4 | L2 |
| 8 | | Explain briefly the various types of mechanical transducers elements | 5 | CO4 | L2 |
| 9 | | With an example explain a primary and second transducer | 5 | CO4 | L2 |
| 10 | | What are the advantages of electrical transducer elements over mechanical transducers elements | 5 | CO4 | L2 |
| 11 | | Differentiate between mechanical and electrical transducer | 5 | CO3 | L2 |
| 12 | | With neat sketch explain coordinate measuring machine . | 5 | CO3 | L2 |
| 13 | | Explain with a neat sketch, the gear tooth vernier calliper. | 5 | CO3 | L2 |
| 14 | | Derive the expression for best size wire | 5 | CO3 | L2 |
| 15 | | Explain the profiles of gear measurement | 5 | CO3 | L2 |
| 16 | | Explain the coordinate measuring machine with neat sketch | 5 | CO3 | L2 |
| 17 | | | | | |

## D3. TEACHING PLAN - 3

### Module – 5

| Title: | Divide and Conquer | Appr Time: | 8 Hrs |
|---|---|---|---|
| **a** | ***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 method, | | L2 |
| 2 | Force measuring inst. Torque measuring inst., Types of dynamometers, | C05 | L2 |

| | | | |
|---|---|---|---|
| 3 | Absorption dynamometer,Prony brake and rope brake dynamometer, and power measuring instruments | C05 | L2 |
| 4 | Pressure measurement, principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. | C05 | L2 |
| 5 | Measurement of strain and temperature: Theory of strain gauges, types, electrical resistance strain gauge, preparation and mounting of strain gauges | C05 | L2 |
| 6 | Gauge factor, methods of strain measurement. Temperature Compensation, Wheatstone bridge circuit | C05 | L2 |
| 7 | Orientation of strain gauges for force and torque, Strain gauge based load cells and torque sensors. | C05 | L2 |
| 8 | Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer | C05 | L2 |
| | | C05 | |
| **c** | **Application Areas** | **C0** | **Level** |
| 1 | Strain gauges are widely used in microelectromechanicalsystem(MEMS) to measure strains such as those induced by force, acceleration, pressure or sound. As example, airbags in cars are often triggered with MEMS accelerometers | C05 | L2 |
| | | | |
| **d** | **Review Questions** | C05 | - |
| 1 | Give the classification of dynamometers with brief working principle of each class. | C05 | L2 |
| 2 | Explain with a neat sketch, the measurement of torque using prony brake dynamometer. | C05 | L2 |
| 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 | What is a thermocouple? State and explain the laws of thermocouple. | C05 | L2 |
| 6 | 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 measure the bending strain. | C05 | L2 |
| 8 | Sketch and explain the working of a platform balance. | C05 | L2 |
| 9 | Discuss the construction and working of an optical pyrometer. | C05 | L2 |
| 10 | What are the necessary precautions to be taken while mounting strain gauges? | C05 | L1 |
| 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 measurement. | C05 | L2 |
| 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 measurement. | C05 | L2 |
| 16 | Explain law of intermediate temperature, with figure | C05 | L2 |
| | | | |
| **e** | **Experiences** | - | - |
| 1 | | | |

## E3. CIA EXAM – 3

### a. Model Question Paper - 3

| Crs Code: | | 18ME46B | Sem: | IV | Marks: | 40 | Time: | 75 minutes | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Course: | | MECHANICAL MEASUREMENTS AND METROLOGY | | | | | | | | |
| **-** | **-** | **Note: Answer any 2 questions, each carry equal marks.** | | | | | | **Marks** | **CO** | **Level** |
| 1 | a | Give the classification of dynamometers with brief working principle of each class. | | | | | | 10 | CO5 | L2 |
| | b | Explain with a neat sketch, the measurement of torque using prony brake dynamometer. | | | | | | 10 | CO5 | L2 |
| | | OR | | | | | | | | |
| 2 | a | Explain with a neat sketch McLeod gauge used for pressure measurement. | | | | | | 10 | CO5 | L2 |
| | b | Explain the working of a resistance thermometer. | | | | | | 10 | CO5 | L4 |
| | | | | | | | | | | |
| 3 | a | Explain with a neat sketch any one type of mechanical strain gauge. | | | | | | 10 | CO5 | L2 |
| | b | Explain with a neat sketch, the working of hydraulic dynamometer. | | | | | | 10 | CO5 | L2 |
| | | OR | | | | | | | | |
| 4 | a | With a neat sketch, explain the Bridgeman gauge, used for pressure measurement. | | | | | | 10 | CO5 | L2 |
| | b | Explain with neat sketch, the working principle of resistance thermometer | | | | | | 10 | CO5 | L2 |

### b. Assignment – 3

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

| Model Assignment Questions | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Crs Code: | 18ME46B | Sem: | IV | Marks: | 5 / 10 | Time: | 90 – 120 minutes | | | |
| Course: | MECHANICAL MEASUREMENTS AND METROLOGY | | | | | | | | | |
| Note: Each student to answer 2-3 assignments. Each assignment carries equal mark. | | | | | | | | | | |
| **SNo** | **USN** | **Assignment Description** | | | | | | **Marks** | **CO** | **Level** |
| 1 | | What are the methods of force measurement | | | | | | 5 | CO5 | L2 |
| 2 | | Explain with a neat sketch the analytical balance | | | | | | 5 | CO5 | L2 |
| 3 | | Explain hydraulic dynamometer with neat sketch | | | | | | | CO5 | L2 |
| 4 | | With the help of neat sketch explain the working principle of prony brake dynamometer | | | | | | 5 | CO5 | L2 |
| 5 | | Explain with a neat sketch working of proving ring | | | | | | 5 | CO5 | L2 |
| 6 | | What are electric dynamometers ? How they are classified | | | | | | 5 | CO5 | L2 |
| 7 | | Explain the types of pressure measuring devices | | | | | | 5 | CO5 | L2 |
| 8 | | Explain how a bridge gage is used to measure pressures. | | | | | | 5 | CO5 | L2 |
| 9 | | Explain with a neat sketch the measurement of low pressure by McLeod gauge | | | | | | 5 | CO5 | L2 |
| 10 | | Where pirani gauge is used and give the working principle with neat sketch | | | | | | 5 | CO5 | L2 |
| 11 | | What is thermocouple ? Explain the principle on which it works | | | | | | 5 | CO5 | L2 |
| 12 | | State the laws governing the functioning of thermocouples | | | | | | 5 | CO5 | L2 |
| 13 | | Write a short notes on thermocouple ? | | | | | | 5 | CO5 | |
| 14 | | Describe the construction and working of radiation on pyrometer | | | | | | 5 | CO5 | |
| 15 | | Describe the construction and working of optical pyrometer | | | | | | 5 | CO5 | |

## F. EXAM PREPARATION

### 1. University Model Question Paper

| Course: | MECHANICAL MEASUREMENTS AND METROLOGY | | | | | Month / Year | May /2020 | |
|---|---|---|---|---|---|---|---|---|
| Crs Code: | 18ME46B | Sem: | IV | Marks: | 100 | Time: | 180 minutes | |
| - | **Note** | Answer all FIVE full questions. All questions carry equal marks. | | | | **Marks** | **CO** | **Level** |
| 1 | a | What is metrology? State the objectives of Metrology. | | | | 8 | CO1 | L2 |
| | b | Explain with a neat sketch International Prototype meter and imperial standard yard. | | | | 12 | CO1 | L2 |
| | | **OR** | | | | | | |
| 2 | a | Using MI12 set of slip gauges, build the following dimensions<br>i) 48.3275<br>ii) 68.208. | | | | 8 | CO1 | L2 |
| | 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 less than a metre. It is also found that bar B is 0.0002mm longer than bar 'A' bar 'C' is 0.0004mm longer than 'A' and bar 'ID' is 0.0001mm shorter than bar 'A'. -1 he length of all four bars put together is 0.0003mm longer than the calibrated standard metre. Determine the actual dimension of each bar. | | | | 12 | CO1 | |
| 3 | a | Explain how the straightness can be measured by using an autocollimator. | | | | 10 | CO2 | L2 |
| | b | Explain with neat sketch the method of measuring taper angles using sine centre | | | | 10 | CO2 | L2 |
| | | **OR** | | | | | | |
| 4 | a | 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 | a | 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 | a | 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 | a | Explain the working of a CRO. | | | | 10 | CO4 | L2 |
| | b | Explain with sketches i)Photoelectric transducers ii) Photoconductive transducers | | | | 10 | CO4 | L2 |
| | | **OR** | | | | | | |
| 8 | a | 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 | a | 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 | a | 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 | |

## 2. SEE Important Questions

| Course: | MECHANICAL MEASUREMENTS AND METROLOGY | | | | | Month / Year | May /2018 | |
|---|---|---|---|---|---|---|---|---|
| Crs Code: | 18ME46B | Sem: | IV | Marks: | 100 | Time: | 180 minutes | |
| | **Note** | Answer all FIVE full questions. All questions carry equal marks. | | | | - | - | |
| Module | Q no. | Important Question | | | | **Marks** | **CO** | **Year** |
| 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 | CO1 | 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 |

## G. Content to Course Outcomes

### 1. TLPA Parameters

*Table 1: TLPA – Example Course*

| Module-# | Course Content or Syllabus (Split module content into 2 parts which have similar concepts) | Content Teaching Hours | Blooms' Learning Levels for Content | Final Blooms' Level | Identified Action Verbs for Learning | Instruction Methods for Learning | Assessment Methods to Measure Learning |
|---|---|---|---|---|---|---|---|
| *A* | *B* | *C* | *D* | *E* | *F* | *G* | *H* |
| 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<br>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<br>Linear Measurement and angular measurements: Slip gauges- Indian 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, slip gauge accessories, problems on 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 | 8 | L2 | L2 | Understand | Chalk and Board | Assignment-1 |
| 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-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<br><br>Comparators:Functional requirements, | 9 | L2 | L2 | Understand | Chalk and Talk | Assignment-1 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | classisfication, mechanical-Johnson Mikrokator, sigma comparators, dial indicator, electrical- principles, , LVDT, Pneumatic- back pressure gauges, Solex comparators and optical comparators- Zeiss ultra-optimeter | | | | | | |
| 3 | Measurement of screw thread and gear:<br>Terminology of screw threads, measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3-wire methods, best size wire. Screw thread gauges, Tool maker's microscope.<br>Gear tooth terminology, tooth thickness measurement using constant chord method, addendum comparator method and base tangent method, measurement of pitch, concentricity, run out, and involute profile. Gear roll tester for composite error.<br>Advances in metrology: | 7 | L2 | L2 | Understand | Chalk and Board | Assignment-1 |
| 4 | Measurement systems and basic concepts of measurement methods:<br>Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysteresis, repeatability, linearity, loading effect, system response-time delay. Errors in measurement, classification of errors.<br>Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers.<br>Intermediate modifying and terminating devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs | 8 | L2 | L2 | Understand | Chalk and Board | Assignment-1 |
| 5 | Force, Torque and Pressure Measurement:Direct methods and indirect method, force measuring inst. Torque measuring inst., Types of dynamometers, Absorption dynamometer, Prony brake and rope brake dynamometer, and power measuring instruments. Pressure measurement, principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge.<br>Measurement of strain and temperature: | 8 | L2 | L2 | Understand | Chalk and Board | Assignment-2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 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.<br>Resistance thermometers, thermocouple, law of thermocouple, materials used for construction, pyrometer, optical pyrometer | | | | | | |

## 2. Concepts and Outcomes:

*Table 2: Concept to Outcome – Example Course*

| Module-# | 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 outcome) | CO Components (1.Action Verb, 2.Knowledge, 3.Condition / Methodology, 4.Benchmark) | Course Outcome<br>**Student Should be able to ...** |
|---|---|---|---|---|---|---|
| *A* | *I* | *J* | *K* | *L* | *M* | *N* |
| 1 | Students should be able to understand the concept of metrology and standards of measurement. | Measurement | Metrology | Comprehend the method of measurement | - Understand measuring equipment | Understand the measurement method |
| 2 | Students should be able to acquire the knowledge of limit, fit, tolerance. | Mechanism | measuring principles | Understanding about measuring mechanisms | Understand measuring mechanisms | Understand concept and relationships of limit, fit, tolerance.. |
| 3 | Students should be able to understand the knowledge of linear and angular measurement | Instrument | Measurement | Have knowledge of linear and angular measurement | Understand features of components | Understand different instrument of linear and angular measurement |
| 4 | Students should be | Transduce | Devices | Understand the working of | Comprehend the working of | Understand the working terminating |

| | | | | | | |
|---|---|---|---|---|---|---|
| | able to understand the concept of transducers, measurement system, terminating devices. | rs | | terminating devices | terminating devices | devices |
| 5 | Students should be able to Understand the measurement of Force, Torque, Temperature and strain. | Mesureme nt | Devices | Explain the working of different measuring devices | Understand different measuring devices | Analyse the different measuring devices for force, torque, temperature. |