A theoretical study of laminar forced convection with a parabolic velocity profile inside parallel-plate channels and circular ducts, subjected to a sinusoidally varying inlet temperature, is presented. Thermal diffusion in the duct wall and a boundary condition that accounts for external convection are considered. A new methodology is presented to this extended Graetz problem by using the Laplace transform with a Ritz method. The variation of the amplitudes and phase lag for the centerline, wall, and fluid bulk temperature are investigated. The wall heat flux along the channel is also determined. It is concluded that for large values of wall thermal capacitance, the thermal wave is rapidly damped along the duct and the Biot number will slightly affect the dimensionless temperature amplitude. The effects of the wall transverse conduction are more pronounced at large values of the parameter β. The results are plotted and tabulated for comparison with the literature