Association for Machines and Mechanisms News Bulletin

Volume 9, No. 4 October 2017

Message from the Editor-in-Chief

Publication of the October 2017 issue of the Bulletin of the Association for Machines and Mechanisms (AMM) is now ready. This Volume 9, No. 4, October 2017 issue of the Bulletin of the AMM is co-edited by Dr. Shital S. Chiddarwar, the Zonal Vice President (West).

In this issue, an article, named, **"Kinematic synthesis of planar mechanisms – an overview"**, is included authored by **P.M. Padole** Professor, Mechanical Engineering Department, Visvesvaraya National Institute of Technology, Nagpur.

Announcements of different events being organized around the world are there in this issue of the bulletin. iNaCoMM, the flagship event of the AMM, is being organised in this year 2017 by Bhaba Atomic Research Centre on December 13-15 2017 in Mumbai. This is the 3rd International and 18th National Conference on Machines and Mechanisms. There will also be a Student Mechanism Design Contest during this event.

Dr. G. Sarvana Kumar, The Secretary AMM, and other office bearers are heartily thanked for extending the background support in publishing this issue. The existing Editorial Team of the Bulletin of the AMM is completing its 4-year term by the end of this year, and hope the forth-coming Annual General Body meeting will choose a new Editorial Team who will continue the publication of this bulletin in a better way. Best wishes to the New Editorial Team in advance!

AMM members and others are invited to contribute articles, and the same may please be sent to the editorial team for January 2018 issue of the New Year. Constructive suggestions, comments towards improving the quality of the Bulletin of the AMM are welcome.

Hope for a Very Happy New Year 2018 !

Prof. Santanu Das
Editor-in-Chief

Our Objectives and Activities

The main objective of AMM is to contribute to mechanical design at all levels starting from academic research to industrial initiatives, thereby enhancing the quality and reliability of indigenous machines. With this in view, AMM organises the International & National Conference on Machines and Mechanisms, iNaCoMM, and the workshops on Industrial Problems on Machines and Mechanisms, IPRoMM regularly.

Inside This Issue

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About the Association of Machines and Mechanisms (AMM)

AMM headquarters are currently located at the Department of Engineering Design, IIT Madras. A new set of office bearers have taken charge of the affairs of AMM. AMM invites both individual and corporate membership from Indian academia, research organizations and industry. Membership benefits and other information about AMM are available at www.ammindia.org. The body of Zonal Vice Presidents (ZVPs) is active over the past several years with representations from the four corners of the country. They are playing the role of nodal agencies so as to decentralise the AMM official activities and to organise workshops under the aegis of AMM to popularise the mechanism science in their respective regions. They also form the editorial team of this news bulletin. AMM invites contributory articles from its members and others working in the various fields of mechanisms science for this quarterly news bulletin. Interested people can contact the editorial team.

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Meaning of the word, 'Teacher', is one who is :

T - Thoughtful
E- Energetic
A- Active
C- Creative
H- Honest
E- Efficient
R- Responsible

--- Anonymous

Kinematic Synthesis of Planar Mechanisms – An Overview

P.M. Padole
Professor, Mechanical Engineering Department,
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The story of the kinematic analysis and synthesis begins with random growth of machines and mechanisms in the nineteenth century. In fact machines and mechanism are words giving two different images, which are close to each other. The term machine is associated with the use and transmission of the force, and motion also with varying degree but role of the force is dominating. The mechanisms whereas, definitely related to motion rather than force. The machine mainly consists of different types of mechanisms.

The kinematic analysis is the science related to determination of motion parameters of the given machine or mechanisms. It may be related to displacement, velocity, acceleration, jerk etc. However, kinematic synthesis is just reverse problem, it is the determination of mechanisms, which are suppose to satisfy some motion requirements in terms of displacements, velocity, acceleration etc. Thus, kinematic synthesis is the fundamental step in the design to create the new hardware to satisfy particular needs of the motion.

In the nineteenth century many researchers like Prof. Franz Reuleaux, Prof. Kurt Hain, R. Beyer, Prof. Burmestar, Hartmann etc. put forth many concepts and graphical procedures related to mechanism synthesis and analysis.

The major three steps followed in kinematic synthesis are :

(i) Type synthesis (ii) Number synthesis and (iii) Dimensional synthesis

TYPE SYNTHESIS

It is related to the selection of optimum mechanism from amongst available mechanisms (like gears, cams, chains, linkages etc.), which will satisfy the requirements in the best possible manner. The concept was first introduced by Prof. Reuleaux, and it may be considered as part of the art of the engineering, rather than scientific approach. The designer has to largely rely on his own ingenuity, experience, technical literature and judgement. Various parameters like space required, accuracy, reliability, life, cost etc need to be considered before reaching to the final solution.

NUMBER SYNTHESIS

This is related to number of links and connections required to give desired degree of freedom. This deals with the movability study of the mechanisms, based on number of links and joints. Grubler suggested the famous criterion to determine the degree of freedom of the planar mechanisms.

$F = 3(n-1) -2j-h$

Where, F = DOF, j = Number of lower pairs, h = number of higher pairs.

Relative lengths of the linkages also affect the movability of the mechanisms. Grashof and Harding presented the concept of class I and Class II chains. Class I chains have better movability as compared to Class II chains.

Grashof's criterion to decide the type of chains is

if $l + s \leq p + q$ – Class I

$l + s > p + q$ – Class II

where, l = largest link, s = shortest link, p & q = remaining links.

Dimensional Synthesis

It is the scientific approach to obtain the actual dimensions of the mechanisms capable of performing new functions and / or doing the old jobs with better efficiency and accuracy. The dimensional synthesis procedures can be broadly classified into two types:

(i) Graphical approaches

(ii) Analytical / Mathematical procedures

Graphical methods are quick and have advantage of staying close to the physical problems. It gives better understanding of the problem. However, it is a tedious under repeated use, and lacks accuracy to large extend.

Analytical / Mathematical procedures give accurate results and also better forth repetitive useand suitable for digital computers.

Most of synthesis procedures arepresented for four bar mechanisms by different researchers because

(i) It is the simplest possible lower pair planar mechanism, widely used.

(ii) Many mechanisms which are not basic 4-bar, but it's equivalent 4-bar can be obtained and the concept can be used

(iii) More complex mechanism have 4-bar as elements and hence the theory of 4-bar can be applied.

(iv) Many mechanism may not have physical form of 4-bar, but their equivalent 4-bar skeleton can be obtain.

Fig. 1 shows various equivalents four bar mechanisms.

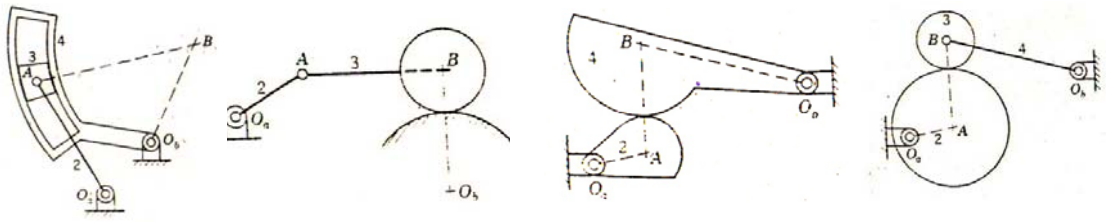


Fig. 1 Equivalence of four bar mechanisms [1]*

* Number indicates reference given at the end.

Kinematic requirements for which dimensional synthesis, need to be carry out can be broadly classified into following types

(i) Coordination of input and output link motions or function generation

(ii) Path generation – The point on the coupler is expected to travel along a given path. The path can be described by precision points. The problem can be with prescribed timings or without prescribed timings.

(iii) Position Generation / Rigid body guidance. The coupler plane is desired to be guided through different positions.

Fig. 2 shows different types of problems of kinematic synthesis.

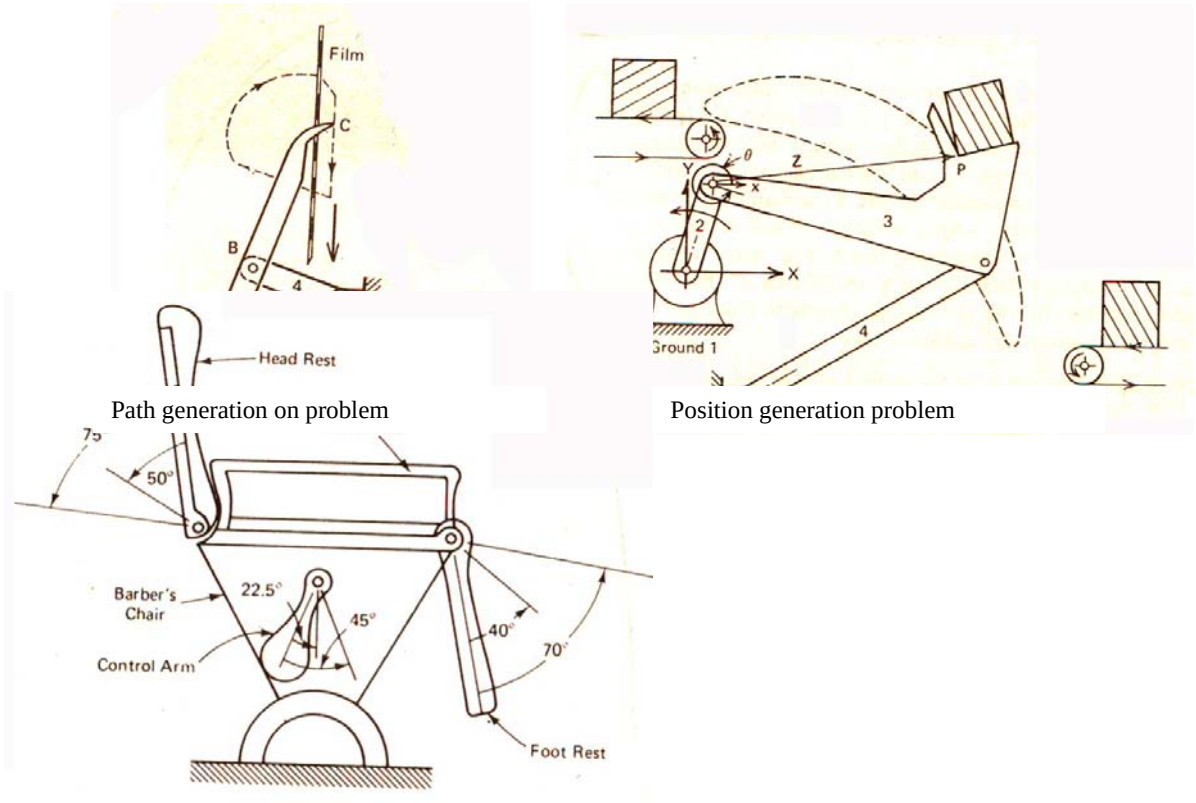


Fig. 2 different types of problems of kinematic synthesis [2]

Graphical Methods of Kinematic Synthesis

The concept of Pole (P_{12}) is very important in graphical procedure. It is the point about which body can be considered to have rotary motion when it moves from one position to other. Image of any point on the coupler in the next position can be obtained by using the pole.

Function Generation Problem

The concept of the relative pole (R_{12}) similar to pole is developed for function generation problem. This concept can be used to synthesize mechanisms to coordinate up to three positions of input link and corresponding three positions of output link.

The concept of inversion is also used to synthesize a four bar linkage to coordinate input output link positions.

To coordinate large number of positions of input and corresponding output link, *overlay technique* is suggested, which is trial-error method giving mechanism with sufficient accuracy.

Position Generation Problem

The coupler is required to be guided through different positions. In this problem mechanism can be obtained if at least two points on the coupler can be chosen, images of which will be on circular arcs. These two points can be selected as moving pivots and corresponding centres of the circular arcs can be treated as fixed pivots.

For 3 position generation any two points on the coupler can be selected as moving pivots and mechanisms can be obtained easily. The concept of pole triangle is used.

However, for four position generation randomly any point on the coupler can be selected as moving pivot, because four images of that point may not lie on circular arc.

Here, concept of circle point curve and centre point curve suggested by Burmeter is used for synthesizing the mechanism.

PATH GENERATION PROBLEM

In Path Generation Problem a mechanism is to be synthesized, so that coupler point traces the desired path. The path generation can be without / with prescribed timings. In the problem of path generation with prescribed timings, it is expected to have definite relationship between input link angular motion and path generation.

The path is described by accuracy points. For three precision points, an inversion technique is used for synthesizing the mechanisms. However, for four and five precisions points, point position reduction methods are used to design the mechanisms.

ANALYTICAL METHODS OF KINEMATIC SYNTHESIS

Analytical methods of synthesis of mechanisms, give better accuracy, good for repetitive operation and compatible for digital computers.

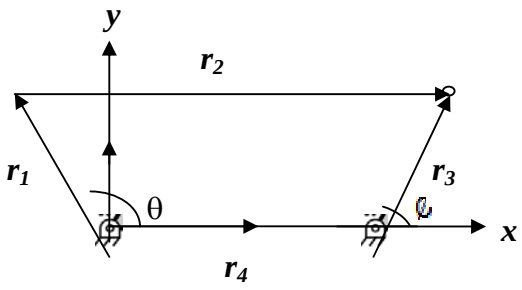
Well-known Freudenstein close loop equation can be used for synthesizing four bar linkage for function generation.

$K_1\cos\theta - K_2\cos\phi + K_3 = -\cos(\theta - \phi)$

Where

$K_1 = r_1/r_4$, $K_2 = r_1/r_2$

$$K_3 = \frac{r_2^2 - r_1^2 - r_3^2 - r_4^2}{2r_2r_4}$$



Precision points are selected as per Chebyshev's spacing to reduce the structural error. J[th] precision point is given by

$$x_j = \frac{x_f + x_s}{2} - \frac{x_f - x_s}{2}\cos\frac{(2j-1)\pi}{2n}$$

x_s = starting point

x_f = end point

n = number of precision points.

The concept of displacement matrix is extensively used for synthesizing mechanisms for rigid body guidance, path generation problems by Suh and Radcliffe. The method is readily suitable for digital computers.

The complex number system, representing 'DYADS' is used to design planar mechanisms for function, path and position generation problems. Prof. Sandor and Erdman used this concept extensively to synthesize the mechanism for complex situations.

ADJUSTABLE MECHANISMS

Mechanisms composed of links, cam, gears and their combinations are used in machines to generate predetermined motion characteristics. Different kinds of motions can be obtained from the same mechanism if it can be made adjustable. In this respect, linkage mechanisms offer greater advantages over the cam and gear mechanisms because they can be readily adjusted. The adjustment in the four bar planar mechanism can be done by

(i) Change in the position of one of the fixed pivots,

(ii) Change in the length of one of the links,

(iii) Combination of above.

The different ways by which the four bar mechanism can be adjusted is shown in figure-3. Most common form of adjustment is to change the position of one of the fixed pivots with respect to moving pivots. This has advantage that adjustment can be done without changing the length of any other links except fixed link. Figure (3C) in shows this type of adjustment.

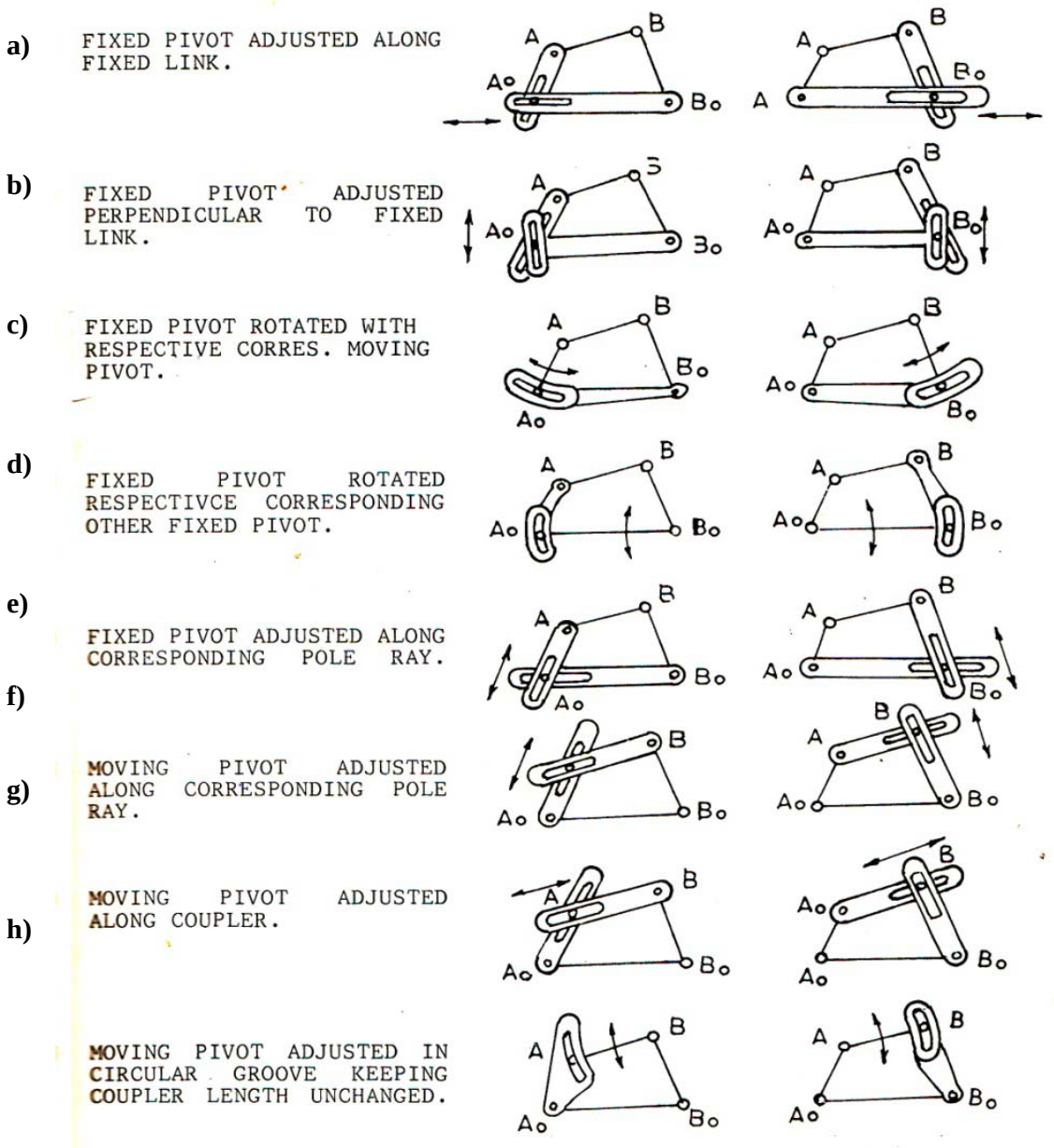


Fig. 3 Ways of adjusting the mechanisms [9]

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Forthcoming Events

iNaCoMM 2017

December 13-15, 2017

www.inacomm2017.org

SMDC

Student Mechanism Design Contest

Objective:

One of the key objectives of the Association for Machines and Mechanisms (AMM) is to promote innovation among the students. A mechanism design contest has been integral part of iNaCoMM since 2009. The purpose of the competition is to encourage the students to apply their theoretical knowledge in the domain of mechanisms and machines to solve problems relevant to the society.

Eligibility:

Participation is restricted to individuals/groups of students (up to three members), who should be registered as full-time students/research scholars/project staff in recognized institutes.

Participation:

Participants are invited to submit proposals for design, construction and operation of mechanisms which are innovative and capable of solving a challenging design problem. The design problem may be chosen from a wide range of application domains - from agricultural and rural technology to automobile and aerospace engineering.

Guidelines:

- Participants must submit a 2-page proposal outlining the design challenge and novelty/innovation of the proposed design. The proposals have to be submitted through email, with the subject line **"Proposal for the Student Mechanism Design Contest"** to the email address: inacomm2017@barc.gov.in
- The winner will be decided based on the extent of innovation, difficulty of the design challenge, effectiveness of the proposed solution towards solving the actual problem etc.
- In any matter related to the contest, the decision of the judges and/or the organisers will be final and binding.
- Finished prototypes are to be demonstrated during iNaCoMM 2017 (December 13 - December 15, 2017) before a panel of judges.
- The finalists will be provided with TA/DA.

- **1st Prize: ₹10,000**
- **2nd Prize: ₹6,000**
- **3rd Prize: ₹4,000**

All participants will be awarded with Certificates from AMM

Important Dates

- **Submission of Proposal - 25th September, 2017**
- **Result of 1st Round Elimination - 10th October, 2017**
- **Submission of Detailed Design - 10th November, 2017**
- **Result of 2nd Round Elimination - 20th November, 2017**
- **Demonstration by Finalist - 13th-15th December, 2017**

3rd International and 18th National Conference on Machines & Mechanisms

Organized by

Division of Remote Handling & Robotics

Bhabha Atomic Research Centre Mumbai

IFToMM

IFToMM Asian Mechanism and Machine Science (Asian MMS 2018)

December 17-20, Bengaluru, India

J. N. Tata Auditorium, Indian Institute of Science (IISc), Bengaluru, India

Welcome to Asian MMS 2018!

Asian Conference on Mechanism and Machine Science (Asian MMS 2018) is an international conference organized under the patronage of IFToMM. The aim of the conference is to bring together academic researchers, industry professionals, and students in the fields of mechanism and machine science. The first Asian MMS 2010 was held in Taipei. This conference is the fifth in the series after Tokyo in 2012, Tianjin in 2014, and Guangzhou in 2016. The Asian MMS 2018, although primarily intended for Asian countries, serves as a global platform for the participants to exchange ideas and present their research in the following topics.

Topics

- Theoretical kinematics
- Computational kinematics
- Machine elements
- Actuators and sensors involving mechanics
- Gearing and transmissions

- Linkages and cams
- Mechanism design
- Dynamics of machinery
- Tribology
- Vehicle mechanisms, dynamics, and design
- Reliability in machines and mechanisms
- Experimental methods in mechanisms
- Robotics and mechatronics
- Biomechanics
- Micro/nano mechanisms and systems
- Medical/heathcare devices
- Nature and machines
- Compliant mechanisms
- History of mechanism and machine science
- Education in mechanism and machine science
- Reconfigurable mechanisms and reconfigurable manipulators
- Parallel and serial manipulators

Important dates

Call for special session proposals	**October, 15, 2017**
First call for papers	**October, 15, 2017**
Second call for papers	**December, 1, 2017**
Session proposal ends	**February, 1, 2018**
Third call for papers	**February, 1, 2018**
Abstract Submission	**April, 10, 2018**
Acceptance of abstract	**May, 1, 2018**
Full paper submission	**July, 1, 2018**
Acceptance of full paper	**September, 1, 2018**
Final manuscript submission	**September, 15, 2018**
Final programme	**November, 1, 2018**

Conference dates

Pre-conference workshop	**December, 17, 2018**
Conference	**December, 18-19, 2018**
Sight-seeing	**December, 20, 2018**

Registration

Registration opens	**September, 1, 2018**
Author registration deadline	**October, 1, 2018**
Early bird registration closes	**October, 15, 2018**

Proceedings

Selected papaers of the conference will be published in a Springer book. Authors will have full access to e-book.

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IFToMM

15 th IFToMM World Congress June 30 - July 4 2019

www.iftomm2019.com

Call for Paper

15th IFToMM World Congress will be held in Krakow, Poland in June 30 – July 4, 2019. IFToMM World Congress is held every 4 years and is the largest congress on mechanism and machine science. It will provide opportunityfor researchers, scholars and students with interests in the theory and practice of mechanisms and machines for new ideas, sharing experiences, and discussing future developments. We hereby would like to extend our sincere welcome to you and to ensure all of you a wonderful congress and a memorable visit during your stay in Krakow during 2019 IFToMM World Congress!

Sincerely yours
Organizing Committee

TOPICS OF THE CONGRESS

Papers are welcome on the general areas of the theory and practice of machines and mechanisms, but not limited to the topics of the IFToMM Technical Committees and Permanent Commissions, namely:

- Biomechanical engineering
- Computational kinematics
- Design methodology
- Nanomechanical engineering
- Computational kinematics
- Design methodology
- Dynamics of machinery
- Education
- Gearing and transmissions
- History of MMS
- Linkages and mechanical controls
- Mechatronics
- Micromechanisms
- Multibody dynamics
- Reliability of machines and mechanisms
- Robotics
- Rotor dynamics
- Standardization of terminology
- Sustainable energy systems
- Transmission machinery
- Tribology
- Vibration
- Others

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Prof. Teresa Zielińska – Warsaw

PRESENTATION AND PROCEEDINGS

The official language is English. Registered participants will receive one Digital Proceedings.

PAPER SUBMISSION

All papers must be submitted electronically and they will be reviewed. Authors are requested to submit a full length paper, 4 pages (minimum) to 10 pages (maximum). The abstracts are NOT acceptable. The format will follow the IFToMM template that is available in the congress webpage

IMPORTANT DATES

15 December, 2018	Start registration
10 January, 2019	Paper submission deadline
10 April, 2019	Notification on final paper Acceptance
30 May, 2019	Deadline for paying fee of presenting authors
30 May, 2019	Final full paper submission
End of June (First week of July)	IFToMM Congress

CONGRESS LOCATION

The conference will take place in the Auditorium Maximum of the Jagiellonian University. Krakow is the capital of Małopolska province located on the south of Poland, large academic and cultural centre and is one of the most visited cities in Poland. There are numerous historical monuments, good hotels, restaurants and recreational opportunities. It is not a simple task to describe the unique character of Krakow to those who still have not had the opportunity to visit this city. This uniqueness is primarily due to the rare cultural heritage embodied within the city walls. Here, in the year 1000, a Roman Catholic bishopric was founded. Here, the residential royal castle was constructed on the Wawel Hill, becoming the site for the coronations and burials of kings, as Krakow was the capital of Poland from the 11th to 17th century.

ACCOMODATION

A variety of hotels with special rate in different standards with the room rate ranging from EURO 80 to EURO 180 will be listed on the IFToMM 2019 website.

TRAVEL INFORMATION

Krakow airport is located about 10 km from the city centre and has a number of direct flight connections with major European airports (Munich, Frankfurt, Vienna, Berlin, Paris, Brussels, London, and others).
International airport in Kraków (10 km from the city)
http://www.krakowairport.pl/en
International airport in Katowice (80 km from the city)
http://www.katowice-airport.com

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www.iftomm2019.com

Also find link: http://iftomm2019.com/ and actual official IFToMM website: iftomm.net

Third International Scientific Conference "Mechanics 2018"

(21-23 June 2018)

Georgian Technical University, Tbilisi, Georgia

International Federation for the promotion the of machines and mechanisms science (IFToMM) and Georgian Committee of IFToMM with the assistance and support of Georgian Technical University, Institute of Machines Mechanics, Georgian Aviation University, Ak. Tsereteli State University, will held on June 21-23, 2018 in Tbilisi, Georgia, Third International Scientific Conference "Mechanics 2018".

The conference will be held in accordance with the Resolution of the International Scientific Conference "Mechanics 2014" (19-21 June 2014) that was organized under the patronage of IFToMM, Georgian Committee of IFToMM, Georgian Technical University and Institute of Machines Mechanics.

We are honored to invite you to participate in the conference.
Please see www.gsiftomm.org.ge
Contact Email ID: mechanics2018@gciftomm.org.ge

Organizational Committee

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