Masters Thesis Information Showcase
Spring Semester-2026
Year 2026

	Department: Physics Programme: Masters of Science Specialization: Physics
1	**Title of the Thesis** Heat and Mass Transfer for second grade fluid: simulation and modelling
2	**Abstract** (min 300 to 500 words) The flow dynamics of a second-grade viscoelastic fluid has been analyzed. Magnetohydrodynamics (MHD) also been applied in porous cylindrical container. By applying Differential Transform Method an exact solution was derived. This solution contains three components: velocity of the fluid, concentration, and temperature. The fluid moves through the cylindrical geometry. Boundary conditions have been applied which are mainly time dependent, all the conditions are the function of time. these constraints allowed to investigate both elastic and viscos responses across various temporal functions. The result of the study can be applied in industrial processes, involving polymer solutions and oil characteristics. Using python, graphical representation of the concentration, temperature, and velocity profiles are had been provided.
3	**Impact on SDG#___"** (min 500 words) (Please mention the impact of the relevant attained SDG) **Impact of My Thesis on Multiple SDGs (4, 7, 9, and 13)** My thesis, "Heat and Mass Transfer for second-grade fluid: simulation and modelling," addresses critical challenges in energy, industry, climate, and education. By developing predictive computational models for viscoelastic fluids, my research creates ripple effects across four Sustainable Development Goals: SDG 4 (Quality Education), SDG 7 (Affordable and Clean Energy), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 13 (Climate Action). Each goal benefits from the fundamental and applied knowledge generated through this work. **SDG 9: Industry, Innovation, and Infrastructure (Primary Impact)** Second-grade fluids are ubiquitous in polymer processing, food manufacturing, lubricant production, and chemical engineering. Their non-linear rheology makes heat and mass transfer prediction difficult, leading to inefficient equipment design. My research provides accurate simulation tools that optimize heat exchangers, reactors, and pipelines. This reduces material waste, minimizes pumping energy, and extends equipment lifespan. By enabling data-driven design, my work fosters sustainable industrialization (Target 9.4) and enhances technological capabilities (Target 9.5). The computational models themselves are innovations that reduce reliance on costly physical prototypes, accelerating R&D cycles in multiple sectors. **SDG 7: Affordable and Clean Energy** Thermal systems are the backbone of energy production and consumption. My models improve the efficiency of solar thermal collectors, geothermal plants, and industrial cooling loops that use second-grade fluids. By predicting optimal flow rates, temperature

	distributions, and concentration profiles, I help engineers design systems that capture and transfer heat with minimal losses. This directly supports Target 7.3 (doubling energy efficiency improvement) and Target 7.2 (increasing renewable energy share). For example, nanofluids based on second-grade fluids can enhance solar absorption by 20–30%, making clean energy more cost-effective for off-grid communities. Additionally, better thermal management in electronics and power plants reduces parasitic energy consumption, lowering operational costs and expanding energy access. **SDG 13: Climate Action** Energy efficiency translates directly into emissions reduction. Industries like petrochemicals, metallurgy, and food processing consume enormous amounts of heat. A 5–10% improvement in thermal efficiency, enabled by my models, can avoid millions of tons of CO_2 annually. My research also supports carbon capture technologies by modelling mass transfer in absorption columns, where second-grade fluids improve gas-liquid contact. Furthermore, by promoting renewable thermal systems, my work accelerates the transition away from fossil fuels. This aligns with Target 13.2 (integrating climate measures into industrial policies) and Target 13.3 (building capacity for climate mitigation). In a warming world, my models also help design air-cooled heat exchangers that reduce freshwater dependency which is an important climate adaptation strategy. **SDG 4: Quality Education** Finally, my thesis contributes to education by creating open-access learning resources. The simulation codes, case studies, and methodologies I develop can be integrated into graduate engineering curricula worldwide, especially in developing countries where experimental facilities are scarce. Students learn advanced computational fluid dynamics, numerical methods, and non-Newtonian fluid behavior—skills essential for modern engineering (Target 4.4). By publishing my work in open-access journals and sharing datasets, I enable faculty and researchers in resource-constrained institutions to conduct cutting-edge research without expensive lab equipment (Target 4.7). My presentations at international conferences also foster collaborative learning and mentorship.
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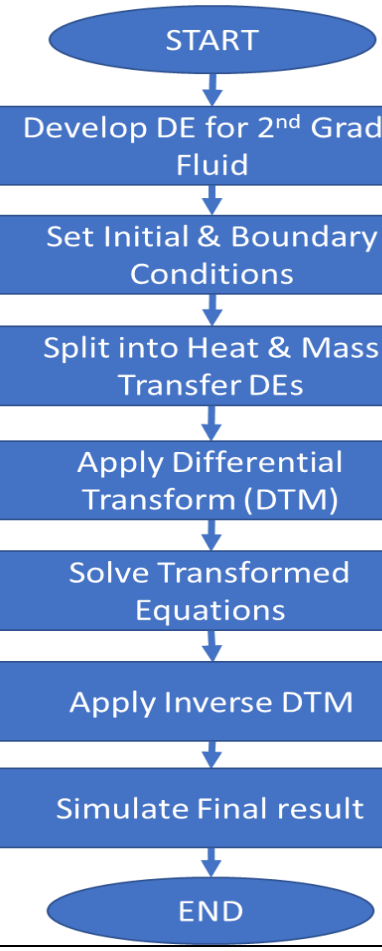
5	**Supervisor & Co-supervisor Name** (along with contact details) **Supervisor:** Dr. Roohi Zafar Associate Professor Department of Physics, NED University of Engineering & Technology, Karachi Pakistan Email: roohizj@neduet.edu.pk **Co-supervisor:** Dr. Saba Javaid Associate Professor Department of Physics, NED University of Engineering & Technology, Karachi Pakistan Email: sabaj@neduet.edu.pk
6	**Graphical Abstract**


START
Develop DE for 2nd Grade Fluid
Set Initial & Boundary Conditions
Split into Heat & Mass Transfer DEs
Apply Differential Transform (DTM)
Solve Transformed Equations
Apply Inverse DTM
Simulate Final result
END