Strategic Plan 2015-2020,
Department of Mathematics

Overall strategy
Mathematics is acknowledged as the language of science. The mathematical sciences identify structures and study their relationships. They formulate powerful abstract concepts and models that unify, clarify and predict phenomena in science and technology. The development of theories and problem solving within such abstract models and the associated interaction with specific applications in more concrete settings, are the essence of modern mathematics. The ability to detect similar structures and to derive results that are applicable across different sciences represents an enormous strength.

As one of the largest centres of mathematical fields in Norway, the Department of Mathematics has a responsibility for covering a wide spectre of research areas. This is important from a national research point of view. At the same time this is necesssary in order to offer a research based education program in the various fields of mathematics. At the same time the department needs to streamline its activities in order to establish and maintain robust and sustainable research groups. Thus, it is necessary to focus the attention on a realistic number of fields.

Across the various sciences there is an increasing need for mathematical expertise. As a result, there are plentiful opportunities for cooperation with other research fields. Meanwhile, it is essential that methodological problems and challenges are studied from a generic point of view whenever possible. It is in this context very important to emphasize that mathematical sciences has an intrinsic value and represents a research field in itself, and is not merely a supporting field for other sciences.

Our vision is that the Department of Mathematics should consolidate its leading role in Norway within a wide range of areas of mathematical research, and that our scientific contributions in these areas should be of the highest quality. Furthermore, the Department of Mathematics should have a strong and visible activity within key application areas, and initiate and participate in interdisciplinary environments where methodological research in collaboration with relevant groups can act as a mutual source of inspiration. Special focus will be placed on methodological research within the UiO’s focus areas: Life science, energy, climate, and environment.

To improve the utilization of available funding, the Department of Mathematics will prioritize professional research support. It is in this context important that a systematic review of current funding sources is carried out including major funding opportunities such as FRIPRO Toppforsk, Centres of Excellence (CoE/SFF), Centres for Research-based innovation (CRI/SFI) at the Research Council of Norway (RCN) and the European framework programme Horizon 2020.

The Department of Mathematics will also cooperate with relevant groups in industry, business and public administration on the basis of established agreements and strategic alliances. It is our goal to strengthen this activity further beyond its current levels,
particularly in connection with doctoral education. An important tool in this context will be to utilize the Industrial PhD scheme and Public Sector PhD scheme.

The education offered at the Department of Mathematics should reflect the breadth of our academic activity. At the same time it is necessary to see education as a shared responsibility for all our researchers. This should be emphasized in connection with appointments to academic positions.

Our courses will be robust and sustainable, and will be supported by collaboration between researchers. This is especially important for our courses at undergraduate level. At master level the courses will be research-based with considerable room for innovation and creativity. To ensure this, it is desirable to maintain a flexibility that is adapted to the interests of students and researchers’ own activities.

The Department of Mathematics is also responsible for basic education in mathematical sciences for the rest of the Faculty of Mathematics and Natural Sciences. This education should, as is the tradition, be designed in close dialogue with the other Departments within the Faculty. The Department of Mathematics wishes in this context to continue its leadership role in connection with the integration of computational methods in the Faculty’s education and research. We want to be especially active in developing courses that as far as possible support the activities of the rest of the Faculty, and participate in joint research projects.

The Department of Mathematics is keen to strengthen recruitment to our undergraduate programs. This means not only that the number of applicants should be maintained or increased, but also that we recruit candidates with the best possible background from the lower level schools enabling them to complete a course of study. For our bachelor programs, the basis for this is in the mathematical subjects taught in primary and secondary schools. As such, the Department of Mathematics wishes to contribute to the strengthening of quality of mathematical education, and seeks to ensure that more pupils are encouraged to specialize in mathematics in high school. Our contributions in this regard include investment in teacher education in mathematics and natural sciences and cooperation with the Department of Teachers education and School Research in the area of mathematics education. The Department of Mathematics also sees the potential for increased recruitment to our bachelor programs through the UNG(youth) scheme and will continue these efforts.

When it comes to recruiting for graduate study, it is important to reduce the dropout rate at bachelor level. In addition, we will make it easier to recruit students from the Faculty’s other bachelor programs and other educational institutions to our masters programs, provided that these students have the necessary prerequisites.

At all levels of study it is important for recruitment that our programs and research have a high profile through the Department website and social media, and that the diversity of career possibilities are made more visible. In the wake of the ongoing revision of the study programs it is desirable that this has high priority.

Women are still significantly under-represented in the mathematical sciences. The Department of Mathematics sees the Faculty’s action plan for gender equality as an important means to improve the gender balance, and will follow up this plan to the fullest extent possible. Special focus will be placed on measures to strengthen the recruitment of women to academic positions. Furthermore, the Department will pave the way for women to qualify for promotion to professor.
In a 10-year perspective the Department of Mathematics faces a significant generational change where younger people will replace large portions of the academic staff. To realize our academic vision it is essential that it is prioritized so that we focus our activity, emphasize professional and technological development and consolidate our research groups. At the same time there is a large and often untapped potential for a greater degree of collaboration across research groups and sections. It is therefore our aim that those recruited can contribute to realizing this potential. In relation to other disciplines, the Department of Mathematics will build on and strengthen the cooperative relationships we have today with a particular focus on collaboration within our own Faculty.

The sections of the Department

Section 1. Mechanics

RCN-evaluation: While the group is very good, its impact will be improved by a higher percentage of publications in top journals. It would also benefit from closer interactions with the Partial Differential Equations group.

The section’s research profile is characterized by the coupling between theory and applications. The combination of development and use of theoretical analysis, advanced computational methods and modern experiments in the Hydrodynamic Laboratory has given the section several breakthroughs in both basic research and industrial applications. The section has over time built up a very strong expertise in a variety of areas within mechanics. In recent years the section has also established a more uniform academic profile built on continuum mechanics involving both fluid and solid mechanics. This represents a significant change of the section’s activities and is an important strategic move to strengthen cooperation within the section. The section has, as noted in the RCN-evaluation, also a great potential for cooperation with Section 4.

The section has a strong tradition in hydrodynamic wave theory. This activity will still be important into the future. Furthermore, there will be increased focus on computational mechanics through the two most recent appointments; Mikael Mortensen and Kent-Andre Mardal. This will strengthen cooperation with Simula and Section 4. In addition, the section is involved in two of the Faculty’s Strategic Research Initiatives, "4DSpace" and "Earth Flow", and through these, the section cooperates particularly with the Department of Physics and Department of Geosciences. The section also has activities in the field of biomechanics.

A new priority for the section is multiphase flow. This activity is supported by funding from “Akademiaavtalen” with Statoil.

The section has ambitions to join an application for CoE in 2016. When the new position in multiphase are filled, the section will have 7 academic staff in full-time positions. To strengthen solid mechanics it is desirable to add a further person within the plan period.

Section 2. Statistics and biostatistics

RCN-evaluation: The group is held in high regard by the international community. However, considering its strength, the self-evaluation gives little indication of post-doc visits and, more generally, there is a lack of
An important goal for Section 2 is to maintain an outstanding core group for methodological statistics, with good connections to research groups from various fields of applications. The splitting of the former statistics group into Sections 2 and 3 involves a strategic challenge for the field of statistics. It is important that this division does not cause the statistics community at the Department to appear reduced. It is therefore necessary to facilitate cooperation with Section 3 related to research, teaching and supervision, and in the recruitment of students.

The section is involved in two of the Faculty's Strategic Research Initiatives in life sciences: "CELS" and "PharmaTox". Through these, the section cooperates in particular with the Department of Biosciences, the Department of Informatics and the School of Pharmacy. The section also has a longstanding and well-established cooperation with the statistics group at the Faculty of Medicine (OCBE). The fact that this environment has now grown very large (about 25 permanent positions) provides both strategic challenges and opportunities for the section.

The section has participated in the CRI "Statistics for innovation" that has just ended. The section has recently (2015) been assigned a new CRI along with OCBE and the Norwegian Computing Center, called "Big Insight", with a hub at the Department of Mathematics. Big Insight will be a central part of the section's future activities.

A new priority for the section is "big data", i.e., methods for the analysis of large, complex datasets. This is central within the new CRI, in connection with the Strategic Research Initiatives and in recent RCN projects. The section also cooperates with the Department of Informatics in this direction. This is underpinned by a position in data science funded through the "Akademiaavtalen" with Statoil, but it is not yet clear whether this position goes to the section or whether it goes to the Department of Informatics.

There is an increasing need for statistical expertise both at our own faculty, at the university and in society at large. The section has for the moment 7 academic employees in full-time positions, of which two will be retiring by 2020. With the increasing responsibilities and the growing demand from faculty researchers about collaboration faced by the section, it is highly desirable to replace both these positions. In relation to the increasing importance of data-driven research, there is an obvious potential for further growth. This is emphasized also in the RCN evaluation.

The section’s teaching duties range from bachelor, master and doctoral courses for the department’s own students, to several user-oriented courses for the faculty’s other students. When it comes to teaching and supervision, the activity of the section must be coordinated with Section 3, so that the overall teaching and supervision capacity is maintained.

Section 3. Stochastic analysis, finance, insurance, and risk

RCN-evaluation: The Committee recommends continuing the association of internationally recognized scientists to the group through these positions. The group should continue in its current direction with a strong component in more fundamental research, complemented by applications in finance, insurance and energy markets.
The research activity at Section 3 is within the areas of risk and reliability theory, stochastic analysis, mathematical finance, statistics, and insurance mathematics. The research spans from the development of theory within probability and stochastic analysis, to applied science with a focus on insurance, economics, industrial risk and energy.

The Section is involved in the Faculty's strategic research initiative "STORE" (Stochastics of Renewable Energy Markets). This initiative builds on existing activity within the section, among others connected to the research plan of CMA2 and following the recommendation of the RCN-evaluation. STORE is also connected to the energy initiative at UiO. The establishment of STORE is an important tool to achieve synergy among the different research groups in the section. The section has ambitions to participate in an CoE, together with other sections at the Department and groups outside. In addition, the section wants to be active in network applications in Horizon2020.

The research group in risk and reliability theory has a key role in relationship to the collaboration agreement with DNV-GL, and is also involved in the new CRI "Big Insight".

The Section has 8 full time professors at the start of the plan period, where three will retire within the plan period. To replace these positions the Department has already announced one position in stochastic analysis and one in insurance mathematics. The position in stochastic analysis is bridge-funded by RCN as part of the follow-up of the mathematics evaluation. The third retirement is connected to the research group in risk and reliability theory. To follow up the intentions in the collaboration agreement with DNV-GL and the section’s involvement in "Big Insight", it is desirable to hire a replacement for this position as well.

Section 4. Differential Equations and Computational Mathematics

RCN-evaluation: The group will have a challenge to maintain the high level of activity when the CMA is phased out. It will be important to find new sources for funding. One possibility is the growing application of mathematics in the life sciences. The group interacts well with other groups within the department but better synergy with the Fluid Mechanics group could be beneficial and increase the applied side of the research in the group.

Section 4 consists of two research groups, Computational Mathematics and Partial Differential Equations. Within the Computational Mathematics group the activity is focused on geometrical modeling and optimization, in addition to differential equations. The section was central in connection with the CoE CMA, and has also played a key role in the extension of CMA.

In line with the the RCN-evaluation, the Department plans to stimulate a closer collaboration between this section and Section 1, where differential equations and computations are central. There is also a considerable potential for increased activity within life science. Life science is one of the most important scientific areas at UiO, and both in medical science and biology the use of mathematical models is of increasing importance. The Department therefore wants to contribute to further activity in the area of mathematical sciences within life science and, in addition to statistics, differential equations and computations will then be central areas. Optimization, which today is only covered by one person, is another area with great potential for applications, particularly in statistics and mathematical finance, i.e., Sections 2 and 3. The expertise of the section is also attractive to several other research areas, internally and externally.
Such an increased activity within the section is, however, to a large degree dependent on obtaining new positions.

The activity at the section represents part of a new research area at the Department. This activity has been established during the last 10-15 years due to the CMA and the transfer of scientists from the Department of Informatics. The section has, in the beginning of the plan period, 8 scientists in full-time positions, where the present section leader will retire during the plan period. The section also has one person in a permanent 20%-position. In addition to the research activity the section is very active in the development of the computational science teaching program at the faculty. It would be desirable to employ another person in order to replace the announced retirement. The section also wants to be active in application processes for CoE and similar projects for excellent research, which also may lead to further increased activity/positions.

Section 5. Algebra, geometry and topology

**RCN-evaluation:** Two recent post-doctoral positions have provided an important opportunity for renewal of the algebra and algebraic geometry group, since the last permanent appointment was in 1992. However there is a need to consolidate the group and strengthen its internal collaboration by developing a common research programme. The group has an important networking role among other algebra and algebraic geometry groups in Norway, especially in Bergen and Tromsø. It is strongly encouraged to strengthen these links.

Since the last evaluation the geometry and topology group has lost three members through retirement but only one new permanent appointment has been made. The group can clearly attract top researchers from abroad as visitors and as postdocs. It also has excellent scientific and administrative leadership. Further appointments in this area, broadly defined, should be good for the future development of the group, of pure mathematics in the department, and of the subject area within Norway.

There are two research groups in section 5, "Geometry and Topology", and "Algebra and Algebraic Geometry". The section aims at contributing important scientific publications in a broad spectrum within mathematics. The activity in the group of "Algebra and Algebraic Geometry" will for the most part be in enumerative and projective algebraic geometry, singularity theory and in deformation theory. The group in "Geometry and Topology" will perform research in algebraic topology and motivic homotopy theory with applications in geometric topology, manifolds and algebraic K-theory. Over time the section wants to cover also differential geometry and Lie theory to develop a broader research activity of common interests to the whole section.

Both research groups apply regularly for external funding, mainly the FRIPRO program of RCN and EU-programs. To strengthen the national cooperation in these fields, the section organizes applications for research networks, in line with the recommendations of the RCN-evaluation.

The section gives graduate (master) courses in algebra, number theory, geometry and topology.

The section has at the start of the current period 9 fulltime permanent scientific staff, 4 in “Geometry and Topology” and 5 in “Algebra and Algebraic Geometry”. By the end of the period, 4 of these will have reached retirement, two from each group. One position is
already announced, financed partly by RCN as a follow up of the evaluation. The announcement is broadly defined for the whole section, and it is not yet decided.

The department finds it important to secure and maintain the leading position of the groups in “Geometry and Topology” and in “Algebra and Algebraic Geometry”. To achieve this, it is desirable to replace all of the four expected retirements. There are at present many highly qualified applicants for positions within these fields.

Section 6. Several Complex Variables, Logic and Operator Algebra

**RCN-evaluation:** The Committee recommends merging the small, but well-functioning, group in Several Complex Variables with the excellent Operator Algebra group into an Analysis group. With regard to the very small Logic group, the Committee thinks that mathematical logic as a subject should be represented at the University of Oslo. The Committee encourages the department to examine possibilities of a joint appointment with another department, on a permanent basis, for the professor II in that group.

Section 6 consists of the three research groups “Several Complex Variables”, “Logic” and “Operator Algebra”. Common features of these groups are that they conduct pure research and the members of the groups take part in the teaching of basic courses in mathematics. At the beginning of the plan period, there are 7 people employed in full-time scientific positions, 4 in “Operator Algebra”, 2 in “Several Complex Variables” and 1 in “Logic”. During the plan period, 3 members of the section will retire, one from each research group. The groups differ with respect to size and age distribution, and the challenges for the next five year period will also differ.

Operator Algebra has many ramifications within other fields of mathematics, but also within mathematical physics. The present research activity covers quantum groups, representation theory, non-commutative dynamical systems, graph algebras, semigroup algebras, non-commutative harmonic analysis and quantum information theory.

The research in Several Complex Variables is focused on problems related to holomorphic maps, approximation theory and complex dynamics.

The groups in Several Complex Variables and Operator Algebra are both highly active in searching for external funding. For the time being, they have one RCN-project, one RCN-network project and one ERC StG. Both groups have a newly employed Professor II whose expertise is of benefit to the other sections. There will be two new postdocs in Operator Algebra, funded by RCN. Both groups are vital in their respective national networks, and they are both parts of wide, international networks. It is a basic ambition to continue the search for external funding from RCN and EU, and to strengthen and expand the national cooperation and the international network. It is strongly desirable that the retirement in Operator Algebra is replaced within the group, so that a future employment can be used to contribute new energy and competence to the group. The group in Several Complex Variables faces the challenge of being reduced to one member within the five-year period. In order to avoid a group of sub-critical size it is necessary to strengthen the group with at least one new employment.

Over the last years, the research in Logic at the department has mainly been within computability theory with an emphasis on problems from theoretical computer science. Since the research group in Logic as of today consists of only 1 person, the retirement represents a challenge. If the aims of the RCN-evaluation is to be met, the consequence must be that the department either employs a new person within logic at the
Department of Mathematics, or that the responsibility for logic is taken over by the Department of Informatics. In both cases there will be a need in the larger logic group at the University for someone with basic qualifications in mathematics, and then it will be natural that this person is employed at the Department of Mathematics. However, for a continuation of logic at the Department to be robust, it will be essential that the group has tight bonds with logicians at the Department of Informatics and other departments.

The Department sees it as important to use new employments within Section 6 to set the ground for well functioning research groups. In order to achieve this, one aims at maintaining the size of the section. New positions should be advertised in such a way that all three groups will have the opportunity to employ new members.