FACULTY OF ENGINEERING & TECHNOLOGY

First Year Master of Engineering

Semester I

Course Code: 102320105

Course Title: Advanced Metrology and Experimental Techniques

Type of Course: Program Elective II

Course Objectives: To provide an insight into modern inspecting techniques along with the classical metrology so as to enhance the ability to apply knowledge of measurements and demonstarte excellent skills and techniques.

Teaching & Examination Scheme:

Contact hours per week			Course Credits	Examination Marks (Maximum / Passing)				
				Internal		External		Total
Lecture	Tutorial	Practical		Theory	J/V/P*	Theory	J/V/P*	
3	2	0	4	40/16	20/08	60/24	30/12	150/60

* **J**: Jury; **V**: Viva; **P**: Practical

Detailed Syllabus:

Sr.	Contents	Hours
1	Introduction: Concept of accuracy, Need for high precision measurement, Accuracy of numerical control system, Inaccuracy due to thermal aspects, Detailed surface roughness concept, Dimensioning & Dimensional chains, Surface and form metrology flatness, roughness, waviness cylindricity, Methods of improving accuracy & surface finish, Influence of forced vibration on accuracy, Dimensional wear of cutting tools and its influences on accuracy.	7
2	Causes and Types of Experimental Errors, Error Analysis on a Common sense Basis, Uncertainty Analysis and Propagation of Uncertainty, Evaluation of Uncertainties for Complicated Data Reduction, Statistical Analysis of Experimental Data, Probability Distributions, The Gaussian or Normal Error Distribution, Comparison of Data with Normal Distribution, The Chi-Square Test of Goodness of Fit, Method of Least Squares, The Correlation Coefficient, Multivariable Regression, Standard Deviation of the Mean, Students t-Distribution, Graphical Analysis and Curve Fitting, Choice of Graph Formats, Causation, Correlations, and Curve-fits, General Considerations in Data Analysis	7
3	Design of Experiments: Introduction, Types of Experiments, Experiment Design Factors, Experiment Design Protocol and Examples.	4

4	Laser Metrology: Free electron laser – optical alignment, measurement of distance – interferometry, reversible counting, refractive index correction, reversible counting, refractive indexcorrection, surface topography and optical component testing, beam modulation telemetry,	**5**
5	Coordinate Measuring Machine: Co-ordinate metrology, CMM configurations, hardware components, Software, Probe sensors, Displacement devices, Performance Evaluations, Dynamic errors, Thermal effects diagram, Temperature variations environment control, applications.	**8**
6	Machine Vision and Image Processing: Machine vision systems, Illumination, Magnification, Vision system measurement multisensory systems. Overview of Image Processing, Computer imaging systems, Image Analysis, Pre-processing.	**8**
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Suggested Specification table with Marks (Theory) (Revised Bloom's Taxonomy):

Distribution of Theory Marks						R: Remembering; U: Understanding; A: Application, N: Analyze; E: Evaluate; C: Create
R	**U**	**A**	**N**	**E**	**C**	
10	15	20	10	10	5	

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

Reference Books:

1	Experimental Methods for Engineers, Holman J P, McGraw-Hill.
2	Industrial Metrology, Smith G, Springer.
3	Fundamentals of Dimensional Metrology, Dotson C. Cengage.
4	Metrology and Measurement, Bewoor, A. K. and Kulkarni,V. A., McGraw-Hill.
5	Image Processing, Analysis, and Machine Vision, Sonka M, Hlavac V, and Boyle R Cengage.
6	Co-ordinate Measuring Machines and Systems, Bosch J A, Giddings and Lewis Dayton, Marcel Dekker.
7	Understanding and Applying Machine, Vision Nello, Z. Marcel Dekker.
8	Lasers – Principles, Types and Applications, Nambikar K New Age International Limited Publishers.
9	Lasers – Principles and Applications, Wilson J and Hawker J F B, Prentice Hall.
10	Springer Handbook of Metrology and Testing, Horst Czichos, Tetsuya Saito, Leslie Smith, Springer.

Course Outcomes (CO):

Sr.	Course Outcome Statements	%weightage
CO-1	Students will conceptualize fundamentals of metrology.	**30**
CO-2	Students will be able to apply concepts of data analysis and design of experiments.	**40**
CO-3	Students will learn advanced techniques used in metrology	**30**
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CO-5	Click or tap here to enter text.	Click
CO-6	Click or tap here to enter text.	Click
CO-7	Click or tap here to enter text.	Click
CO-8	Click or tap here to enter text.	Click
CO-9	Click or tap here to enter text.	Click
CO-10	Click or tap here to enter text.	Click

List of Practicals / Tutorials:

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1	Measurement of surface finish of a polished components.
2	Measurement of flatness of a surface plate.
3	Evaluation of roundness and cylindricity.
4	Statistical analysis using experimental data.
5	Analysis of Variance (ANOVA)
6	Measurement of Geometric and Form features using CMM.
7	Creation of CAD data from a physical component using CMM.
8	Generation of surface from point cloud using CMM.
9	Depth measurement using vision system (stereoscopic image).
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Supplementary learning Material:

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Curriculum Revision:

Version:	**1**
Drafted on (Month-Year):	Apr-20
Last Reviewed on (Month-Year):	Jul-20
Next Review on (Month-Year):	Apr-22