References

1. **Jonathan M. Borwein & Adrian S. Lewis**, *Convex Analysis and Nonlinear Optimization: Theory and Examples*, CMS Books in Mathematics, Springer, 2006.
2. **Jean-Baptiste Hiriart-Urruty & Claude Lemaréchal**, *Fundamentals of Convex Analysis*, Springer, 2004.
3. **Boris S. Mordukhovich & Nguyen Mau Nam**, *An Easy Path to Convex Analysis and Applications*, Morgan & Claypool, 2014.
4. **R. Tyrrell Rockafellar**, *Convex Analysis*, Princeton University Press, 1997.
5. **C. Zălinescu,** *Convex Analysis in General Vector Spaces,* World Scientific, 2002.

MATH20-R08: HYPERBOLIC SYSTEM OF CONSERVATION LAWS AND BOUNDARY LAYER THEORY

Total Marks: **100 (Theory: 70, Internal Assessment: 30)**
Duration of Examination: **3 Hrs.**
Workload: **4 Lectures per week.** Credits: **4**

Hyperbolic system of conservation laws: Fundamental concepts and examples, Scalar and system of conservation laws, Riemann Problem, Entropy condition, Classical and non-classical shocks, Similarity method.
Boundary layer theory: Laminar boundary layer, Turbulent flow, Turbulent boundary layer; Heat and Mass transfer, conduction, convection and radiation; Thermal boundary layer; Modeling and method of solution of the problems.

References

1. **G. B. Whitham**, *Linear and Nonlinear Waves*, John Wiley, 1999.
2. **Vishnu D. Sharma**, *Quasilinear Hyperbolic Systems, Compressible Flows and Waves*, CRC, 2010.
3. **Philippe G. LeFloch**, *Hyperbolic Systems of Conservation Laws: The Theory of Classical and Nonclassical Shock Waves*, Springer Basel AG, 2002.
4. **Hermann Schlichting & Klaus Gersten**, *Boundary-Layer Theory*, Springer, 2017.
5. **Tuncer Cebeci**, *Analysis of Turbulent Flows*, Elsevier, 2004.
6. **J.P. Holman & Souvik Bhattacharyya**, *Heat Transfer in SI Units*, Tata McGraw-Hill, 2011.
7. **George W. Bluman & Sukeyuki Kumei**, *Symmetries and Differential Equations*, Springer, New York, 1996.
8. **Eleuterio F. Toro**, *Riemann Solvers and Numerical Methods for Fluid Dynamics*: *A Practical Introduction*, Springer, 2009.

MATH20-R09: PARTIAL DIFFERENTIAL EQUATIONS: THEORY AND NUMERICS

Total Marks: **100 (Theory: 70, Internal Assessment: 30)**
Duration of Examination: **3 Hrs.**
Workload: **4 Lectures per week.** Credits: **4**

Maximum principles for second order linear parabolic, elliptic and hyperbolic partial differential equations; Weak solutions for second order linear parabolic, elliptic and hyperbolic partial differential equations; Lax–Milgram theorem, Local existence, uniqueness and regularity results for second order linear parabolic, elliptic and hyperbolic partial differential equations.