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COMPUTER INTEGRATED LABORATORY TESTING

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KEY WORDS: Engineering Materials, Test Equipment, P/C, computer, retrofit, laboratory, transducer, thermocouple, LVDT, Young's Modulus, temperature, pressure, Datalogger.

PREREQUISITE KNOWLEDGE: This material is intended for the Engineering Materials laboratory. The course is for second or third year engineering students with college chemistry and calculus based physics prerequisites. This computerized instrumentation would also be profitable for college Vocational/Technical or H.S. courses with such laboratories.

OBJECTIVES: Integration of computers into the Engineering Materials Science Laboratory course, where existing test equipment is not computerized, is the objective of this work. This includes temperature vs. time for phase change experiments; pressure vs. elongation for stress vs. strain; beam bending; creep; or a wide variety of experiments where change can be measured by transducers, strain/resistance (s/r) gages or bridges, thermocouples or similar devices that produce a resistance or voltage change. Input from such sensors is fed through a Datalogger to a P/C or 386. Data is imported to a spread sheet program for tables, graphs and charts.

EQUIPMENT AND SUPPLIES: Equipment and supplies include the following: 1) Sensors for specific test, i, temperature thermocouple, or pressure transducer, or Linear Variable Differential Transformer, or S/R strain gages, etc.; 2) Datalogger and related program for P/C, or storage; 3) P/C; 4) Spread sheet program for the computer; 5) Any additional standard test equipment used without computer instrumentation for the specific test, such as a universal testing machine. 6) Normal specimens for the test, such as a wood tensile or compression sample, material to undergo phase change, beam to be bent, etc.

PROCEDURE: Lab 1) To demonstrate and produce a material phase change curve we shall do the following: 1) Measure temperature vs. time during cooling from a liquid to a solid with thermocouples connected to the data logger and the P/C. 2) Import the data into a spread sheet and produce a data table and graphs/curves of time vs. temperature for the cooling curves and related phase change point. 3) Discussion should interpret the curves which display the delay in cooling when phase change is taking place. 4) This combined with a phase diagram of the materials used allows the determination of the composition of the material.

A common materials experiment is to use a lead+antimony alloy to demonstrate the phase change, with delayed cooling recorded at the phase change point of the specific composition. Here the material is heated to 330 ^{o} C, and the thermocouple is inserted in the liquid which is then allowed to cool. Assuming the same approximate temperature differential and conductivity of the container, the liquid will cool at a constant rate to the point of phase change; it will hold that temperature until the heat of phase change has been transferred and the cooling rate for the solid phase will be displayed. The fact that this data is not normally taken or reduced by computer points out the difference of a computer integrated experiment from a conventional one. The student must analyze the data to be sure that it is meaningful. Materials such as antifreeze and water, with different phase change points may be substituted.

Lab 2) A demonstration of the modulus of elasticity and related stress strain curve, plastic performance, maximum and failure strength is done with force measurements taken by pressure transducer on the ram and change in gage length measured by an LVDT attached to the test sample. The pressure transducer and the LVDT signals are fed, with the given time interval, to the data logger and then to the P/C for recording. Parallel readings can be taken with an S/R strain gage and the LVDT mounted to the same sample, both measuring displacement. Our experience is that the S/R gage glue bond to the sample is broken prior to the material failure in the plastic range.

This process of recording data by sensors that are connected to a data logger which adds a time base, and the data logger in turn to a computer, places the materials labs into a computer integrated mode with minimum expense, maximum flexibility and in a commercial model and level. The sensor signals are input into a spread sheet for tabular records, curve generation and graph printing. The laborious process of hand recordings, related errors, data entering time and errors are eliminated and the tabular and graph quality is enhanced. Much of the equipment can be shared with the physics lab for other experiments.

CREDITS: Noise level and temperature environment research by the author was facilitated by Gerald Duffy of the Instrumentation Division of the NCEL at Port Hueneme, California. Mr Duffy introduced and set up the Campbell Scientific Micrologger, thermocouples and microphones for the study. Mr Duffy has continued to give counsel for this Ventura College project.

REFERENCES: Elements of Material Science & Engineering, Van Vlack; Introduction to Materials science for Engineers, Shackelford; Engineering Materials and Their Applications, Flinn;
21X Operators Manual, Campbell Scientific Inc.
Synergistic effects of heat & high level noise on runway joint sealants; Alumbaugh, Dahl, Hoffard

SOURCE OF SUPPLIES AND EQUIPMENT WITH COST ESTIMATE:

Campbell Scientific:		
21X - 21X MICROLOGGER W/40K RAM	1845.	
ALK21X - ALKALINE BATTERY BASE FOR 21X		INC.
SC32A - OPTICALLY ISOLATED RS232 INTERFACE	130.	
SC25PS - RS232 RIBBON CBL W/PINS TO PINS/SK		25.
PC208 - SUPPORT SOFTWARE	200.	
AM416 - 16CHNL 4 WIRE INPUT MULTIPLEXER	435.	
VIATRAN:		
PRESSURE TRANSDUCER MODEL 241 0-1000 PSIG	315.	

SCHLUMBERGER:	
LVDT ARC 15	265.
TRANSDUCER CONDITIONER OD3	295.

S/R STRAIN GAGES; THERMOCOUPLE WIRE; 386 OR P/C COMPUTER.
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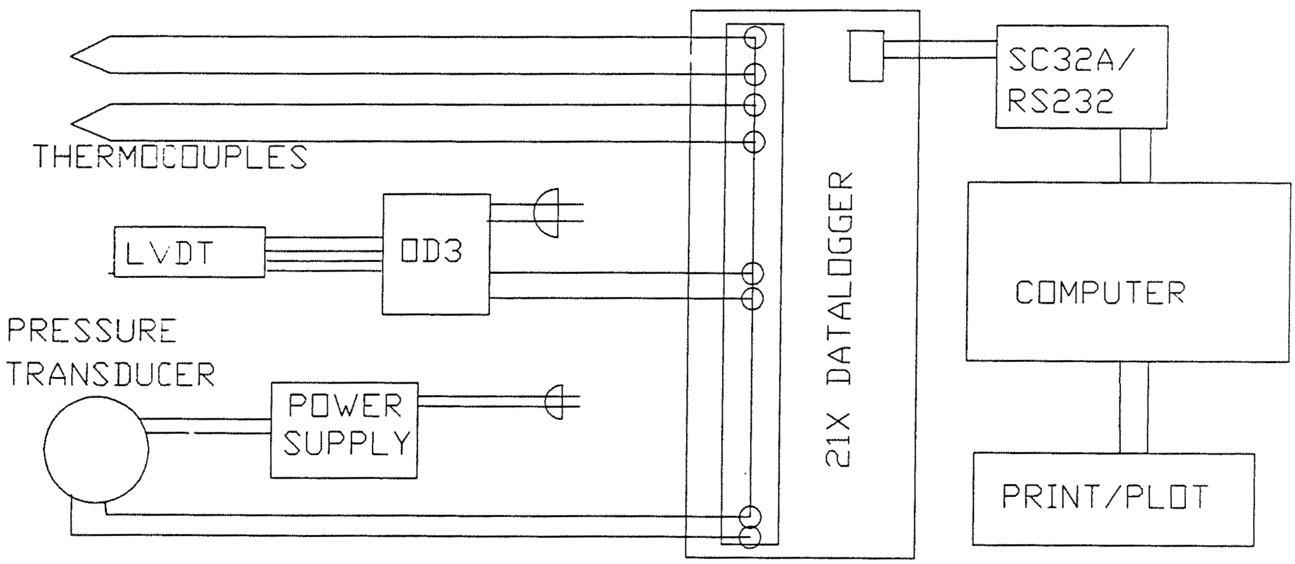

COMPUTER INTEGRATED LABORATORY DIAGRAM