DYNAMIC BEHAVIOUR OF MATERIALS

PROF. PRASENJIT KHANIKAR

Department of Mechanical Engineering
IIT Guwahati

PRE-REQUISITES : Solid Mechanics and Materials Science

INTENDED AUDIENCE : Mechanical Engineers, Civil Engineers, Materials Engineers

COURSE OUTLINE :

Study of materials behavior in extreme environments and development of new materials for such environments has become a vital research area for materials scientists and engineers in the 21 st century. Mechanical properties of materials under dynamic loading are considered as an important area of research and development in defense, automotive and aerospace industries. Under dynamic loading conditions, the inertial effects come to play an important role in the deformation behavior of the material. Many materials exhibit strain rate sensitivity at higher strain rates, i.e., flow stress dependence on strain rates. In addition, the failure mechanisms under high strain rate loading conditions are generally different than those occur in low strain rate. Furthermore, the deformation and failure mechanisms are controlled by the microstructure of the materials. This course will be important to mechanical, materials and civil engineers to understand materials behavior for ballistic applications, explosive forming or welding applications, automotive and aerospace applications.

ABOUT INSTRUCTOR :

Prof. Prasenjit Khanikar is an Assistant Professor of Mechanical Engineering Department at the Indian Institute of Technology, Guwahati. His research interests include development of materials and structures for high strain rate applications, modeling and experimental characterization of materials microstructure and crystalline plasticity. Dr. Khanikar received his PhD in Mechanical Engineering from North Carolina State University, USA. Before joining IIT Guwahati, he was working as a Postdoctoral Research Scientist at Columbia University in the City of New York, USA.

COURSE PLAN :

Week 1: Introduction: Dynamic deformation and failure

Week 2: Introduction to waves: Elastic waves; Types of elastic waves; Reflection, Refraction Interaction of waves

Week 3: Plastic waves and shock waves: Plastic waves of uniaxial stress, uniaxial strain and combined stress; Taylor's experiments; Shock waves

Week 4: Shock wave induced phase transformation; Explosive-material interaction and detonation

Week 5: Experimental techniques for dynamic deformation: Intermediate strain rate tests; Split Hopkinson pressure bar; expanding ring test; gun systems

Week 6: Review of mechanical behavior of materials (especially metals): Elastic and plastic deformation of metals; dislocation mechanics;

Week 7: Plastic deformation of metals at high strain rates: Empirical constitutive equations; relationship between dislocation velocity and applied stress; physically based constitute equations

Week 8: Plastic deformation in shock waves: Strengthening due to shock wave propagation; Dislocation generation; Point defect generation and deformation twinning

Week 9: Strain localization/shear bands: Constitutive models; Metallurgical aspects

Week 10: Dynamic Fracture: Fundamentals of fracture mechanics; Limiting crack speed, crack and dynamic fracture toughness; Spalling and fragmentation

Week 11: Dynamic deformation of materials other than metals: Polymers; Ceramics; Composites

Week 12: Applications: Armor applications; Explosive welding and forming