(Module Name)

Advanced Mechanical Behaviour of Materials

Course Catalogue

2023-2024

College/ Institute	Erbil Technical engineering
Department	Mechanical and Energy Tech. Engineering
Module Name	Advanced Mechanical Behaviour of Materials
Module Code	AMB101
Degree	Technical Diploma ☐ Bachler ☐ High Diploma ☐ Master ☐ PhD ↗
Semester	1
Qualification	PhD in Mechanical Engineering
Scientific Title	Assistant professor
ECTS (Credits)	7
Module type	Prerequisite ☐ Core ↗ Assist. ☐
Weekly hours	3
Weekly hours (Theory)	(3)hr Class (8)Total hrs Workload
Weekly hours (Practical)	( )hr Class ( )Total hrs Workload
Number of Weeks	12
Lecturer (Theory)	Assist. Prof. Dr. Gailan Ismail Hasan
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Lecturer (Practical)	
E-Mail & Mobile NO.	
Websites	

Course Book

Course Description	**Advanced mechanical behavior of materials dials with macroscopic elasticity and plasticity properties of different material. Also, study viscoelasticity properties with modern materials whilst maintaining a logical flow of theory to follow in. Different Chapters intended as a review of certain fundamental aspects of mechanics of materials, using the material's response to unidirectional stress to provide an overview of mechanical properties without addressing the complexities of multidirectional stress states. We will cover elastic and plastic deformation, yielding criteria, fracture and fatigue of materials including crystalline and amorphous metals, semiconductors, ceramics, and (bio) polymers, and will focus on the design and processing of materials from the atomic to the macro-scale to achieve desired mechanical behavior. We will cover special topics in mechanical behavior for material systems such as geometry of deformation and work hardening, geometric dislocation theory, with reference to current research and publications. We focus on imperfections like point and line defects also interfacial and volumetric defects** **At the end we focus on temperature and environmental dependent effects, describing the key relationship between conditions, microstructure and behavior.**
Course objectives	**The main objectives:** **1. Contribute student to recognition different elastic and plastic deformation, how they applied in respect to different materials (crystalline and amorphous metals, semiconductors, ceramics, and (bio) polymers).** **2. To realizing different design and processing of materials from the atomic to the macro-scale to achieve desired mechanical behavior.** **3. To deals with different material systems such as geometry of deformation and work hardening, geometric dislocation theory.** **4. To understand effect of temperatures and environmental dependent mechanical properties.**
Student's obligation	**Class attendance, preparing seminar presentation. Quiz for each chapter. (More than 2 quiz at the end), homework after each chapter. Article review**
Required Learning Materials	**Data show, power point, white board, seminar, pictures.**

	Task		Weight (Marks)	Due Week	Relevant Learning Outcome
Evaluation	Paper Review		10%		
	Assignments	Homework			
		Class Activity			
		Report			
		Seminar	5%		
		Essay			
		Project			
	Quiz		10%		
	Attendance		5%		
	Midterm Exam		20%		
	Final Exam		50%		
	Total		100%		

Specific learning outcome:	The main outcome: **1. Elastic and plastic deformation is most efficient way to study mechanical behaviour of different brittle and ductile materials.** **2. Design and processing of materials under three principal normal stresses.** **3. Identifying different modern materials like different crystalline and amorphous metals, semiconductors, ceramics, and (bio) polymers** **4. Dealing with deferent surface yielding which leads to imperfections like point and line defects also interfacial and volumetric defects** **5. Learning how temperature and environmental dependent effects mechanical properties.**
Course References:	1. Marc Andr´e Meyers, (2009), “Mechanical Behavior of Materials “Second Edition, Cambridge. 2. WILLIAM F. HOSFORD, (2005), “Mechanical Behavior of Materials” Cambridge. 3. J. Rösler · H. Harders · M. Bäker, (2007),” Mechanical Behaviour of Engineering Materials” Springer. 4. Norman E. Dowling, (2013), “Mechanical Behavior of Materials” Fourth Edition, Pearson Education Limited, England.

Course topics (Theory)	Week	Learning Outcome
Introduction: Macroscopic elasticity, classifying loads on materials,	1	Classification of loads on materials
Macroscopic elasticity, longitudinal stress and strain, shear stress and strain, strain energy (or deformation energy)	2	Elasticity behaviour of material
Macroscopic plasticity, plastic deformation in tension, tensile curve parameters, necking	3	Plasticity behaviour of material

Macroscopic plasticity, plastic deformation in compression, Plastic Deformation of Polymers, Plastic Deformation of Glasses	**4**	Plasticity behaviour of material
Viscoelasticity, rheological models-, temperature and strain rate, maxwell model, kelvin–voigt model, standard linear solid model	**5**	Viscoelasticity of materials
Viscoelasticity,–, generalized maxwell model, damping, elastic modulus – relaxed versus unrelaxed, thermoelastic effect	**6**	To study some model
Yielding plasticity theory (flow, yield, and failure criteria), need for failure criteria, general form of failure criteria, maximum normal stress fracture criteria, graphical representation of the normal stress Criteria.	**7**	To study metal flow.
yielding plasticity theory(flow, yield, and failure criteria), maximum shear stress yield criterion, graphical representation of the shear stress criteria, failure criteria for brittle materials, yield criteria for ductile polymers, failure criteria for composite materials	**8**	To study some failure criteria
Geometry of deformation, stress required for slip, slip in systems and work-hardening, strengthening mechanisms independent slip systems in polycrystals.	**9**	Slip and work-hardening mechanisms
Work-hardening in polycrystals, taylor's theory, seeger's theory, kuhlmann--wilsdorf's theory, softening mechanisms, texture strengthening	**10**	Different Theories on hardening
Imperfections: point defects, atomic or electronic point defects, production of point defects, effect of point defects on mechanical properties, radiation damage, volumetric defects, grain boundaries in plastic deformation (grain-size strengthening),	**11**	Imperfections during work hardening.
Imperfections: line defects, behavior of dislocations, stress field around dislocations, energy of dislocations, dislocations in various Structures, dislocations in Ceramics,	**12**	
Sources of dislocations, deformation produced by motion of dislocations, the movement of dislocations: temperature and strain rate effects, dislocations in electronic materials.	**13**	
Temperature dependence of flow stress, super-plasticity, combined strain and strain-rate effects, strain-rate sensitivity of bcc metals, temperature dependence, combined temperature and strain-rate effects, hot working	**14**	
Environmentally assisted fracture in metals, environmental effects in polymers, environmental effects in ceramics	**15**	

Questions Example Design:

Stress and strain application (elastic and plastic deformation) on different materials problems to be solved.

Extra notes:

Lecture 13 to 15 used as titles for article reviews.

External Evaluator

Assis. Prof. Dr. Younis Khalid