

COURSE TEMPLATE

1.	Department centre Proposing the course	Applied Mechanics
2.	Course Title	Experimental Methods
3.	L-T-P Structure	3-0-2
4.	Credits	4
5.	Course Number	AML 130
6.	Status (Category for Program)	
7.	Pre-requisite	none
8.	Status vis a vis other course	No overlap
9.	Not allowed for (indicate program names)	Allowed for all
10.	Frequency of offering	Every sem
11.	Faculty who will teach the course	Prof. S N Singh, Prof Suhail Ahmad, Prof. S.V. Veeravalli, Dr. Vikrant Tiwari, Prof. D K Sehgal, Dr. S Pradyumna,
12.	Will the course require any visiting faculty	no
13.	Course Objective (50 words) Measurements are a core component of any engineering discipline. To ensure higher level of accuracy, repeat measurements are taken which do not give the same value. The 1st part of the course teaches them how to analyze the data and extract the detailed information. The 2nd part of the course focuses on the dynamics characteristics of the Instruments which an engineering student is liable to use. The 3rd part of the course discusses some of the common instruments used for measurements of important parameters such as Displacement, force, Pressure, flow rate etc.	
14.	Course Contents (about 100 words) (Include Laboratory/ Design Activities)	
	The Course content covers the following broad topics: 1. Experimental Analysis: Types of measurements and errors, Relative frequency distribution, Histogram, True value, Precision of measurement, Method of least squares, the curve fitting, General linear regression, Theory of errors, Binomial and Gaussian distribution, Chi-square test. 2. Experimental Methods: <i>Principles of Measurement, Basic Elements of a Measuring Device.</i> Displacement measurement, Force and Torque Measurement, Temperature Measurement, Pressure Measurement, Fluid Velocity Measurement, Miscellaneous measurements. 3. Dynamics of Measurements: Dynamic Response of a Measuring Instrument, Response to Transient and Periodic Signals, First and Second order systems as well as their Dynamic Response Characteristics. 4. Laboratory The experiments have been designed to understand Experimental Analysis physically. Laboratory will enable the students to apply various statistical methodologies (viz. Mean, Median, Mode, Std Dev. etc) to get the optimum output from the day to day Engineering life experiment	

15	Lecture Outline(with topics and No. of lectures)	
Module No.	Topic	No. of Hours
i)	Types of measurements and errors, Internal and external estimates of errors, Relative frequency distribution, Histogram, True value, Precision of measurement, Best estimate of true value and precision, Methods of calculating best estimate of true value and standard deviation	7
ii)	Combination of measurements, accuracy of the mean, Significant digits. Method of least squares and its application to the calculation of best estimate of true value, the curve fitting,	8
iii)	General linear regression, Comparison and combination of measurements. Extensions of least square method. Theory of errors, Binomial and Gaussian distribution, Confidence limits, Significance test, principle of maximum likelihood and goodness of fit, Chi-square test.	9
iv)	<u>Displacement measurement</u> : Dial Gauge, Microcator, Optical Method, Pneumatic Transducer, Strain Gauges, Variable Inductance and Capacitance Transducer, Piezo-Electric, Electro-Kinetic, Photo-Electric, Ionization, Vibrating Wire And Vacuum Tube Transducer. <u>Force and Torque Measurement</u> : Elastic Type, Fluid Load Cell, Dynamometers. <u>Temperature Measurement</u> : Bi-Materials, Pressure and Resistance Thermometers, Thermocouples and Pyrometers. <u>Pressure Measurement</u> : McLeod Gauge, Pirani Gauge, Ionization Gauge, Manometers, Bourdon Tube, Resistance Gauges. <u>Fluid Velocity Measurement</u> : Pitot tube and Hot Wire Anemometer, LDA. Flow Measurement in Confined Passages and Open Channels. <u>Miscellaneous measurements</u>	10
v)	Dynamic Response of a Measuring Instrument, Response to Transient and Periodic Signals, First and Second order systems as well as their Dynamic Response Characteristics.	8
	Course Total	42

16	Brief Description of Tutorial Activities	
Tutorial sheets will be supplied to the students. They are expected to work out the problems and clarify their difficulties in the tutorial hour.		
17	Brief Description of Laboratory Activities	
Module No.	Experimental Description	No. of Hours
i)	Plot the histogram for first 50 and all 100 observed readings of the diameter of the marbles.	2
ii)	Determination of (i) Mode (ii) Median (iii) Mean (iv) Standard Deviation (v) precision (vi) Standard error (vii) approximate decimal places for the data of experiment No. 1.	2
iii)	Determination of time for 10 oscillations of a compound pendulum by repeated measurements (50 times). Calculation of period of oscillation of the pendulum using the principle of combination of measurements. Determination of best estimate of mean, standard deviation and accuracy of the period of the compound pendulum (use the method of assumed mean). Calculation of the radius of gyration and its error.	2
iv)	To measure the area of a given irregular figure on a graph paper by the planimeter and compare with the approximate area obtained by calculating the squares on the graph paper. Determination of accuracy and precision of the instrument.	2
v)	To obtain the load-deflection characteristics of an end loaded cantilever by strain gauge (electric resistance type). Reading of the strain at a point in the cantilever for different loads applied on this beam are recorded. A best straight line is to be fitted through these points, using (i) method of sequential differences (ii) method of extended differences and (iii) least squares method. Estimation of standard deviation and standard error in the slope and intercept. Note the function of the strain gauge in the load transducer. Study the wheatstone bridge used in this experiment.	2
vi)	(i) To draw the calibration curves for obstruction type of flowmeters. Discharge, $Q=K(h)^n$, where, h is the manometer reading, K and n are constants to be determined from the calibration data. (ii) For one of these obstruction type flows measuring devices take readings of the manometer, h, for different Q. Plot a best straight line by the method of least squares. Calculate the best estimate of K and n as well as their errors.	2

vii)	Obtain 30 readings for coefficient of static friction between the given body and the plane. Test for Gaussian law using chi- square test; Compare graphically the histogram of the data with the expected Gaussian curve.	2
viii)	To study the working of a linearly variable differential transformer and to use it to measure the level of liquid in a tank. Draw the circuit of the set-up and explain its working. Fit a best fit straight line by residual plot method.	2
ix)	To study the working of a pneumatic displacement transducer and plot its characteristics. Comparison with the ideal behaviour.	2
x)	To study the various types of force measuring devices available in the laboratory. Draw the characteristics of the transducer. Using this, determine the weight of unknown block and estimate the accuracy of the method. Study the use of a dial gauge as a displacement measuring devices.	2
	To study the various types of temperature measuring devices and compare these methods.	2
	To study the working of a bourdon tube pressure gauge. Using a dead weight tester this gauge is to be calibrated.	2
	Total	24
18.	Suggested text and reference materials	

	I Main References 1. Instrumentation, Measurement and Analysis by B C Nakra and K K Chaudhary, Tata McGraw Hill, 1985. 2. Principles of Measurement, Precision, Error and Truth by N C Barford, Addison Wesley, 1967. 3. Physical Measurement and Analysis by N N Cook and E Rabinowicz, Addison Wesley, 1963. 4. Experimental Methods for Engineers by J P Holman and W J Gajda, McGraw Hill Co., 1978. II Additional References 1. "Measurement Systems, application and Design" by E A Doebelin, McGraw Hill, 1975. 2. "Statistical treatment of Experimental data" by Huger D Young, McGraw Hill Co. 3. "Experimental Errors and their Treatment" by M G Goned and H R Hiregoudar, Orient Longman, India. 4. "Engineering Fundamentals in Measurements" Probability Statistics and dimensions by K C Crandall and R W Seabloom, McGraw Hill Co. 5. "Experimental Method and Measurement" by S D Brobert, J P Marsden and T W Holnes, Heinemann Educational Books. 6. "Instrumentation for Measurements in Engineering" by S Gupta, V K Technical Publishers. 7. "Instrumentation Devices and Systems" by C S Rangan, G R Sarma and V S V Mani, Tata McGraw Hill, 1983.
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S N SINGH
Course Co-ordinator
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