

Abstract

Designing an Electronic Device to Measure The Athletes' Muscle Ability

Dr-hany Mohamed zkria azab (*)

The research aims to measure athletes muscle ability through:

- Designing an electronic device to measure athletes muscle ability.
- Rationing and calibrating the device scientifically

The sample was selected intentionally and consisted of (25) different sports players registered at Egyptian federations (15) males, and (10) females

The most important results were that the designed device has a high degree of validity and reliability, calibration by specialists from Faculty of Engineering revealed the following:

- Testing calibration distances using Tool Maker Microscope with accuracy of 0.001 mm and found that the device gives an approximate error in distances equal to 0.0333 of a millimeter.
- time performance measurement test using Programmable logic controller with mechanical sensor show that the device gives an approximate error of 0.099 second

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Designing an Electronic Device to Measure The Athletes' Muscle Ability

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-Introduction:

Physical Education and Sports is necessary measures for nations' progress, so all states are working on continuity of promotion and development of physical education and sport programs a means for health, physical, psychological and moral development of its citizens, this development mainly based on using measurement and evaluation methods.

Allawi & Radwan, (1996, p.2) indicate the importance of tests and measurements as tools for identifying individual achievement and usefulness of the training process and effectiveness in raising motivation towards training and practice and trying to access top sports levels)

- Research importance:

Muscle ability is of the main ingredients in many athletic activities, including jumping, throwing, barriers in athletics, shooting, jumping and passing in basketball, handball, hockey, gymnastics, exercise etc.

Larson, Weiokm , Bochr ,Kiortn ,Bavrd , Kaznz , Hnagan , Ywaikrt and Hook indicate that ability is an important component of physical fitness. Anarionowe Larson , Weiokm , Bochr ,Matioz, Kiortn, Woagos, Clark argue that ability is an important component in Motor Fitness, Clark , Hawk , Umatioz , Mac J, Kanzn, kolman, Baruwen Nedlr, Dargnt indicate that muscle ability is of main components of the motor ability.(quoted by Zakria, 2010, p,304)

Hassanien (2004, p.45) mentions that there are two common methods to measure muscle ability,

- a. Measurement of muscle ability through output of maximum force with maximum speed by pushing the body against gravity, as in the use of long and vertical jump tests form stability or movement .
- b. Measurement of muscle ability through output of maximum force with maximum speed by pushing the body after a tool as in using throwing tool for maximum possible distance tests (medical-ball wands. etc.) and indicates that jump from stability (long or vertical), measures muscle ability devoid of any other factors which makes this method more valid in muscle ability measurement

Through a reference survey, researcher found that methods of measuring athletes' legs ability through output of maximum force with maximum speed by pushing the body against gravity are

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- 1) Sargent vertical jump test from stability
- 2) Adjusted vertical jump test from stability
- 3) Vertical jump test from stability down of the electronic device (Version) .
- 4) Babel test for legs muscles ability

Through first test description: Sargent vertical jump test from stability (appendix 1) the researcher concluded that:

- 1) The performance of the test using chalk manually.
- 2) Based on one variable (distance only) to measure muscle ability.
- 3) Efficiency index is calculated, not muscle ability.

Through the second test description Adjusted vertical jump test from stability. (appendix 2) the researcher concluded that:

- 1) It is only based on distance to extract the muscle ability.
- 2) Balogov belt fixed around player waist may affect jump distance .

As for the third test, the researcher visited the Olympic Center in Maadi and found that device measures one variable only (distance) (appendix 3).

As for the fourth test Babel test of muscle ability .

Researchers have adopted physical equation for muscle ability attachment shows (4) description of the test.

- The researchers used the following formula to extract the ability

$$\text{Ability} = \frac{\text{Mass} \times \text{Distance} \times \text{acceleration gravity}}{\sqrt{\frac{\text{distance} \times 2}{\text{acceleration gravity}}}}$$

The origin of physical law of ability

$$\text{Ability} = \frac{\text{Mass} \times \text{Distance} \times \text{acceleration gravity}}{\text{Time}}$$

The researchers replaced all the time by $\sqrt{\frac{\text{distance} \times 2}{\text{acceleration gravity}}}$

The researchers based on the distance = initial velocity $\times \frac{1}{2} \times \text{acceleration gravity} \times (\text{distance})^2$

This means that researcher considered one of the following two situations:

- 1- primary speed of the player = zero
(That means the player is still and this is a mistake because the value of speed is calculated from the moment of starting.)

- ∴ Primary speed \neq zero because the player began to jump quickly, is equal zero, where the player stops to touch and the last speed up then fall.
- 2- that they considered the speed of ascent = landing speed, so the ascent up = landing time

This really only occurs in the case of free fall of objects.

All this prompted a researcher to move towards objectivity in measurement and far from selfness and the trend of modern technology to keep up with today's challenges through the design of an electronic device to measure muscle ability for athletes.

The researcher was keen to measure the ability of muscle by the following

$$\text{Force} = \text{mass} \times \text{acceleration gravity} \qquad F = ma$$

$$\text{Work} = \text{body mass} \times \text{distance} \times \text{acceleration gravity} \qquad W = m.g.d$$

$$\text{The ability of muscle} = \frac{\text{work}}{\text{time}}$$

$$\text{The ability of muscle} = \frac{\text{body mass} \times \text{distance} \times \text{acceleration gravity}}{\text{time}} \qquad P = \frac{m.g.d}{t}$$

- Giving the results electronically individually without using any external tools.
- Print reports immediately after completion of the process of measurement including (name of the player – results of the three attempts-the best results try – weight – length of ... Etc).
- A database for the player to continue his training during the season.
- The device will give the number of variables including (force-displacement – time – ability – the absolute degree of ability).

- Research objective

The research aims to measure the athletes muscle athletes through:

- Designing an electronic device to measure athletes muscle ability.
- Rationing and calibrating the device scientifically

- Research hypotheses

- The proposed device can be used to measure the ability of muscle for athletes.
- The device has a degree of validity and reliability and high calibrated by specialists from the Faculty of Engineering.

- Research terms

An electronic device:

It Is a way to measure electronic circuits made of electronic and designed a special security and is used to measure the muscle ability of legs and the results of the measurements are printed immediately after completion of each athlete through the computer program prepared for it. (Procedural definition)

Muscle Ability:

It is the rate at which they are doing the work for the time and often accompanied by work against gravity and limited distance, it also the ability to maximize the force as soon as possible. (Chu & Myer, 2013, p. 166)

Previous studies:

- 1- Zkria (2010), entitled " *Designing digital electronic device to direct feet work to optimum performance for fencing players .*"

The study aims at Designing digital electronic device to direct feet work to optimum performance for fencing players . the researcher used descriptive approach on a Sample of (20) players from national fencing team and the most important results were designing digital electronic device to direct the movements of the feet for optimum performance of the players of fencing.

- 2- Abdul Rahman (2006) entitled " *Proposed electronic device to determine some punches properties for selection of junior boxers in tournaments:* The study aims at designing proposed electronic device to determine some punches properties for selection of junior boxers in tournaments. The researcher used descriptive approach on sample of (719) Player, the most important results of the electronic device, are validity of the device, also helped in measuring properties of some punches.

- 3- Shehata (2004), entitled " *Designing a device to determine electronic specifications and punches in Kung Fu:* The study aimed at *Designing a device to determine electronic specifications and punches in Kung Fu* researcher used a descriptive approach on heroes of the National Egyptian team . The most important results of the electronic specifications observed skills performed by the players measurements vary depending on the level of players and the contact time varies in the skill to depending the artistic performance.

- Research Procedures

Research Methodology

The researcher used the experimental approach due to its suitability to the nature of the research in order to design hardware and software stored on it and applying them.

- Research Sample

The sample was selected intentionally and consisted of (25) different sports players registered at Egyptian federations (15) males, and (10) females

Data collection methods

Reference survey:

The researcher reviewed the references and scientific studies in order to become acquainted with the tests used to measure athletes muscle ability.

Tools and equipment for the innovative device:

- Ruler unit to measure lengths.
- Microcontroller unit.
- Base unit

- Laptop + programs for measuring muscle ability.
- Cable to connect measurement parts to each other.
- Computer printer.
- Vertison Device to measure legs muscle ability.

- Research performing steps:

- The researcher divided the basic experience to "five" phases as follows:

Phase I:

The researcher in this phase designs the implementation of modular innovative device for measuring the ability of muscle.

- The base unit, and the ruler unit, micro control Unit) used in the measurement process and so with the help of the office specializes in designing electronic devices. After providing all the necessary resources from the private tools of research.

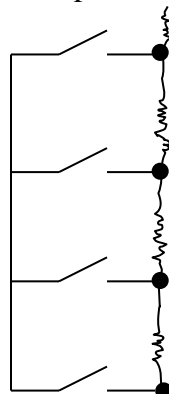
The researcher will show the findings at this stage.

Lengths ruler unit:

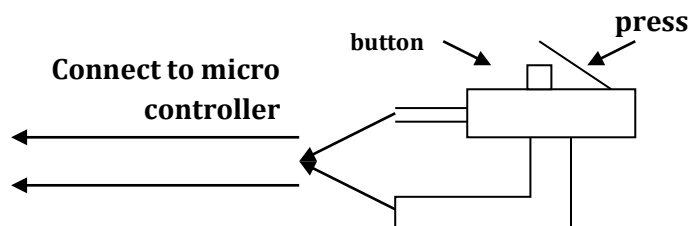
It converts the press at equal distances effort suitable with lengths measured by micro control.

The idea of the ruler:

A piecemeal effort by resistance in a row In values connected respectively counted 50 resistance and every resistance is (1 k) and the key after pressing the Connect effort intersection of resistance when pressed.



- **Base unit:** base by Sticky micro switch to press it when standing (pause standby) and when it is left it gives an electrical signal to the microcontroller to start counting time.



- Micro control unit:

Programmable PIC16F876 28 pin powered from (+ V5) by connecting to USB port with Oscillator crystal, the unit programmed through special programming unit after compiling the program to machine language and there is a USB connection to transfer data from micro control to the computer.

It Works to:

- Ensures that the athlete was standing on the base to start the measurement process.
- Recording the value of the maximum height without jumping (distance 1) by pressing on the ruler.
- When the athlete jumps high, it begins calculating the time in milliseconds until pressing on the ruler.
- record the second jumping (distance 2).



The micro control sends three values in the case of stand up and stand ready to jump in the case of the highest as well as the time to the computer through the USB port:

- First Value is the distance recorded when the player stands on the base and record the maximum height without jumping.



-The second Value Second distance after the second of highest jump.

- The third Value is the test performance test time.

Shifted	Time	Speed	Power	Abs Dgree
Test One				
Test Two				
Test Three				
Best one				

- Phase II:

Second phase of the experiment implement at the same time of the first phase, due to physical part correlation with computer programs designed to measure muscle ability. The researcher has required the most important points and steps to determine the requirements of the input and output and the contents of the windows proposed programs and design forms of the tests and the database the entire program was to measure the ability of muscle and the researcher will display some windows for the program.

- Phase III:

The researcher tested the device designed as a whole (units and programs) it has reached a number of hundreds times to identify the validity of every part and come to the problems and find appropriate solutions.

During the measurement, the researcher faced a problem we will show it in the following example:

- A player of Mass of 50 k distance (offset) for the top 15 cm 0.3 seconds in this case

$$\text{Ability} = \frac{50 \times 15 \times 9.8}{0.3} = 245$$

- Another player mass of 50 k distance of 30 cm during a time of 0.6 seconds.

$$\text{Ability} = \frac{50 \times 30 \times 9.8}{0.6} = 245$$

Note:- that the output of the ability is the same despite the fact that the ability of the first player to jump is less than the second player.

-researcher suggests:

Hit the amount of ability output \times the amount of displacement again.

Where to cut the greatest distance has a great factor in the case of equal ability.

He was a researcher called it (absolute degree of ability)

And thus the degree of absolute ability = $\frac{\text{mass of body} \times (\text{displacement})^2 \times \text{acceleration gravity}}{\text{Time}}$

-phase IV:

The researcher conducting scientific transactions of the device

- honesty related on the test

And it held a researcher associated with the work of honesty and it has been measuring on a sample of (15) boys players, and (10) of the girls players and so as to reach that innovative device is honest to measure the displacement broken up or not.

Table (1)**Significant differences between the measurement result of vertical jump by using the innovative device and device for Olympic Centre (Vertision).**

n = 25

variables	Unit	Olympic Centre		innovative device		R value	average	T value
		Mean	SD	Mean	SD			
Measure the clipped to the top offset	cm	7.643	34.408	7.557	34.397	0.997	0.011	0.098

"r" significant at (23 degrees of freedom) and (0.05) significance level = 0.396

"T" significant at (24 degrees of freedom) and (0.05) significance level = 0.0+

It is clear from Table (1) that the value of (r) calculated is greater than the value of (r) significant; also evidenced by table (1) that the value of (t) calculated is less than the value of (t) significant. The matter which shows lack of statistically significant differences between vertical jump measurement results using innovative device and the device's Olympic Center, and which indicates that the device is designed to measure the vertical jump, which measured by the device's Olympic Center (Criterion validity).

Table (2)**Reliability coefficient of vertical jump distance for the innovative device**

n = 25

NO	Experiment	unit	App.1		App.2		correlation coefficient
			Mean	SD	Mean	SD	
1	Measure the clipped to the top offset	Cm	34.397	7.557	34,378	7,572	1,000

"r" significant at (23 degrees of freedom) and (0.05) significance level = 0.396

It is clear from Table (2) reliability coefficient measurement using the vertical jump innovative device, where it is clear that the value of the correlation coefficient with significance at the 0.05 level, which indicates the reliability of the measurement results.

-Phase V:

The researcher calibrated innovative device by Department of the Faculty of Engineering Benha in the period from 04/01/2014 till 04/14/2014. The results of the calibration are:

- 1- Distance tested and calibrated using the device **TOOL Maker Microscope** with 0.001 accurately shows that the device gives an error in distances about 0.0333 millimeter.
- 2- Performance time tested and calibrated using the **PROGRAMMABLE LOGICAL CONTROLLER WITH MECHANICAL SENCORS** and show that the device gives the approximate time as much as approximately 0.099 of a second.

Based on the foregoing, the device is valid for measuring displacement and time of performance to test the ability of muscle .(appendix 5)

Statistical process:

- Mean.
- Standard deviation.
- Correlation coefficient of Pearson.
- Test t

- Discussion:

The researcher will discuss the results of the study in light of the objective of research and hypothesis and view previous results are as follows:

▪ First hypotheses:

Which states, " The proposed device can be used to measure the ability of muscle for athletes. "

The device has:

- A high degree of validity at 0.05 level of significance.
- A high degree of correlation at 0.05 level.

Could be reached to design a digital electronic device to measure legs muscle of the ability, the researcher conformed validity and reliability using the test and re-test of the device the user in question will be discussed during the first hypothesis of the following:

- To determine the validity of the device.
- To determine the reliability of the device.

Table (1) show that the value of (r) calculated is greater than the value of (r) significant; also evidenced by table (1) that the value of (t) calculated is less than the value of (t) significant. The matter which shows lack of statistically significant differences between vertical jump measurement results using innovative device and the device's Olympic Center, and which indicates that the device is designed to measure the vertical jump, which measured by the device's Olympic Center (Criterion validity).

Table (2) show that reliability coefficient measurement using the vertical jump innovative device, where it is clear that the value of the correlation coefficient with significance at the 0.05 level, which indicates the reliability of the measurement results.

Second hypotheses:

Which states: This device has a degree of validity and reliability and high calibrated by specialists from the Faculty of Engineering:

- 1- Testing calibration distances using Tool Maker Microscope with accuracy of 0.001 mm and found that it gives approximate distances error of 0.0333 millimeter.

- 2- time performance measurement test using Programmable logic controller with mechanical sensor and show that the device gives an error in the approximate time approximately 0.099 second.

-Conclusions and Recommendations:

Conclusions:

In the light of the objective of the research and the sample application that was taken and the statistical process that have been done and through the search results that have been reached the researcher, concluded the following:

- 1- Designing an electronic device to measure legs muscle ability.
- 2- Ensure the validity of the device.
- 3- Ensure reliability of the device using test/retest.
- 4- Designed device has a degree of reliability and validity in the measurement of legs muscle ability.

Recommendations:

In the light of the conclusions reached, the researcher recommends the following:

- 1- Using the device designed to measure legs muscle ability in training programs.
- 2- Using the device on faculties of physical education and sports clubs and Olympic centers.
- 3- Development of the device to take more advantage of it more to serve educational and training process.
- 4- Designing various training programs for designed device for use in the development of legs muscle ability.

References

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Appendix (1)

Vertical jump test to Sargent

-The purpose of the test:

The ability to measure the muscle of the two men in the highest vertical jump.

▪ The necessary tools:

- Panel of wood (blackboard) painted black display of 0.5 meters and a length of 1.5 Mitr. white lines drawn on it and the distance between each line and the other 2 cm.
- Smooth wall height of not less than 3.6 meters from the ground.
- Cut chalk or lime powder. A piece of cloth to clear signs of lime after every attempt by the laboratory.

▪ procedure:

- Prove the blackboard on the wall so as to be on the edge of her height allows for shorter lead testing laboratory that. and shall prove that the painting away from the wall a distance of not less than 15 cm so there is no friction against the wall during a jump up.
- Draws a line on the ground perpendicular to the wall length of 30 cm.

▪ Description of performance:

- Tester clutching a piece of chalk length of at least 2.5 cm and then stand facing the panel. And extends his hand for a high maximum and determines what can be a sign of magnesium powder or chalk on the board. Note adjoined with the heels of the land.
- Tester Stands the laboratory then facing side of the plate, so that the feet on the line 30 cm.
- Tester shake arms down and back with dismay forward and bend down and bend your knees to put just the right angle.
- Tester extended knees and feet together payment to bounce up strongly with weighted arms forward and higher to reach their maximum height possible. Where the chalk mark on the board or the wall at the highest point reached by the
- Tester is shake nearby arm forward and down when landing.

▪ Test instructions:

- Payment must be made pedicures together and develop consistency.
- Before doing jump up, the testershake arms forward and down to adjust the timing of the movement. So as to reach the maximum height possible.
- Given to the laboratory from three attempts to five consecutive attempts are calculated as a result of his best attempt.
- Measurements are taken to the nearest 1 cm.
- Jump to the top of the feet have put together consistency and not take a step or upgrading.

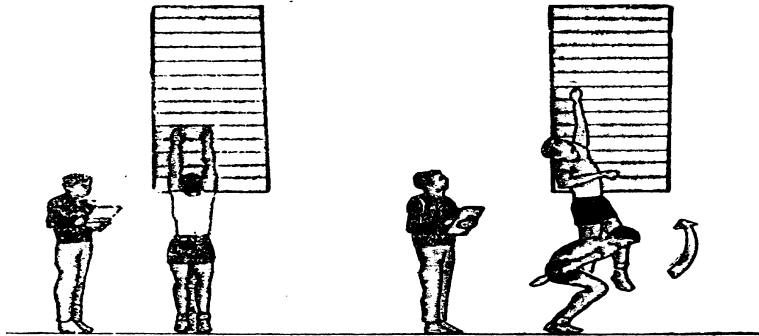
- Non-D piece of chalk outside the fingers of the hand so as not to affect the results.
- Preferred parking arbitrator on a table or ladder near the painting so he can read the results of the various attempts clearly.

▪ **Test management:**

- Recorder: call the names and record the results.
- Monitor: calculates grades and note performance.

▪ **Account grades:**

The degree of the tester are: the number of centimeters between the line of stand and mark the result jump up close to 1 cm would.



Appendix (2)

Adjusted Vertical jump test from stability

Introduced many modifications Ali Sargent test in order to raise the degree of sincerity and reduce errors caused by placing the initial mark on the blackboard, where it was noted the large number of errors occur in this part of the test.

Among the most important amendments:

Amendment introduced by AbalgeoffAbalogovThe following test specifications in the light of the amendment:

• **The purpose of the test:** measuring the ability of muscle to muscle men.

• **Tools:** Ibalogeoff belt consists of

1. leather strap wraps the central player.
2. nylon thread passes the middle of the bottom of the measuring tape, and a terminal of the highest Sticky belt and the other party free movement and passes belt loop installed.
3. tape measure.
4. piece of metal with a hole passes, including a measuring tape, proving ground by screws.
5. installed belt loop passes the nylon thread.

• **Performance Specifications:** From a standing position wraps the belt around the middle of the player so that the metal piece between his feet, and notes that have a measuring tape stretched completely, determine the reading phenomenon of the tape in front of slot metal piece and recorded, and the laboratory with this situation Balothb vertical to the maximum possible distance is noted that tape will move up with the movement of the player and the bounce will prove at the highest height up to him, the new reading recorded on the tape in front of the coin slot.

• **Guidance's:**

1. draw a circle on the ground is 50 cm in diameter jump from within.
2. If you cancel the attempt fell outside the lab after the jump circle drawn on the ground.
3. Tester has two tries to record best of it.

• **Record:** record the initial reading and the second reading and the difference between the two readings reflect the ability of muscle to the laboratory.

Appendix (3)

Certificate of vertical jump test measurement in Maadi Olympic Center.



إفـادة

يشهد المركز الرياضي لتدريب الفرق القومية بالمعادي بأن
الدكتور / هاني محمد زكريا - كلية تربية رياضية جامعة
بنها قام بعمل القياسات على عينة عددها ٢٥ لاعب (١٥
لاعب + ١٠ لاعبات) على أجهزة الطول والوزن والوثب
العمودي من القياسات وهذه إفادة منا بذلك .

مدير الطب الرياضي والإدارة العلمية

د. مجدي الصباغ

Appendix (4)

The Babel test of the muscle ability

Test vertical jump of three steps.

The purpose of the test: measuring the ability of muscle to muscle men for men.

Hardware and tools: Balance Medical - tape measure - perhaps a wall Sticky tape measure - chalk - Square planned.

-Description of performance:

1. is measured weight and height extended arm high.
2. The probationers perform warm-up appropriately.
3. when the tester is ready to start line and begins accelerating upward to cut the distance to the plate for the Advancement of only three steps, and upon arrival to the highest height possible to refer to the access point by chalk.
4. Tester have two tries and record best of it.
5. retries are wrong.

Record: recorded weight and high jump each laboratory and processed using the following equation note that weight:

$$\text{Ability} = \frac{\text{Mass} \times \text{Distance} \times 9.8}{\sqrt{\frac{\text{distance} \times 2}{9.8}}}$$

$$\text{Ability} = \frac{\text{power} \times \text{Acceleration}}{\text{Time}} \dots\dots\dots (100: 9)$$

$$\text{Distance} = \frac{(\text{time})^2 \times \text{Acceleration}}{2} \dots\dots\dots (100: 9)$$

The player can use the mass in kg on to beat the extension of the equation $\times 9.8$.

Appendix (5)
Calibration results (faculty of engineering, Benha university)

**جامعة بنها**
كلية الهندسة بنها
مؤسسة الوحدة الورش والمعامل والإستشارات

بناء على طلب السيد الدكتور / هاني محمد زكريا عزب
بعمل معايرة لجهاز قياس القدرة العضلية لكل من:-
١- قياس المسافة المقطوعة
٢- زمن الأداء
فأته قد تم عمل :-

١- اختبار معايرة المسافات وذلك باستخدام جهاز **Tool maker microscope** مم بدقه ٠.٠٠١
وتبين أن الجهاز قيد المعايرة يعطى خطأ في المسافات بقدر تقريبي حوالي ٠.٠٣٣٣ من المليمتر
٢- اختبار قياس زمن الأداء وذلك باستخدام **Programmable logic controller with Mechanical Sensor**
وتبين أن الجهاز قيد المعايرة يعطى خطأ في المسافات بقدر تقريبي حوالي ٠.٠٩٩ من الثاني
وبناء على ما سبق، فإن الجهاز صالح لقياس الإزاحة وزمن الاداء لاختبار القدرة العضلية
في حدود الاستخدام الذي تم أثناء المعايرة طبقا للمنحنيات المرفقة وفي نطاق الخطاء المبين.
وقد تحرر ذلك لسيادته دون ادنى مسؤولية على الكلية.

رئيس قسم الهندسة الميكانيكية
د. / أحمد محمد العسال
٠١٤٤ ٤١٤٤

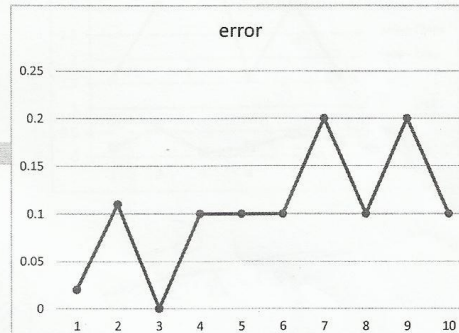
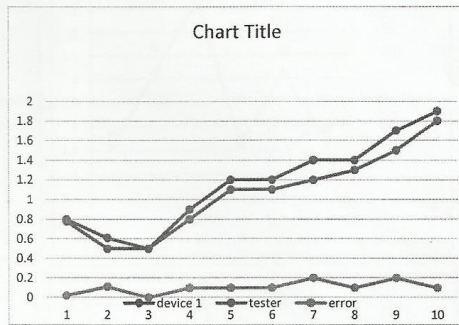
عميد الكلية ورئيس الوحدة
د. / محمد السيد يسوي
٢٠٢٥



time calibration test

By using PLC (programmable logic control) device with mechanical sensors

No	device 1	tester	error
1	0.8	0.78	0.02
2	0.61	0.5	0.11
3	0.5	0.5	0
4	0.9	0.8	0.1
5	1.2	1.1	0.1
6	1.2	1.1	0.1
7	1.4	1.2	0.2
8	1.4	1.3	0.1
9	1.7	1.5	0.2
10	1.9	1.8	0.1



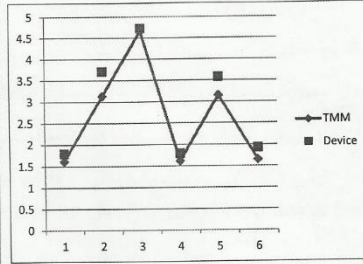
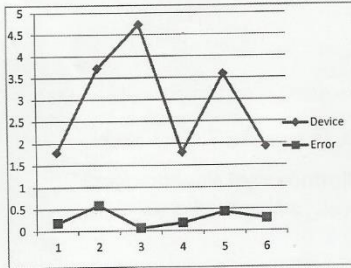
the error of reading up to 0.0999 of sec.

Handwritten signature and stamp of Beniha University Faculty of Engineering. The stamp is circular with the university's name in Arabic and English, and the year 1435.

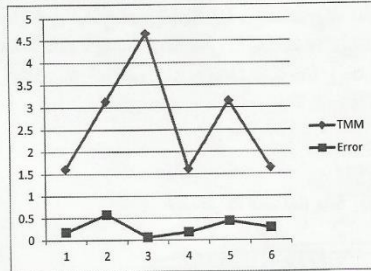


Tool Maker Microscope, 0.001 mm

	1	2	3	2	3	4
positions	1:02	1:03	1:04	2:03	2:04	3:04
TMM	1.6106	3.128	4.66	1.6118	3.1464	1.6392
Device	1.792	3.712	4.724	1.792	3.582	1.92
Error	0.1814	0.584	0.064	0.1802	0.4356	0.2808



the error of distance up to 0.033



Handwritten signature and stamp of Benha University.