# ICRAMCS 2026

THE EIGHTH EDITION OF THE INTERNATIONAL CONFERENCE ON RESEARCH IN APPLIED MATHEMATICS AND COMPUTER SCIENCE
April 23-24-25, 2026 | Marrakech, Morocco


# Time-delayed optimal control of SEIR dynamics

## Communication Info


**Authors:**
Mohcine EL BAROUDI [1]
Hassan LAARABI [1]
Samira ZOUHRI [1]
Mostafa RACHIK [1]
Abdelhadi ABTA [1,2]

*[1] LAMS, Hassan II University of Casablanca, Faculty of Sciences Ben M'sik, Casablanca, Morocco.*
*[2] Polydisciplinary Faculty of Safi, Cadi Ayyad University, Safi, Morocco.*



**Keywords:**
(1) SEIR
(2) optimal control
(3) time delay
(4) Pontryagin maximum principle.


## Abstract


This paper studies a time-delayed optimal control problem for an SEIR epidemic model, building on the classical compartmental modelling paradigm [1]. We incorporate multiple time delays in both the state dynamics and the implementation of interventions, and we consider three bounded controls representing mask adoption, vaccination, and active screening/testing. The objective is to decrease the exposed and infectious populations, denoted by E(t) and I(t), while increasing the recovered class R(t), over a fixed time horizon and under mixed state–control constraints. Using Pontryagin's Maximum Principle for delayed systems, we derive necessary optimality conditions and a characterization of candidate optimal controls, following the constrained delay-control methodology in [3]. The resulting optimality system is solved numerically to compare scenarios with late-start interventions. Simulations indicate that, immediately after the delay phase, rapid reinforcement of mask adoption together with accelerated vaccination coverage yields the largest early reduction in transmission, after which intensified screening/testing provides additional suppression [4]. These conclusions align with related optimal-control analyses and simulation-based epidemic studies reported in [2,5].




## References


[1] W.O. Kermack, A.G. McKendrick, A contribution to the mathematical theory of epidemics, Proceedings of the Royal Society of London. Series A, 115(772), 1927, 700–721.
[2] X. Lü, H.-w. Hui, F.-f. Liu, Y.-l. Bai, Stability and optimal control strategies for a novel epidemic model, Nonlinear Dynamics, 106, 2021, 1491–1507.
[3] L. Göllmann, D. Kern, H. Maurer, Optimal control problems with delays in state and control variables subject to mixed control–state constraints, Optimal Control Applications and Methods, 30(4), 2009, 341–365.
[4] M. El Baroudi, H. Laarabi, S. Zouhri, M. Rachik, A. Abta, Stochastic optimal control model: mask wearing and active screening/testing, Journal of Applied Mathematics and Computing, 70(6), 2024, 6411–6441.
[5] C. Balsa, I. Lopes, T. Guarda, J. Rufino, Computational simulation of an SEIR stochastic epidemic model, Computational and Mathematical Organization Theory, 29, 2023, 507–525.