COMPUTERIZED LABORATORY IN SCIENCE AND TECHNOLOGY TEACHING: COURSE IN MACHINE ELEMENTS

Ivan Kolarov

Abstract: The Computer registration of physical and mechanical quantities gives a lot of possibilities of machine elements and mechanisms research. The advantages of well-organized computer laboratory both technical and methodological, namely: Registration and on-line observation of a number of processes with random speed; replacement of high-cost specialized laboratory equipment; mathematical data processing; solving educational problems by modern technologies; dealing both with machine objects and ICT by oneself.
The purpose of the paper is to present the results of implementation of universal computer system of registering physical and mechanical quantities researching elastic coupling in the laboratory in Machine Elements at Higher School of Transport, Sofia, Bulgaria. The results are obtained by special stands and the quantities are registered by an universal interface and software. After mathematical processing a number of characteristics and properties important for practice have been obtained such as diagram of friction and dumping in the coupling, shaft angle speed, Fourier analyzing, etc.
Keywords: training, computer measurment, workshops, machine sciences

1. INTRODUCTION

The physical and mechanical parameters such as force (moment), linear and angular deformation and speed are typical parameters to be examined in the laboratory of Machine Elements. Their experimental determination gives important information about the serviceability, technical state and properties of machine elements and mechanisms.
The classic examination on machine elements and mechanisms is done on stands specially designed for that purpose and creating conditions of object operation that are close to the real ones. One, two or more parameters are examined at one and the same time. The registration of results is done most often by mechanical, electromechanical, electropneumatic devices, etc. To obtain complete information about the processes studied, electronic devices for registering rapid processes and mathematical data-processing have been produced in industry. The latter are with high prices and are specialized for a limited number of operations.
Teaching in the laboratory of Machine Elements has to combine classic models of general engineering subjects with fast-developing measuring equipment including the application of computers. The usage of universal computer equipment and software for registering and mathematical processing of electrical quantities obtained from the stands for different topics is quite appropriate under the conditions of a school laboratory.
The purpose of this paper is to present the application of a universal computer system for registering and mathematical analysis of physical and mechanical quantities investigating the

characteristic of an elastic coupling in the laboratory of Machine Elements at the Todor Kableshkov Higher School of Transport in Sofia, Bulgaria.

2. METHODS

A wide range of topics including almost the whole set of machine elements and mechanisms in practice are studied at that laboratory. The base of each examination is measuring characteristic parameters for determining the functional fitness. The parameters searched often changed their values dynamically. They are determined in a theoretical way by models proved in mechanics and experimentally making evaluation of the deviation from the results. The mistake between the results obtained by the two ways is determined. It helps students to understand that the theoretical models existing in mechanics reflect the reality, which has a great impact on their whole engineering education. But to realize this activities it is necessary to have precise measuring equipment allowing true registering of rapid processes.
To carry out laboratory workshops in Machine elements a computer system is tested. It consists of an universal interface with software and a computer. The system is integrated within the school equipment by implementing a diagram shown in Fig. 1.

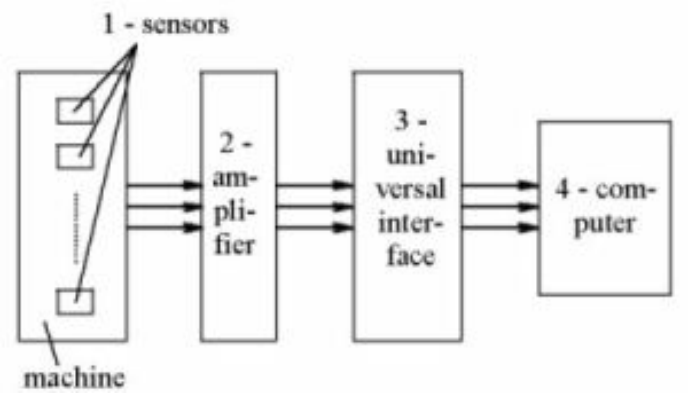
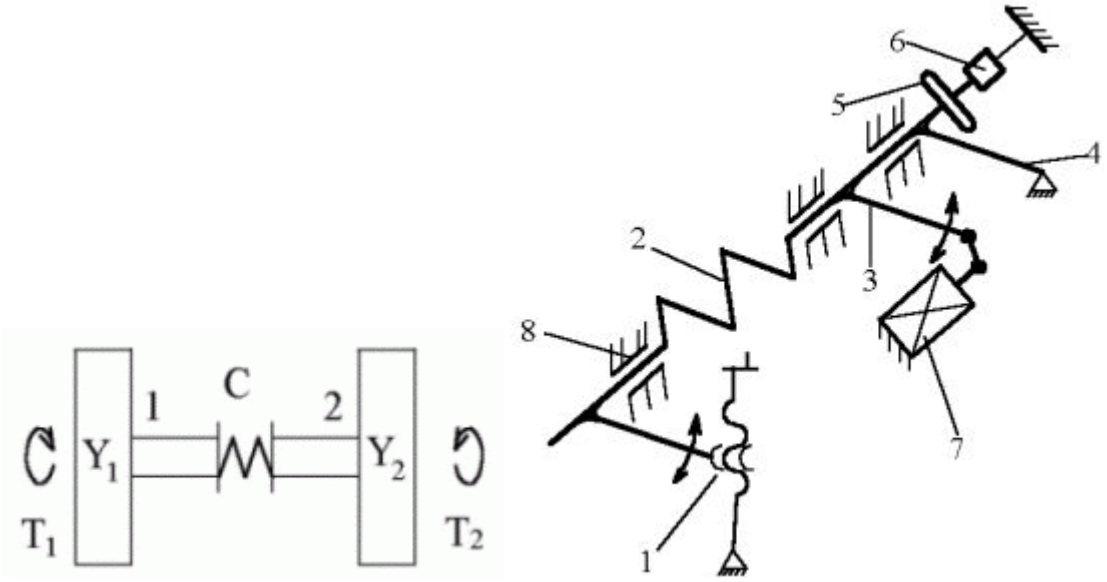


Figure 1. Diagram of measuring physical and mechanical parameters: 1 – sensor, 2 – amplifier, 3 – universal interface, 4 – computer.

Sensors and amplifiers are used depending on the physical nature of parameters measured and are electrically matched. An 12-bit interface and software **e-prolab** for registering and mathematical processing operating in WIN 95/98/XP medium (developed by Dr. Slavko Kocijancic from the University of Ljubljana, Faculty of Education, for mutual work on SI 143008 ComLabSciTech project) are used to test the process of measuring. The examinations are done for the needs of workshops on Elastic Coupling.
The main function of the elastic coupling is to reduce (dampen) the dynamic loads between the joined shafts. Representation of a dynamic model is shown in Fig.2 a, where T_1, T_2 and Y_1 and Y_2 are torques and momentum of input and output shafts. During the laboratory workshops a coupling with an elastic element made of rubber is examined. Rubber is a material with internal friction with elastic deformation. That is the reason for dampening the dynamic loads between the joined shafts.

The elastic coupling is loaded statically and dynamically on a special stan. The diagram and picture of the stand are shown in fig. 2 b and 3. The operation of the stand is as follows: The coupling (5) is loaded statically for torsion by a screw-and-nut gear (1) and a spring (2). The coupling is loaded dynamically by an electric engine and crank mechanism (7). The torsion moment in the coupling is measured by the strain-measuring shaft (6), and its angular deformation - by a strain-measuring bar (4). The signals from the strain-measuring shaft (6) and bar (4) are transmitted to a specialized amplifier and a registered by a computer system (Fig.1).



a b

Figure 2. Representation of a dynamic model (a) and of a diagram of a stand for static and dynamic study (b); 1 – screw-and-nut gear, 2 – cylindrical spring, 3 – flat spring, 4 – strain measuring of the angle of torsion, 5 – elastic coupling, 6 – strain measuring shaft for measuring the torsion moment, 7 – electric engine with a crank mechanism, 8 – supports.

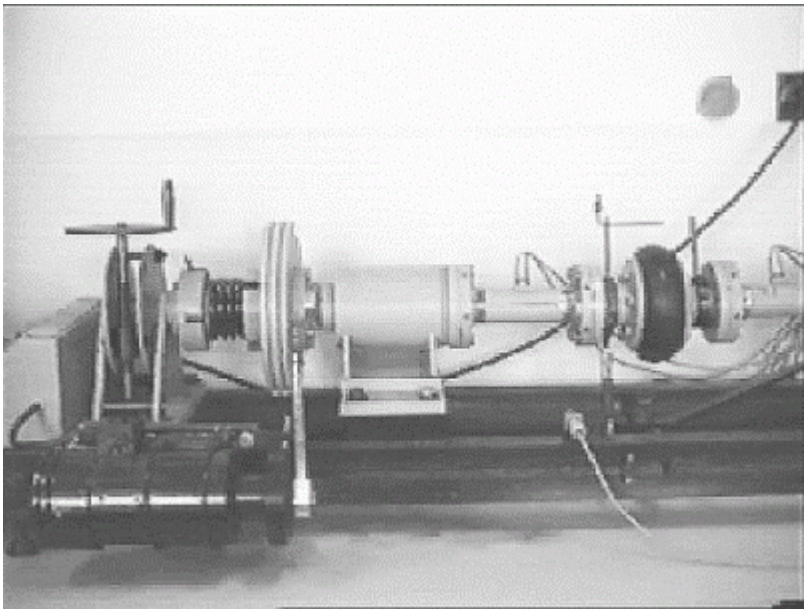


Figure 3. Picture of the stand "Elastic Coupling"

Coefficient of dampening ψ of an elastic coupling is determined from [1]:

$$\psi = \frac{A_{damp}}{A_{poten}},$$

where A_{damp} is the work of the forces of the internal friction in a coupling with deformation, A_{poten} - the mechanical work for coupling deformation. Damping in the coupling is the reason when the torque T_1 dynamically changes the torque T_2 decrease because of deformation.

3. RESULTS

Typical results registered with and dynamic loading of an elastic coupling are shown in Fig. 4 a, b and c. The input T_1 and output T_2 torques and the angular deformation φ have been measured. The dampening ability with dynamic loading has been obtained on the base of registered values. The dynamic study is carried out with a value of the static moment of 0.6 N.m and an amplitude of the dynamic moment of 8 N.m. The additional diagram images in Fig. 4 a and b have been obtained after data registering in a digital kind and their introducing into specialized software for mathematical processing. Values of 0.12 and 0.08 have been obtained for coefficient of dampening with static and dynamic study on a coupling. The frequency of changing of T_1 has been determined by using the built-in function for Fourier analyzing. In Fig. 4 c the effect of coupling dampening could be seen. A dynamically increasing of T_1 estimated on about 9 N.m has been dumped.
The mathematical and experiment results have been combined with video clips.

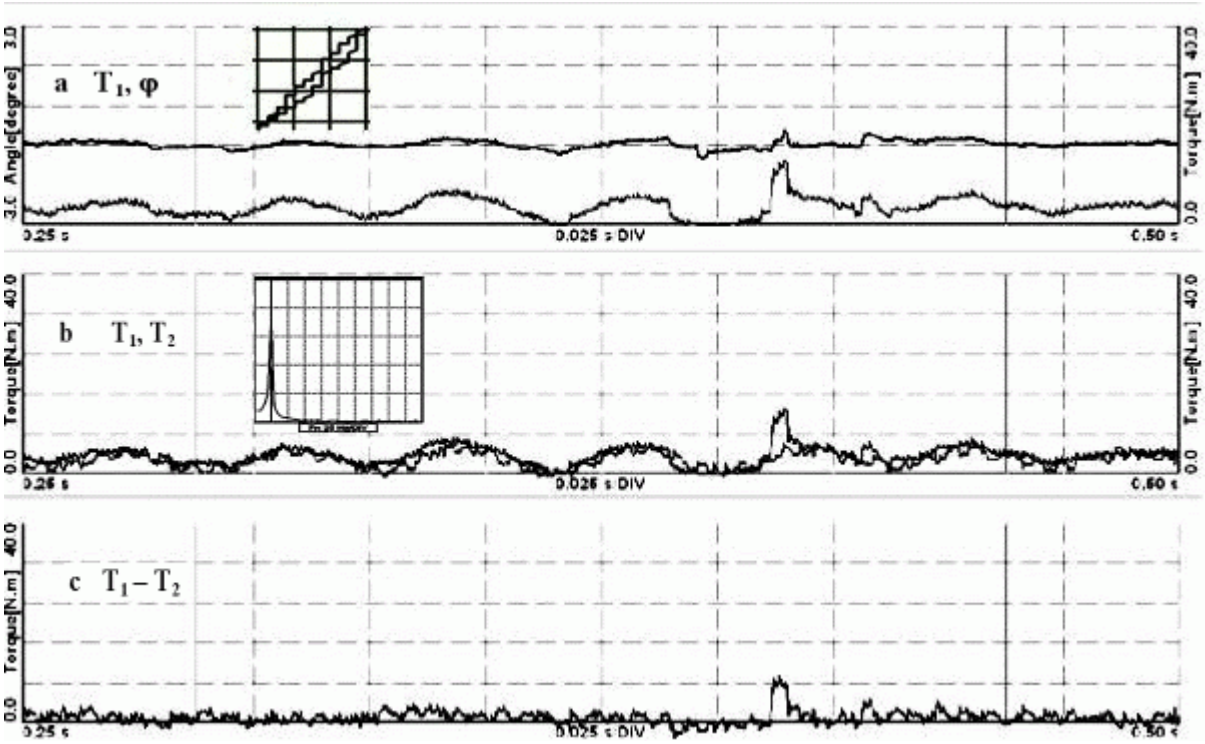


Figure 4. Results obtained with dynamic loading of a coupling; c and d – results of the dampening ability with static and dynamic loading.

4. CONCLUSION

The results obtained on the base of testing the computer system sensor – amplifier – universal interface – computer are valuable for teaching the subject Machine Elements. The computer system is used as an oscilloscope with wide possibilities to regulate the time interval of registering the results for online registering physical and mechanical parameters. An elastic coupling has been investigated by using special stand. The amplitude and frequency analysis of input and output torques and angular deformation are obtained rapidly with the help of **e-prolab** functions built-up in software. This ability of software gives extraordinarily great possibilities solve problems important for machine manufacturing and to substitute high-priced industrial electronic specialized devices. A function for automatic drawing of 2-D dependencies of parameters registered experimentally is built up in software. It allows visualizing fast 2-D diagrams after the measuring done without additional mathematical software. More results at the address http://www.vtu.bg/~ikolarov/workshop/workshops_en.htm have been presented.

After a considerable number of experiments done it is recommended to introduce a computerized system in the process of teaching in the laboratory in Machine Elements.

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References

1. Arnaudov K. and co-authors. Machine Elements, Tehnika, Sofia, 1980 (in Bulgarian).
2. Minchev N., V.Grigorov. Vibration Diagnostics of Rotation and Piston Machines, Tehnika, Sofia, 1980 (in Bulgarian).

I.KOLAROV

Department of Machine Elements, Higher School of Transport, Sofia, Bulgaria

E-mail: ikolarov@mail.bg