

# Heat Transfer on Mixed Convection Flow of Rotating Second Grade Fluid with Ramped Wall Temperature

Ahmad Qushairi Mohamad<sup>1, b)</sup>, Ilyas Khan<sup>2, c)</sup>, Zulkhibri Ismail<sup>3, d)</sup>, Nor Athirah Mohd Zin<sup>1, e)</sup> and Sharidan Shafie<sup>1, a)</sup>

<sup>1</sup>*Department of Mathematical Sciences, Faculty of Science, Universiti Teknologi Malaysia, 81310 UTM Skudai, Johor, Malaysia.*

<sup>2</sup>*College of Engineering Majmaah University, P.O. Box 66, Majmaah 11952, Saudi Arabia.*

<sup>3</sup>*Faculty of Industrial Science & Technology, Universiti Malaysia Pahang, 26300 Kuantan, Pahang, Malaysia.*

<sup>a)</sup>Corresponding author: [sharidan@utm.my](mailto:sharidan@utm.my)

<sup>b)</sup>[ahmadqushairi91@yahoo.com](mailto:ahmadqushairi91@yahoo.com)

<sup>c)</sup>[ilyaskhanqau@yahoo.com](mailto:ilyaskhanqau@yahoo.com)

<sup>d)</sup>[zulkhibri.ismail@gmail.com](mailto:zulkhibri.ismail@gmail.com)

<sup>e)</sup>[norathirah24@gmail.com](mailto:norathirah24@gmail.com)

**Abstract.** This article discussed the effect of ramped wall temperature on rotating second grade fluid in mixed convection flow. The unsteady two dimensional momentum and energy equations of the incompressible fluid are modelled in the form of partial differential equations with initial and oscillating boundary conditions. The governing equations are transformed into non dimensional equations by using the corresponding non dimensional variables. The Laplace transform method is applied into non dimensional equations in order to obtain the analytical solutions of velocity and temperature profiles. Computations are carried out and presented graphically to analyse the effect of second grade fluid parameter, rotation parameter, Grashof number, phase angle, Prandtl number and time on the profiles. It is found that, when Grashof number increases, the velocity increases in primary and secondary velocities. Both velocity and temperature are observed decrease when phase angle and Prandtl number increase. It can be concluded that, the velocity profiles in rotating flow obtained in this study is lower to compare with non-rotating flow. Whereas, the temperature profiles are remain the same for both cases. It is worth to mention that, the exact solutions obtained in this study can be used to check the correctness of the results obtained through numerical schemes.