1.	**Field of study**	**Biophysics**
2.	Faculty	Faculty of Science and Technology
3.	Academic year of entry	2021/2022 (winter term)
4.	Level of qualifications/degree	second-cycle studies
5.	Degree profile	general academic
6.	Mode of study	full-time

Module: Mechanical Behaviour of Materials

Module code: W4-2BF-MB-21-04

1. Number of the ECTS credits: 6

2. Learning outcomes of the module

code	description	learning outcomes of the programme	level of competence (scale 1-5)
MB_04_1	the students will be able to understand the mechanism of plastic deformation and the origin of materials strength	KBF_W01 KBF_W02	4 4
MB_04_2	the students will be able to suggest ways by which engineering materials may be intrinsically strengthened	KBF_U01	4
MB_04_3	the students will be able to derive ductile-brittle transition temperature and select materials accordingly	KBF_U01 KBF_U07	4 3
MB_04_4	the students will be able to understand the high-temperature mechanical behavior of materials and be able to select the materials for high-temperature applications	KBF_U01 KBF_W02	4 4
MB_04_5	the students will be able to design and select engineering components based on the principles of fracture mechanics and fatigue	KBF_U01 KBF_W01 KBF_W02 KBF_W04	4 4 4 4
MB_04_6	the students will be able to improve materials resistance to fracture and fatigue performance	KBF_U01	4

3. Module description

Description	1. Introduction to deformation behavior: Concept of stresses and strains, engineering stresses and strains, Different types of loading and temperature encountered in applications. 2. Tensile Test - stress-strain response for metal, ceramic, and polymer, elastic region, yield point, plastic deformation, necking, and fracture. 3. Bonding and Material Behaviour, theoretical estimates of yield strength in metals and ceramics.

	4. Elasticity (the state of stress and strain, stress and strain tensor, tensor transformation, principal stress and strain, elastic stress-strain relation, anisotropy, elastic behavior of metals, ceramics, and polymers). 5. Viscoelasticity (Molecular foundations of polymer viscoelasticity. Rouse-Bueche theory, Boltzmann superposition principle, mechanical models, distribution of relaxation and retardation times, interrelationships between mechanical spectra, the glass transition, secondary relaxations, dielectric relaxations. 6. Plasticity (Hydrostatic and Deviatoric stress, Octahedral stress, yield criteria, and yield surface, texture and distortion of yield surface, Limitation of engineering strain at large deformation, true stress and true strain, effective stress, effective strain, flow rules, strain hardening, Ramberg-Osgood equation, stress-strain relation in plasticity, plastic deformation of metals and polymers). 7. Microscopic view of plastic deformation: crystals and defects, classification of defects, thermodynamics of defects, the geometry of dislocations, slip and glide, dislocation generation - Frank Read and grain boundary sources, stress and strain field around dislocations, force on dislocation - self-stress, dislocation interactions, partial dislocations, twinning, dislocation movement and strain rate, deformation behavior of single crystal, critical resolved shear stress (CRSS), deformation of poly-crystals, Hall-Petch and other hardening mechanisms, grain size effect - source limited plasticity, Hall-Petch breakdown, dislocations in ceramics and glasses. Effects of microstructure on the mechanics of polymeric media: deformation modes, yield, rubber toughening, alloys and blends. 8. Fracture mechanics (energetics of fracture growth, plasticity at the fracture tip, measurement of fracture toughness, -Linear fracture mechanics -KIC. Elasto-plastic fracture mechanics - JIC, Measurement and ASTM standards, Design based on fracture mechanics, the effect of environment, effect of microstructure on KIC and JIC. Application of fracture mechanics in the design of metals, ceramics, polymers and composites, damage tolerance design, elements of fractography) 9. Fatigue (S-N curves, low- and high-cycle fatigue, laboratory testing in fatigue, residual stress, surface and environmental effects, fatigue of cracked components, designing out fatigue failure, Life cycle prediction, Fatigue in metals, ceramics, polymers, and composites. 10. Creep. Creep in crystalline materials (stress-strain-time relationship, creep testing, different stages of creep, creep mechanisms and creep mechanism maps, diffusion, creep and stress rupture, creep under multi-axial loading, microstructural aspects of creep and design of creep resistant alloys, high-temperature deformation of ceramics and polymers.
Prerequisites	

4. Assessment of the learning outcomes of the module

code	type	description	learning outcomes of the module
MB_04_w_1	exam	oral exam Requirement for examination: Knowledge of the mechanical behavior of a wide variety of materials ranging from conventional metals and alloys, ceramics and polymers to hybrid materials and biomaterials, at different length and time scales, from the continuum description of properties to the atomistic and molecular mechanisms that confer those properties to all materials. Knowledge of the micro-mechanics of deformation of metals, ceramics, polymers, and composites. Knowledge of the fundamentals of elasticity and viscoelasticity, plasticity, imperfections/defects in crystals, deformation and strain-hardening, fracture, strengthening of alloys, martensitic transformations	MB_04_1, MB_04_2, MB_04_3, MB_04_4, MB_04_5, MB_04_6

5. Forms of teaching						
code	form of teaching			required hours of student's own work		assessment of the learning outcomes of the module
	type	description (including teaching methods)	number of hours	description	number of hours	
MB_04_fs_1	lecture	Detailed discussion by the lecturer of the issues listed in the table "module description" using the table and/or multimedia presentations	48	Supplementary reading, working with the textbook	102	MB_04_w_1