ANNEX B: PHYSICAL SCIENCES AND ENGINEERING

Primary Area: **Mathematics** Disciplines: All areas of mathematics, pure and applied, mathematical foundations of computer science, mathematical physics and statistics
Sub-disciplines including but not limited to: • Logic and foundations • Algebra • Number theory • Algebraic and complex geometry • Lie groups, Lie algebras • Geometry and global analysis • Topology • Analysis • Operator algebras and functional analysis • ODE and dynamical systems • Theoretical aspects of partial differential equations • Mathematical physics • Probability • Mathematical statistics • Generic statistical methodology and modelling • Discrete mathematics and combinatorics • Mathematical aspects of computer science • Numerical analysis • Scientific computing and data processing • Control theory, optimisation and operational research • Application of mathematics in sciences • Application of mathematics in industry and society

Primary Area: **Fundamental Constituents of Matter** Disciplines: Particle, nuclear, plasma, atomic, molecular, gas, and optical physics
Sub-disciplines including but not limited to: • Theory of fundamental interactions • Phenomenology of fundamental interactions • Experimental particle physics with accelerators • Experimental particle physics without accelerators • Classical and quantum physics of gravitational interactions • Nuclear, hadron and heavy ion physics • Nuclear and particle astrophysics • Gas and plasma physics • Electromagnetism • Atomic, molecular physics • Ultra-cold atoms and molecules • Optics, non-linear optics and nano-optics • Quantum optics and quantum information • Lasers, ultra-short lasers and laser physics • Thermodynamics • Non-linear physics • Metrology and measurement • Equilibrium and non-equilibrium statistical mechanics: steady states and dynamics

Primary Area: **Condensed Matter Physics** Disciplines: Structure, electronic properties, fluids, nanosciences, biological physics
Sub-disciplines including but not limited to: • Structure of solids, material growth and characterisation • Mechanical and acoustical properties of condensed matter, lattice dynamics • Transport properties of condensed matter • Electronic properties of materials, surfaces, interfaces, nanostructures • Physical properties of semiconductors and insulators • Macroscopic quantum phenomena, e.g. superconductivity, superfluidity, quantum Hall effect • Spintronics • Magnetism and strongly correlated systems • Condensed matter – beam interactions (photons, electrons, etc.) • Nanophysics, e.g. nanoelectronics, nanophotonics, nanomagnetism, nanoelectromechanics • Mesoscopic quantum physics and solid-state quantum technologies • Molecular electronics • Structure and dynamics of disordered systems, e.g. soft matter (gels, colloids, liquid crystals), granular matter, liquids, glasses, defects • Fluid dynamics (physics) • Statistical physics: phase transitions, condensed matter systems, models of complex systems, interdisciplinary applications • Physics of biological systems

Primary Area: **Physical and Analytical Chemical Sciences** Disciplines: Analytical chemistry, chemical theory, physical chemistry/chemical physics
Sub-disciplines including but not limited to: • Physical chemistry • Spectroscopic and spectrometric techniques • Molecular architecture and Structure • Surface science and nanostructures • Analytical chemistry • Chemical physics • Chemical instrumentation • Electrochemistry, electrodialysis, microfluidics, sensors • Method development in chemistry • Heterogeneous catalysis • Physical chemistry of biological systems • Chemical reactions: mechanisms, dynamics, kinetics and catalytic reactions • Theoretical and computational chemistry • Radiation and Nuclear chemistry • Photochemistry • Corrosion • Characterisation methods of materials • Environment chemistry

Primary Area: **Synthetic Chemistry and Materials** Disciplines: New materials and new synthetic approaches, structure-properties relations, solid state chemistry, molecular architecture, organic chemistry
Sub-disciplines including but not limited to: • Structural properties of materials • Solid state materials chemistry • Surface modification • Thin films • Ionic liquids • New materials: oxides, alloys, composite, organic-inorganic hybrid, nanoparticles • Biomaterials synthesis • Intelligent materials synthesis – self assembled materials • Coordination chemistry • Colloid chemistry • Biological chemistry and chemical biology • Chemistry of condensed matter • Homogeneous catalysis • Macromolecular chemistry • Polymer chemistry • Supramolecular chemistry • Organic chemistry • Medicinal chemistry

Primary Area: **Computer Science and Informatics**

Disciplines: Informatics and information systems, computer science, scientific computing, intelligent systems

Sub-disciplines including but not limited to:

- Computer architecture, embedded systems, operating systems
- Distributed systems, parallel computing, sensor networks, cyber-physical systems
- Software engineering, programming languages and systems
- Theoretical computer science, formal methods, automata
- Security, privacy, cryptology, quantum cryptography
- Algorithms and complexity, distributed, parallel and network algorithms, algorithmic game theory
- Artificial intelligence, intelligent systems, natural language processing
- Computer graphics, computer vision, multimedia, computer games
- Human computer interaction and interface, visualisation
- Web and information systems, data management systems, information retrieval and digital libraries, data fusion
- Machine learning, statistical data processing and applications using signal processing (e.g. speech, image, video)
- Scientific computing, simulation and modelling tools
- Bioinformatics, bio-inspired computing, and natural computing
- Quantum computing (formal methods, algorithms and other computer science aspects)

Primary Area: **Systems and Communication Engineering**

Disciplines: Electrical, electronic, communication, optical and systems engineering

Sub-disciplines including but not limited to:

- Control engineering
- Electrical engineering: power components and/or systems
- Simulation engineering and modelling
- Micro- and nano-) systems engineering
- (Micro- and nano-) electronic, optoelectronic and photonic components
- Communication systems, wireless technology, high-frequency technology
- Signal processing
- Networks, e.g. communication networks and nodes, Internet of Things, sensor networks, networks of robots
- Man-machine interfaces
- Robotics
- Components and systems for applications (in e.g. medicine, biology, environment)
- Electrical energy production, distribution, applications

Primary Area: **Products and Processes Engineering**

Disciplines: Product and process design, chemical, civil, environmental, mechanical, vehicle engineering, energy processes and relevant computational methods

Sub-disciplines including but not limited to:

- Aerospace engineering
- Chemical engineering, technical chemistry
- Civil engineering, architecture, offshore construction, lightweight construction, geotechnics
- Computational engineering
- Fluid mechanics
- Energy processes engineering
- Mechanical engineering
- Propulsion engineering, e.g. hydraulic, turbo, piston, hybrid engines
- Production technology, process engineering
- Manufacturing engineering and industrial design
- Environmental engineering, e.g. sustainable design, waste and water treatment, recycling,
- regeneration or recovery of compounds, carbon capture & storage
- Naval/marine engineering
- Industrial bioengineering
- Automotive and rail engineering; multi-/inter-modal transport engineering

Primary Area: **Materials Engineering**

Disciplines: Advanced materials development: performance enhancement, modelling, large-scale preparation, modification, tailoring, optimisation, novel and combined use of materials, etc.

Sub-disciplines including but not limited to:

- Engineering of biomaterials, biomimetic, bioinspired and bio-enabled materials
- Engineering of metals and alloys
- Engineering of ceramics and glasses
- Engineering of polymers and plastics
- Engineering of composites and hybrid materials
- Engineering of carbon materials
- Engineering of metal oxides
- Engineering of alternative established or emergent materials
- Nanomaterials engineering, e.g. nanoparticles, nanoporous materials, 1D & 2D nanomaterials
- Soft materials engineering, e.g. gels, foams, colloids
- Porous materials engineering, e.g. covalent-organic, metal-organic, porous aromatic frameworks
- Semi-conducting and magnetic materials engineering
- Metamaterials engineering
- Computational methods for materials engineering

Primary Area: **Universe Sciences** Disciplines: Astro-physics/-chemistry/-biology; solar system; planetary systems; stellar, galactic and extragalactic astronomy; cosmology; space sciences; astronomical instrumentation and data
Sub-disciplines including but not limited to: • Solar physics – the Sun and the heliosphere • Solar system science • Exoplanetary science, formation and characterization of extrasolar planets • Astrobiology • Interstellar medium and star formation • Stars – stellar physics, stellar systems • The Milky Way • Galaxies – formation, evolution, clusters • Cosmology and large-scale structure, dark matter, dark energy • Relativistic astrophysics and compact objects • Gravitational wave astronomy • High-energy and particle astronomy • Astronomical instrumentation and data, e.g. telescopes, detectors, techniques, archives, analyses

Primary Area: **Earth System Science** Disciplines: Physical geography, geology, geophysics, atmospheric sciences, oceanography, climatology, cryology, ecology, global environmental change, biogeochemical cycles, natural resources management
Sub-disciplines including but not limited to: • Atmospheric chemistry, atmospheric composition, air pollution • Meteorology, atmospheric physics and dynamics • Climatology and climate change • Terrestrial ecology, land cover change • Geology, tectonics, volcanology • Palaeoclimatology, palaeoecology • Physics of earth's interior, seismology, geodynamics • Oceanography (physical, chemical, biological, geological) • Biogeochemistry, biogeochemical cycles, environmental chemistry • Mineralogy, petrology, igneous petrology, metamorphic petrology • Geochemistry, cosmochemistry, crystal chemistry, isotope geochemistry, thermodynamics • Sedimentology, soil science, palaeontology, earth evolution • Physical geography, geomorphology • Earth observations from space/remote sensing • Geomagnetism, palaeomagnetism • Ozone, upper atmosphere, ionosphere • Hydrology, hydrogeology, engineering and environmental geology, water and soil pollution • Cryosphere, dynamics of snow and ice cover, sea ice, permafrosts and ice sheets • Planetary geology and geophysics • Geohazards • Earth system modelling and interactions